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Basement Rocks of Texas and Southeast New Mexico

PETER T. FLAWN

BUREAU OF ECONOMIC GEOLOGY

THE UNIVERSITY OF TEXAS, AUSTIN

JOHN T. LONSDALE, *Director*

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Errata in Publication 5605

The Yoakum County wells, Fikes & Murchison #17-C Elliott (page 100, Yoakum-2) and Stanolind #1 Argo (page 100, Yoakum-3), have been transposed on the map, Plate 1. Correction of this error changes the contours on the basement surface in this area and shifts the basement high now shown in the north-central part of Yoakum County to the south-central part of the county.

Please Correct Your Copy

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

SAM HOUSTON

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

MIRABEAU B. LAMAR

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Basement Rocks of Texas and Southeast New Mexico

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ABSTRACT

Introduction.—This publication describes the geology of the Precambrian basement rocks of Texas and southeast New Mexico as determined by a study of well cores and cuttings generously furnished by oil companies operating in the area. Data gathered in the subsurface study are integrated with published data on exposed basement rocks. Table 1 lists 760 wells that penetrate basement in the area of study. Following a discussion of previous work, individual contributions to the project are acknowledged and methods of collection, treatment, and presentation of data are explained. The section is concluded by a discussion of petrographic and structural nomenclature and concepts.

Lithology and structure of the Precambrian basement.—Seven major lithologic and lithologic-structural divisions can be recognized in the Precambrian rocks of the Texas—southeast New Mexico area. They are named as follows: (1) Texas craton, (2) Van Horn mobile belt, (3) Red River mobile belt. (4) Fisher metasedimentary terrane, (5) Panhandle volcanic terrane, (6) Swisher gabbroic terrane, and (7) Wichita igneous province (Pl. I).

Texas craton.—The most fundamental basement element is the Texas craton. It is a northwesterly elongated stable or cratonic mass composed mostly of plutonic igneous rocks of granitic or granodioritic composition; locally there are patches of dioritic and gabbroic rocks and of metamorphosed sedimentary and igneous rocks. Cataclastically altered rocks are developed (1) in a linear zone in southwestern Roosevelt County, New Mexico, (2) along the eastern edge of the Central Basin Platform in Andrews and Ector counties, and (3) along the southern margin of the Fort Stockton high in Pecos County. Petrographically, the Texas craton is distinguished by its great volume of granitic rocks. On the southeast the craton is delimited by the younger Ouachita foldbelt and Balcones fault zone which have developed peripherally to it; on the north and west it passes out of the area of study and is partly concealed by the Panhandle volcanic terrane and complicated by younger intrusions of the Wichita igneous province; in the far southwest it is bordered by the Van Horn mobile belt which eastwardly, through unknown geologic relationships, gives way to the younger Ouachita foldbelt; on the north and northeast the picture is vague, apparently the northern boundary is the Red River mobile belt. To the far west in New Mexico, metasedimentary rocks of varied grade and volcanic rocks indicate the approximate position of the cratonic margin, but poor control makes it difficult to establish a logical picture.

Part of the Texas craton is exposed in the Llano uplift of central Texas where ancient metasedimentary rocks are intruded by granites of several ages. Evidence from this exposure and from gravity maps indicates that the southeastward part of the craton has a greater volume of metasedimentary rocks than the northwestern part, which is apparently composed almost entirely of plutonic rocks. Metamorphism increases from northwest to southeast within the uplift. The gravity picture in the area of the Llano uplift is characterized by irregular or amoeboid anomalies that reflect the complex of granite and intruded metamorphic rocks; this picture changes northward and westward

to a more regular pattern, although perhaps this is in part due to the masking effects of the thickening sedimentary cover.

A lead-uranium age determination on uraninite from a young intrusive pegmatite phase of the granite exposed in the eastern Llano uplift gives an age of 1,100 million years (Holmes, 1931, pp. 330–334, 351); this is checked by a magnetite-helium age determination on the Iron Mountain magnetite mass which has been dated as 1,050 million years (Hurley and Goodman, 1943, p. 321). Recent zircon age determinations on the granites of the western and central Llano uplift range from 874 to 942 million years. Zircon age determinations on granite cored in wells in Schleicher and Pecos counties give 1,000 and 910 million years respectively.

Van Horn mobile belt.—The concept of a Precambrian mobile belt southwest of the craton in west Texas is based chiefly on the Precambrian rocks that crop out in Culberson and Hudspeth counties in the Van Horn area. The Van Horn rocks have been described in detail by King and Flawn (1953). They consist of a metamorphosed sedimentary section, largely quartzofeldspathic, about 20,000 feet thick intruded by rhyolite and diorite, also metamorphosed, and thrust northward over a thick sequence of limestone, volcanic rocks, and sandstone that has suffered extreme deformation along a linear zone that is probably congruent with the cratonic margin. The nature of the original sediments, their thickness, and the character of the deformation, all suggest a deformed geosyncline or a mobile belt. Stratigraphically, the culminating orogeny in this area is post-Hazel formation and pre-Van Horn sandstone, or very probably late Precambrian.

Red River mobile belt.—The Red River mobile belt is an east-west-trending subsurface belt of metasedimentary, metaigneous, and igneous rocks which can be traced from Cooke County west to Floyd and Crosby counties and probably extends farther in both directions. Many of the basement wells in this area are localized in rather closely spaced groups on the structurally high Muenster and Electra elements of the Red River uplift—a late Paleozoic structural feature probably controlled by the older late Precambrian mobile belt—and boundaries are difficult to fix.

From Denton and Cooke counties west to Foard County the belt is marked by a predominance of metasedimentary types ranging from medium to high metamorphic grade in the east, where intrusions in the mobile belt are abundant, to lower metamorphic grade in the western part of the area. The western limit presents a problem. Probably the belt continues westward into Cottle and Motley counties and terminates in northern Crosby County, because metasedimentary rocks have been encountered in that area along the strike of the mobile belt. The uncertainty arises because another metasedimentary belt, the Fisher metasedimentary terrane, trends about north-south in the same area and is separated from the metasedimentary rocks of the Red River belt in Motley and Cottle counties by a narrow band of granite. If the course of the Red River mobile belt is projected still farther westward it corresponds with the trend of the younger Matador structures. The Precambrian rocks of the mobile belt as projected lie beneath the rhyolite flows of the Panhandle volcanic terrane.

Fisher metasedimentary terrane.—The Fisher metasedimentary terrane is named for Fisher County, Texas, where, in the subsurface, it is well developed. Metasedimentary rocks have been encountered beneath Cambrian and younger strata in a wide arcuate area extending from northeast Nolan County north to Dickens County and including parts of Scurry, Jones, Stonewall, Fisher, and Kent counties. On the south in Nolan and Fisher counties these rocks are mostly recrystallized quartzofeldspathic sediments and biotite schist, although a metamorphosed dolomite in Scurry County and a rhyolite in Jones County are probably part of the same terrane. Northward in Dickens

County the rocks are lower metamorphic grade and consist mostly of weakly metamorphosed arkose and phyllite very similar to rocks adjacent on the north in the Red River mobile belt. Some evidence indicates that the metasedimentary rocks of the Fisher terrane are a northward subsurface extension of the metasedimentary rocks exposed in the Llano uplift.

Panhandle volcanic terrane.—In the Panhandle and south plains of Texas and parts of Roosevelt, Lea, and Chaves counties of New Mexico, an extensive area is underlain by volcanic rocks. The rocks are composed chiefly of undeformed and unmetamorphosed flows of rhyolite porphyry, with less amounts of rhyolite tuff and rhyodacite, latite, and andesite flows. The extrusive nature of the bulk of these rocks is indicated by associated tuffs, flowage structures, spherulites, and relict perlitic and crystallitic structures, although it is not unreasonable to expect shallow intrusives in association with such an extensive lava terrane. Locally associated with the volcanic rocks are dolomite and argillaceous siltstone. Seemingly these sedimentary rocks are intercalated in and rest on the volcanic sequence and represent sedimentary accumulations during quiescent periods in the volcanic cycle and thereafter.

Swisher gabbroic terrane.—The basement rock in northeastern Roosevelt County, New Mexico, and Castro, northern Lamb, Swisher, northern Hale, western Floyd, Briscoe, and western Donley counties, Texas, is mostly gabbro and diabase with subordinate related diorite. These mafic rocks comprise the Precambrian surface in the greater part of the area that lies between two separated parts of the Panhandle volcanic terrane, and in some wells they are overlain by Cambrian or Ordovician rocks. Similar gabbro and diabase in the form of sills have been penetrated in the surrounding volcanic terrane. In some wells these gabbro sills in the volcanic sequence can be seen to have intruded and metamorphosed the sedimentary rocks intercalated with and overlying the volcanic rocks. Likewise, wells in the gabbroic terrane proper that did not encounter volcanic rocks also penetrate contact metamorphosed sedimentary rocks.

The gabbro terrane does not form a conspicuous high on the gravity map, and probably it is composed of a series of sheet-like intrusions instead of a deep-rooted mass. The fact that some wells in the volcanic terrane penetrate interlayered gabbroic rocks and contact metamorphosed sedimentary rocks before encountering rhyolite porphyry, and some wells in the gabbroic terrane penetrate similar gabbroic-contact metasedimentary sequences without encountering volcanic rocks, suggests that perhaps this gabbroic terrane is, at least in some areas, no more than a thin skin overlying the volcanic rocks which continue beneath.

Wichita igneous province.—Zircon age determinations on one of the youngest granite series in the Wichita Mountains of southwestern Oklahoma show a late Precambrian age of 670 million years (Larsen et al., 1949). These Wichita Mountain igneous rocks and igneous rocks in the buried Amarillo Mountains of the Texas Panhandle are grouped together as the Wichita igneous province. The Wichita Mountains consist of a complex of granite and gabbro intrusions; in the buried Amarillo Mountains the rocks are mostly granite. In both areas the granites are commonly micrographic.

Age relations.—The oldest unit is the Texas craton whose granites are dated at about 1,000 million years in the Llano uplift. The flanking Van Horn and Red River belts are younger features probably of late Precambrian age. Rocks of the Panhandle volcanic terrane, Swisher gabbroic terrane, and Wichita igneous province are the youngest Precambrian rocks in the area and may be part of the same igneous cycle. Age of the Fisher terrane is uncertain; it may be part of the craton and composed of relatively ancient rocks, or it may be a younger metasedimentary belt developed within the craton.

Conclusion.—Concluding sections deal (1) with the configuration of the basement surface, Precambrian relief, the history of Paleozoic sedimentation on the basement surface, and basement fault zones; (2) problems of the Ouachita foldbelt; (3) post-Precambrian igneous rocks encountered in wells; and (4) reflection of basement divisions in the regional gravity picture.

Major lithologic-structural divisions of the basement in general agree well with regional gravity trends. The margin of the craton and the Van Horn and Red River belts are clearly shown; rootless stratiform terranes are not separately reflected. Gravity anomalies associated with the major Paleozoic structures cut across the older Precambrian trends.

The final section is concerned with the Precambrian history of the region, correlation, subdivisions of Precambrian time, and theories of continental origin. It is suggested that the Texas craton was an independent continental nucleus during middle Precambrian time and subsequently became a part of the larger Paleozoic North American continent by growth through development of flanking orogens during late Precambrian time.

Appendixes.—Appendix I is a glossary of petrographic terms used in this paper; Appendix II presents abbreviated petrographic reports on all well samples studied in the course of the project and shows where the thin-sectioned material can be located; Appendix III is a report on magnetic susceptibility work done during the study, the results of which were largely negative.

INTRODUCTION

Purpose and scope of the investigation.— An investigation of basement rocks in Texas and southeast New Mexico was begun in the spring of 1951, following completion of a study of exposed Precambrian rocks in the Van Horn area of west Texas. Originally the project was intended to be phase three of a three-part program of study of Precambrian rocks of west Texas consisting of (1) investigation of Precambrian rocks of the Van Horn area, (2) investigation of Precambrian rocks in the Franklin Mountains, and (3) investigation of Precambrian rocks encountered in wells in the west Texas—southeast New Mexico area. The results of the first phase of the project have been recently published (King and Flawn, 1953); the second phase of the project was temporarily postponed because of extensive military activity in the Franklin Mountains; the third phase of the project was expanded to include all of Texas where subsurface Precambrian rocks have been penetrated by wells; the results are presented herein.

In the area of this study the term basement has been used to refer both to rocks whose Precambrian age is demonstrated by overlying lower Paleozoic sedimentary rocks (Panhandle, southeast New Mexico, west Texas, north-central Texas) and to igneous and metamorphic rocks whose age cannot be determined by stratigraphic methods (south-central and southwest Texas). In the latter areas crystalline rocks are overlain by Mesozoic rocks. Thus, in an unrestricted sense the term basement refers to those igneous and metamorphic rocks on which younger sedimentary sequences are laid. In the Panhandle, southeast New Mexico, west Texas, and north-central Texas, basement is synonymous with Precambrian; in south-central and southwest Texas basement rocks are probably composed of metamorphosed Paleozoic rocks. Because there is a possibility that the latter are locally thrust over unmetamorphosed Paleozoic rocks, it may be that they cannot properly be considered as basement and that in the Texas area the term should be restricted to Precambrian rocks.

The study of Precambrian basement rocks in Texas and southeast New Mexico was initiated after conference with a number of major oil companies in hopes that a comprehensive investigation of these rocks would aid in structural interpretations and would be of value in geophysical prospecting in this region, which is so important in oil production. The area studied includes central, north, and west Texas and nine counties in southeastern New Mexico. The writer undertook this study with the belief that it would be worthwhile to assemble and integrate data on basement rocks even if they were insufficient to draw pertinent geologic conclusions. For it is only in this way that information can be preserved for future workers who might some day approach the same problem with twice this number of wells for control. It has been especially gratifying and fascinating to see major geologic trends develop and to integrate these trends to compose a logical picture of the hidden foundation below the much-studied sedimentary sections. Many of the conclusions drawn in this paper are tentative and admittedly based on scanty evidence; no doubt they will have to be revised or even abandoned as more wells penetrate the basement.

Previous work.—No modern published work is devoted to the general problems of basement rocks in this area. Information on basement rocks from wells drilled in Texas before 1932 was compiled by Sellards (1933, pp. 44–53, 127–140). Patton (1945a, 1945b) published descriptions of basement rocks from several wells in west Texas. Roth (1949) briefly discussed the basement in his paper on the paleogeology of the Texas

Panhandle and included a map showing basement lithology. Moss (1936) discussed the major features of the area in his general description of the buried Precambrian surface in the United States. Basement rocks are mentioned in papers on various oil fields.

A number of authors have made reference to the Precambrian structures in certain areas of Texas and the control that they have exerted on later structures. At an early date Ver Wiebe (1930) discussed Precambrian trends in north Texas and the Panhandle. Moss (1936, p. 949) mentioned that the west-northwest trend of the Wichita geosyncline was inherited from the Precambrian, and this is in accord with the concept of the subsurface Precambrian Red River mobile belt developed in this paper. Rettger (1932, pp. 486–490) outlined his concept of the "grain of Texas" as interpreted from magnetic anomaly maps and the structures shown in exposed Precambrian rocks. Cheney and Goss (1952, p. 2237) discussed two main structural trends in the rocks of the Llano uplift; a main northwest trend and an intersecting north to north-northeast trend. Adams (1954) has given the name "Texas Peninsula" to a mid-Paleozoic positive feature whose axis more or less coincides with the axis of the Texas craton and which seems to be the result of an upwarping of the craton along its axis; he called the structure the Texas arch. Cheney and Goss (1952, pp. 2262) referred earlier to the southeast part of this feature as the Concho arch and called the northwest-trending basement nose the Concho platform.

It is interesting to note how geologists in years past, working with relatively few subsurface data, were able to develop cogent hypotheses which have strengthened with time. Moss' recognition of the Precambrian ancestor of the later Wichita structure illustrates this, and his penetrating analysis deserves recognition.

The only previous petrographic studies of subsurface basement rocks of particular areas known to the writer are (1) the work of Landes (1927) and Walters (1946) on Kansas subsurface Precambrian rocks and (2) May and Hewitt's report (1948, pp. 129–158) on the basement complex of the Sacramento and San Joaquin valleys of California. The writer has published an abstract (Flawn, 1953b) and a progress report (1954) on the Texas basement problem.

The bulk of the information on the basement is unpublished data in the files of various oil companies. Many companies maintain a basement contour map, and some have kept a file of petrographic descriptions of basement rocks. Mr. Robert Roth, of the Wichita Falls office of the Humble Oil & Refining Company, has a very complete collection of polished core sections and thin sections of basement rocks encountered in wells in the Panhandle and north-central Texas area. The U. S. Geological Survey has considerable data on basement rocks in its Washington, D. C., and Roswell, New Mexico offices. Without exception these unpublished data were made available to the writer, who has leaned heavily upon them.

Acknowledgments.—This project would have been impossible without the cooperation of individuals, companies, and government agencies concerned with the production of petroleum. The foundation of the study is the collection of all available basement cores, cuttings, and thin sections, and this would not have been possible without the wholehearted cooperation of the individuals and organizations operating in Texas and southeast New Mexico.

The following organizations and individuals contributed materially to the success of this research. They are listed alphabetically by organization; the individuals concerned are listed under the organization they represented at the time of their contribution to the project:

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- B. H. Harlton
- B. W. Kleihege
- J. A. Veeder

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S. L. Smith

Brown Geophysical Company
Hart Brown

Cities Service Oil Company
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C. D. Vertrees

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Gulf Oil Corporation
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The Texas Company
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S. C. Giesey
The University of Texas
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T. F. Stipp

The writer was assisted in the magnetic susceptibility work by W. R. Varnell, a graduate student in physics at The University of Texas and formerly a member of the staff of The Texas Company. His careful work on this phase of the problem is gratefully acknowledged. Special thanks are due John T. Lonsdale, Philip B. King, Raymond D. Woods, and Peter H. Masson for critically reading the manuscript.

Collection, treatment, and presentation of data.—The first task was compilation of a comprehensive list of all wells penetrating basement in the area of study. This was achieved by combing the literature, particularly the annual review issue of the Bulletin of the American Association of Petroleum Geologists, by consulting the oil pages of back issues of newspapers, in particular the San Angelo Standard-Times, and by utilizing the files of a number of oil companies. Mr. T. F. Stipp, of the U. S. Geological Survey's Roswell, New Mexico, office, deserves special mention by reason of his generous contribution of tabulations of basement wells which he has kept up to date over a period of years. A preliminary list of basement wells was mimeographed and circulated with a request for corrections and additions.

Following compilation of the master list, the writer visited district offices, division offices, and research laboratories of a number of oil companies and service companies, discussed the project with geologists and administrative officials, and acquainted them of his need for basement cores and cuttings. The response was positive and immediate, and without exception these organizations were willing to devote the time and effort needed to obtain the necessary material. Needless to say, it was not possible to obtain samples from all the basement wells in the area. Records and samples from old shallow wells, mostly drilled before 1932, in the Panhandle, around the Llano uplift, and in north Texas are difficult to locate and, indeed, in many cases no longer exist. The amount of material available ranged from sizable cores through small core chips and cuttings to thin sections only. The only record of the basement encountered in some wells is preserved in the thin-section collections of certain oil companies. The Midland office of the Shell Oil Company, the Stanolind Oil & Gas Company's research laboratory at Tulsa, the Humble Oil & Refining Company's Houston research laboratory and Wichita Falls office, and the Midland office of the Honolulu Oil Corporation were kind enough to loan their collections of thin sections and thus made available data on many wells for which no sample material was located.

Information on individual basement wells is presented in Table 1, which was compiled from the files of a number of oil companies. Some of the information received was conflicting, and although every effort was made to resolve the conflict, it could not always be done. Where there were differences in the basic well information, such as location, completion date, elevation, or total depth, information in the records of the Texas Railroad Commission was considered final. Where differences were due to geologic interpretation in matters of depth to top of basement or age of formation overlying basement, the solution was not as easy, even with the fullest assistance of company geologists.

Petrographic descriptions of thin sections from each well studied are presented in abbreviated form in Appendix II. Basement wells, elevation of basement, formations resting on basement, basement rock types, and major geologic divisions of the basement, are shown on Plate I. In areas where control from basement wells is adequate, contours are drawn on top of the basement and are intended to outline the major topographic and structural features of the known basement. They are not extended into areas where the basement has not been penetrated, and where some other so-called basement maps show contours extrapolated downward from known sedimentary horizons. Plate II shows schematic cross-sections of the basement along lines located on Plate I; Plate III is composed of enlargements of the Central Basin Platform, Fort Stockton high, and Muenster uplift areas from Plate I.

Probably more than 800 wells (excluding Ouachita foldbelt wells) have penetrated basement rocks in Texas and southeast New Mexico; data for 760 of these are listed in Table 1. Many new basement wells have been drilled since the preparation of this manuscript. Cores, cuttings, or thin sections were obtained for 488 basement wells; 251 thin sections from 201 cored basement wells and 485 thin sections of basement cuttings from cored and uncored wells were studied. Pertinent specimens were photomicrographed (Pls. IV to X). At first glance it would appear that it was possible to collect material for only a small percentage of known basement wells; however, a distribution factor must be considered. A large number of wells are crowded closely together in fields. For example, there are more than 200 basement wells in the Brunson area, 23 basement wells in the Keystone field, 9 basement wells in the Embar field. If enough basement material from various field wells was available to give a representative picture of the basement in that locality, no special effort was made to get complete collections; on the other hand, very special efforts were made to obtain basement samples from the sparsely distributed wildcat wells between areas of more complete coverage.

At the outset of the project, magnetic susceptibility and specific gravity determinations were made on suitable material received. After about 100 such determinations were made, the practice was discontinued for the following reasons: (1) of the total basement material received (cores, cuttings, and thin sections) satisfactory magnetic susceptibility determinations were restricted to core samples—only a few samples of cuttings were usable; (2) wide variations in susceptibility of samples of similar rock types and in samples from the same well show that these measurements have little geologic significance unless sampling can be closely controlled, and in this study we are forced to deal with random well samples. The results of the susceptibility work are in Appendix III. An abstract of these results has been published (Flawn, 1953c, pp. 55–58). The magnetic susceptibility research was made possible by the cooperation of Frost Geophysical Corporation and Frost Airborne Surveys, Inc., of Tulsa, Oklahoma. A magnetic susceptibility bridge designed and built by this organization was shipped to Austin for the work.

In assimilating and processing the data in this study, the writer was concerned with the petrography, structure, and topography of the basement, and the regional gravity picture—elements of all of these topics are included in the paper. Unfortunately no regional magnetic coverage was available for the study.

Petrographic Methods

Petrographic nomenclature.—Throughout this report an attempt is made to use a standard and simplified petrographic terminology. It is anticipated that this publication will be of interest to petroleum geologists not familiar with all of the textural terms used by petrographers, and a short glossary of petrographic terms is included to simplify reading (Appendix I).

Rocks of unusual mineral composition which have been given geographic petrographic names are here reduced to common petrographic names and their unusual mineral composition is indicated by appropriate prefixes. Leeuwfonteinite, a biotite-hornblende syenite whose principal feldspar is anorthoclase, can be cited as an extreme example of a rock laboring beneath a geographic name that completely conceals its nature. In this report this rock would be called a *biotite-hornblende - anorthoclase syenite.* This term may seem more unwieldy than *leeuwfonteinite*, but it is not as unwieldy as a petrographic dictionary. Some may point out that *syenite* itself is a geographic name, but from a practical point of view, the mineralogy of syenite is well known by most geologists.

The igneous rock nomenclature used in this paper is shown in Table 2, which should be used in conjunction with the glossary (Appendix I). This system combines elements of both the Niggli and Johannsen classifications (Niggli, 1931, pp. 296–364; Johannsen, 1939, pp. 141–162). In the writer's opinion, most of the igneous rocks can, with appropriate mineral modifiers, be named with these common terms.

Much of the confusion that exists today in the use of these common terms arises from a disagreement over the treatment of the mineral albite. Albite, the sodic end-member of the plagioclase series, is chemically and physically an alkali feldspar which, in petrogenic analysis, is associated with potassium feldspars. Mineralogically, however, albite occurs perthitically intergrown with potassium feldspar and as a separate mineral constituent. It seems desirable in classification to recognize the separately-occurring albite as plagioclase. For example, the feldspar of classic granite is composed of predominant potassium feldspar and subordinate oligoclase or andesine plagioclase; commonly the potassium feldspar is a perthite and contains albite. If, on the other hand, the oligoclase or andesine plagioclase is the predominant feldspar, the rock is a granodiorite. If the accompanying plagioclase is albite instead of oligoclase or andesine, there are two alternatives: (1) lump the albite with potassium feldspar and call both rocks granite, perhaps distinguishing the one as albite granite, or (2) consider the rock in which albite predominates as a special variety of granodiorite and designate it albite granodiorite. (The albite intergrown with potassium feldspar in the form of perthite or microperthite is considered, for classification purposes, an inseparable part of the alkali feldspar.) The writer, in classification, has adopted the latter system. In organizing myriad petrographic data so as to fit nature's continuous systems into pigeonholes, this has proven superior in expressing significant differences in mineral composition. The same problem, of course, arises with the quartz-free analogs of granite and granodiorite—syenite and diorite. If albite is separated from the potassium feldspars, an albite-rich syenite is an albite diorite (see Table 2). Moreover, gradational varieties such as albite-oligoclase present less of a problem if albite is grouped with the plagioclase.

Many of the rocks called *micrographic granite* in this paper are called *granophyres* by other petrographers. In this paper micrographic granite refers to granitic rocks distinguished by a more or less regular intergrowth of quartz and alkali feldspar too fine-grained for recognition without magnification. For its coarser counterpart the name graphic granite has long been employed. The term granophyre has suffered a varied and conflicting usage through the years, but the modern tendency is to use it to include granitic rocks showing regular or cuneiform intergrowth and/or irregular intergrowth and/or myrmekitic intergrowth of quartz and alkali feldspar (see glossary, Appendix I). The term has become a sort of catch-all name for granitic rocks with a microscopic quartz-alkali feldspar intergrowth. Because this paper is pri-

TABLE 2. *Nomenclature for common igneous rocks.*

	Quartz > 5% < 50% of the felsic minerals		Quartz < 5% of the felsic minerals	
	Plagioclase < An 50	Plagioclase > An 50	Plagioclase < An 50	Plagioclase > An 50
Plagioclase* < 5% of total feldspar *Fine-grained and/or glassy equivalent*	Alkali-granite (normally < 1/4 ferro-magnesian minerals) *Rhyolite*		Alkali-syenite (normally < 1/4 ferro-magnesian minerals) *Trachyte*	
Plagioclase > 5 < 50% of total feldspar *Fine-grained and/or glassy equivalent*	Granite (normally < 1/4 ferro-magnesian minerals) *Rhyolite*		Syenite (normally 1/8 - 3/8 ferro-magnesian minerals) *Trachyte*	
Plagioclase > 50 < 95% of total feldspar; alkali feldspar* > 5% *Fine-grained and/or glassy equivalent*	Granodiorite (oligoclase or andesine—others named)‡ (normally < 1/4 ferro-magnesian minerals) *Rhyodacite*	Granogabbro (normally 1/4 - 1/2 ferro-magnesian minerals) *Rhyobasalt*	Syenodiorite (oligoclase or andesine—others named)‡ (normally 1/4 - 1/2 ferro-magnesian minerals) *Trachyandesite*	Syenogabbro (normally 3/8 - 5/8 ferro-magnesian minerals) *Trachybasalt*
Plagioclase > 95% of total feldspar; alkali feldspar < 5% *Fine-grained and/or glassy equivalent*	Quartz diorite (oligoclase or andesine—others named)‡ (normally 1/8 - 3/8 ferro-magnesian minerals) *Dacite*	Quartz gabbro (normally 1/4 - 1/2 ferro-magnesian minerals *Quartz basalt*	Diorite (oligoclase or andesine—others named)‡ (normally 1/4 - 1/2 ferro-magnesian minerals) *Andesite*	Gabbro (normally 3/8 - 5/8 ferro-magnesian minerals) *Basalt*

*Albite is grouped with the alkali feldspar where it occurs in perthitic intergrowths; it is grouped with plagioclase where it is a distinct mineral constituent.

‡ If the plagioclase is other than oligoclase or andesine, the variety must be prefixed to the rock name, that is, albite granodiorite.

NOTE: Rock names are prefixed with *micro* where grain size of the rock is between 0.05 and 1.0 mm, that is, microgranite.

Rock names are prefixed with *leuco* to express abnormally low ferromagnesian content and with *mela* to express abnormally high ferromagnesian mineral content.

Fine-grained <1 mm; medium-grained >1<3 mm; coarse-grained >3<5 mm; very coarse-grained >5 mm.

marily for the practicing petroleum geologist rather than the petrographer, the writer has used the term micrographic granite in a broad sense so as to avoid introduction of a rock name not familiar to many geologists; in the rocks studied cuneiform and irregular intergrowths predominate—myrmekitic intergrowths are rare. It is evident from the name micrographic granite that a type of granite is in question; granophyre, on the other hand, does not have this advantage.

Rhyolite porphyry is a very common rock type in parts of the Panhandle, west Texas, and southeast New Mexico basement, and the use of the term deserves special clarification. Rhyolite is defined herein as a glassy and/or microcrystalline igneous rock that is chemically and, except for the possible presence of glass, mineralogically equivalent to granite. Rhyolite porphyry may be an extrusive rock—a lava flow—or an intrusive rock (generally intruded in a shallow or near-surface environment).

The principal mineral constituents of rhyolite and rhyolite porphyry are potassium feldspar and quartz with subordinate sodic plagioclase. A common rock type encountered in the basement contains phenocrysts of albite and/or potassium feldspar in a groundmass that is mostly cryptocrystalline. No quartz phenocrysts are present, but local coarsenings in the groundmass show that an appreciable quartz content is concealed by cryptocrystallinity. Because these rocks are identical with other rocks in the same area in which quartz is present as phenocrysts or in which a more coarsely crystalline groundmass reveals the presence of quartz, they are included as rhyolite porphyry. Probably some of these rocks strictly speaking are trachyandesite or, if one is an advocate of the term monzonite, they are latites. In the same way albite and quartz phenocrysts occur in a groundmass composed almost entirely of alkali feldspar and quartz. This rock is a rhyolite porphyry, but the same rock with a cryptocrystalline groundmass might, on the basis of the phenocrysts alone, be called dacite or rhyodacite.

Metamorphic rock terminology is in poor repair and a general overhaul to put it on a descriptive and quantitative basis is becoming imperative. Some metamorphic rocks are named purely on the basis of mineralogy (amphibolite); others, such as hornfels, are named on the basis of fabric. The most common metamorphic rocks, such as slate, phyllite, schist, and gneiss, are named according to the nature of their foliation or metamorphic structures and their mineralogy.

In practice, in dealing with cuttings of fine-grained weakly metamorphosed argillaceous rocks, it is difficult to classify the rocks on the basis of structure and mineralogy. With the aid of some excellent suggestions from Dr. August Goldstein, Jr., of the Stanolind Oil & Gas Company's Research Laboratory, the writer outlined a classification of weakly metamorphosed argillaceous rocks based on degree of mineral reconstitution, grain size, and structure (Flawn, 1953a). This classification is used in this paper (Table 3) in a slightly modified form. The lower grain size limit for schist has been revised downward from 0.5 mm to 0.1 mm to provide an overlap between the lower grain size limit for schist and the upper limit of phyllite. The term phyllite is customarily applied to a very fine-grained foliate rock whose constituent minerals cannot be resolved without magnification. In a megascopic view the rock has a characteristic silky sheen or luster caused by tiny mica or chlorite plates in parallel orientation. Most of the rocks called phyllite contain sericite, chlorite, or biotite, and the name carries a connotation of low metamorphic grade. However, conditions of metamorphism, in particular stress conditions, may be such as to produce foliate rocks containing higher grade minerals while inhibiting development of coarser grain size. There seems to be no general agreement on whether foliate rocks containing such minerals as amphibole or garnet but with a grain size less than 0.5 mm should be called phyllite or fine-grained schist.

The term meta-argillite is not entirely satisfactory; it is hardly euphonious and incorporates the questionable practice of prefixing an already metamorphic rock name with *meta*. Possibly terms such as low-rank argillite and high-rank argillite are preferable, but the use of the term meta-argillite is continued in this paper.

In this paper a quartz sandstone which has been weakly metamorphosed so that the argillaceous and ferromagnesian intergranular material is reconstituted to micas and chlorite but in which the quartz has not recrystallized is named *meta-sandstone*. For the higher grade rock in which quartz has recrystallized, the term *metaquartzite* is in common usage. When dealing with the related rock—arkose—a nomenclature problem arises. If, by analogy with quartz sandstone, the weakly metamorphosed unrecrystallized rock is called meta-arkose, we are left without an appropriate term for the higher grade recrystallized arkose. Unfortunately in a previous publication the writer used meta-arkose for the higher grade recrystallized arkose rocks in the Van Horn area (King and Flawn, 1953). He is now of the opinion, however, that meta-arkose should be restricted to weakly metamorphosed partly reconstituted and recrystallized arkose and that a new term be proposed for recrystallized arkose equivalent in metamorphic grade to metaquartzite. In this paper the term *metarkosite*[1] is applied to such rocks.

Possibly the writer may be criticized for not dusting off some previously used name for this type of rock and redefining it. *Granulite* is used by Harker (1939, p. 246), although he notes that it is open to objection because of previous varied usage. In the author's opinion metarkosite is preferable to granulite because it expresses in some degree the nature of the rock in question.

The estimated mineral composition of all rocks examined in thin section is included in Appendix II. Readers accustomed to a different classification of rocks than is used herein may make changes in rock names to satisfy themselves. For example, many of the rocks called granodiorite in this classification might be quartz monzonite to geologists favoring a different system of nomenclature.

Evaluation of petrographic data.—Study of rocks from thin section alone is

[1] This term is equivalent to the *arkosite* of Grout (1932, p. 367); the writer prefers metarkosite to indicate more clearly the metamorphic nature of the rock. *Arkosite* seems more or less the same type of group term as *quartzite*, and for many years it has proven necessary to distinguish metaquartzite from orthoquartzite.

TABLE 3. *Nomenclature for metamorphosed argillaceous rocks.*

DEGREE OF RECONSTITUTION	WITHOUT CLEAVAGE OR PARTING	WITH CLEAVAGE OR PARTING	WITH FOLIATION
Unreconstituted	Claystone Grain size‡ <0.01 mm.	Shale Grain size <0.01 mm	
Less than 50 percent reconstituted	Argillite Grain size up to 0.05 mm	Clay-slate Grain size up to 0.05 mm	
More than 50 percent reconstituted	Meta-argillite Grain size up to 0.05 mm	Slate Grain size up to 0.05 mm	
Completely reconstituted	Hornfels Grain size shows wide range		Phyllite Grain size up to 0.5 mm Schist and gneiss* Grain size >0.1 mm

* Conditions of metamorphism may be such as to produce medium or high-grade metamorphic rocks with grain size less than 0.1 mm. Because of their increased metamorphic grade such rocks cannot be called phyllites; they should be termed very fine-grained schist, gneiss, hornfels, et cetera, depending on their metamorphic structure or texture.

‡ Grain size ranges are not strictly limiting.

not a satisfactory procedure because many of the characteristic structures and relations to be seen in the field and in hand specimens cannot be observed under the microscope. But when studying rocks from wells the geologist must accept a limited method of study; it is not possible to observe field relations and, unless a core is available, it is not possible to make an effective megascopic examination. Interpretations of basement lithology in those many wells for which only cuttings are available are, of course, subject to a greater error than interpretations of basement rock in wells that have been cored. The presence of conglomerate or breccia, for example, may be completely unsuspected in wells from which cuttings only are available. Likewise, metamorphic features such as gneissic structure or slaty cleavage; igneous features such as intrusive contacts or flowage structures; and sedimentary features such as cross-bedding or ripple marks are commonly unrecognizable from the study of cuttings alone. In dealing with cuttings the amount of information that can be gleaned depends on the ratio of size of cuttings to grain size of rock. Fine cuttings of coarse-grained rocks may be composed only of individual constituent mineral fragments that give no clue as to the fabric of the rock, whereas large cuttings of fine-grained rocks are representative rock chips. Thus, without opportunity to examine field relations or even cores, the petrographer is handicapped and may have difficulty in classifying rocks that are altered, or without diagnostic texture, or whose texture cannot be determined because of fineness of cuttings. It is understandable that under such circumstances petrographers may differ on a rock name.

Resolution of petrographic data.—There is little value in hundreds of petrographic descriptions of basement well cores or cuttings unless the material can be organized or grouped to yield a picture with geologic significance. Four major rock types can be distinguished among the basement rocks in the west Texas—southeast New Mexico area: metasedimentary rocks, meta-igneous rocks, volcanic rocks (tuffs and lava flows), and plutonic rocks. The last heading includes megascopically crystalline intrusive igneous rocks of various mineralogy with characteristically hypidiomorphic granular fabric such as granites, granodiorites, syenites, quartz diorites, diorites, and gabbros. With the present spacing of wells it is not possible to map the various subtypes of the plutonic terrane except where a distinctive family, such as gabbro-diabase, is penetrated exclusively over a wide area. In the large view, moreover, it is doubtful if such subdivision would be of great geologic significance in a regional study of the basement. Rock classifications set up pigeonholes defined arbitrarily so that the feldspar of a granite, for example, is predominantly potassium feldspar while the feldspar of granodiorite is dominantly plagioclase. In many so-called homogeneous rock masses the relative percentage of these two feldspars varies from place to place so that both granite and granodiorite are present. The same variation commonly takes place in the quartz content so that a rock mass may range in composition from quartz syenite to granite, depending on whether it has 4 percent quartz or 8 percent quartz. The writer has examined core fragments of basement rock taken at close intervals that ranged from granodiorite to quartz diorite to diorite and, presumably, such changes in composition are common within that intrusive body. If it were possible to study such bodies closely it is certain that these changes would be of geologic significance, but when dealing with random well samples such a study is beyond the realm of possibility.

Discussion of Structural Nomenclature and Concepts

A great deal of the credit for the modern concepts of the structure of the earth's crust belongs to Leopold Kober whose classic work *Der Bau der Erde* ranks high in geological literature. Discussing stable versus mobile elements of the earth's crust he says (Kober, 1921, p. 21):

> Die alten erstarrten Tafeln wollen wir hier kurzweg auch als *Kratogen* bezeichnen. Die Orogenetischen Zonen als *Orogen*. Dieser Begriff fällt in gewissem Sinne mit dem der Geosynklinale zusammen.
>
> Dabei müssen wir festhalten, dass das Orogen die ausgepresste Geosynklinale ist, also eine Zone, die viel schmäler ist als die ursprüngliche Geosynklinale. Wir werden später sehen, dass wir das Breitenverhältnis des Orogen zur Geosynklinale mit 1:2—3 setzen dürften, d.h. die Geosynklinale wird durch die grossen Gebirgsbildungen im Orogen auf ½–⅓ der ursprünglichen Breite zusammengepresst.

> The ancient solidified crustal plates we will here, for brevity, refer to as *Kratogen;* the orogenic zones as *Orogen*. This concept coincides in a certain sense with that of the geosyncline.
>
> Here we must continue to bear in mind that the orogen is the compressed or squeezed out geosyncline, that is, a zone which is much narrower than the original geosyncline. We will later see that we may estimate the ratio of widths of the orogen to the geosyncline at 1:2—3, that means the geosyncline is pressed together through the major mountain building in the orogen to ½ to ⅓ of the original width.

Stille (1936, p. 84) suggested that *Kraton* would be a better word form than Kober's *Kratogen,* and from this the English *craton* stems. Kay (1951, pp. 4, 107) defines *craton* as a relatively immobile part of the earth, although large size is also inherent in the term. Epeirogenic movement, tilting, and warping do not impugn the concept of the craton as a stable or immobile block. It is contraposed to the mobile belt (Kober's orogen)—a linear and commonly arcuate prism of rock that at one time in geologic history achieved considerable mobility through the action of orogenic forces. Mobile belts of the geologic past are recognized today as foldbelts, and the record of the mobility of the constituent rocks is read in their folded, thrust-faulted, metamorphosed, and intruded state. As pointed out by Kay (1951, p. 4), stability and mobility are transitory properties. The craton may grow as once mobile areas are welded to it, or it may be divided by new mobile belts forming within the once stable area. The question of how much mobility a craton can achieve without invalidating the principle of stability or how much mobility must be attained before a prism of rocks qualifies as a mobile belt is one of degree.

Recognition of a once mobile zone by a study of well cores and cuttings is an inductive process. Four characteristics are common to the major mobile belts of the past that are exposed to view at the earth's surface: (1) a great thickness of sedimentary rocks, (2) more or less metamorphism and advanced to extreme deformation of the sedimentary rock prism, (3) the presence of intruded meta-igneous and igneous rocks, and (4) a linear or arcuate form. Of these four characteristics only the first—thickness of the sedimentary prism—is not susceptible to demonstration by study of well samples. Oil companies are for the most part reluctant to drill thousands of feet of metamorphic rocks, and only the driller who contracted to "go to granite" is happy drilling a soft mica schist. The microscopic record of the most important feature of the once mobile belt—mobility of the rock prism—can be read in the metamorphic structures of the constituent rocks.

The word *terrane* is used in this paper chiefly because of its lack of genetic implications. It was much used by reconnaissance geologists before the turn of the century when, in investigations of *terra incognita,* its noncommital nature made it particularly apt. It is especially applicable in subsurface studies of Precambrian rocks, which are certainly an unknown territory. The term may be defined as an area of similar rock type.

The Precambrian igneous rocks of the Wichita Mountains and their subsurface extension in the buried Amarillo Mountains of the Texas Panhandle are grouped together as the Wichita igneous *province* because they appear to be related mineralogically and temporally.

Some geologists may be troubled by application of the term "craton" to an area where the basement has subsided deeply in a number of basins, preferring to consider a craton as an upwarped enduringly positive area in the strict sense of a "shield." However, subsidence and development of sedimentary basins within the stable area do not preclude the concept of the craton. Kay (1951, p. 4) says:

> The early Paleozoic craton of North America which had persisting influence on continental development and has close correlation with present structures is an hedreocraton ("steadfast craton") (Kay, 1947), a term introduced to retain a constant reference in discussing prolonged history. Although the hedreocraton was comparatively stable, geosynclines or basins subsiding during deposition formed in many areas at several times. The volume of contained rocks is great, but relatively small compared to that of the rocks in the orthogeosynclines that surround the hedreocraton.

King (1951, p. 3) refers to the continental nucleus, as it exists today as the Central Stable Region:

> This is the *Central Stable Region* of North America, the nucleus of the continent, which has been only mildly deformed since the beginning of Paleozoic time. Within it, Pre-Cambrian basement rocks stand relatively high, forming a wide platform which to the south and west is more or less mantled by Paleozoic and Mesozoic sediments, but to the north and east emerges to form the Laurentian Shield.
>
> In this account, the Central Stable Region will be treated under two headings—the *Laurentian Shield*, or emerged part of the Pre-Cambrian platform, and the Interior Lowlands, where the platform is mantled by Paleozoic and later sediments. The visible structures of the shield are mainly those of Pre-Cambrian rocks, and those of the surrounding lowlands are mainly those of the Paleozoic and Mesozoic cover. Since the beginning of Paleozoic time, the shield has probably been somewhat less mobile than the adjacent lowlands, and it may never have been completely covered by sediments. However, the tectonic differences between the two parts of the stable reregion are those of degree rather than kind, and the boundary between them is determined by retention or removal of the sedimentary cover by accidents of Cenozoic and earlier erosion.

In this paper we are trying to reconstruct structural history throughout a long span of time, and because structural properties such as stability and mobility are transitory features as applied to a particular segment of the earth's crust, a word of nomenclatorial caution is in order. The features shown on Plate I, the Texas craton and various mobile belts, are features of Precambrian time. Their stability and mobility are properties they possessed during a span of time in that era. The mobility of structural zones such as the Van Horn mobile belt and the Red River mobile belt was destroyed by deformation and intrusion in late Precambrian orogenies. The hedreocraton of Kay (1951, p. 4) and the Central Stable Region of King (1951, p. 3), on the other hand, are names applied to the expanded continental nucleus as it existed at the beginning of Paleozoic time. This expanded stable core includes both the stabilized mobile belts of earlier time and the older Precambrian stable areas as well. The Texas craton is a smaller Precambrian craton within the larger Paleozoic craton; the Van Horn and Red River mobile belts are late Precambrian mobile belts but also, without mobility, are part of the Paleozoic craton. The term Texas craton may be properly applied to both an independent Precambrian stable mass and to a geographical division of the Paleozoic craton (or hedreocraton) because of its uninterrupted billion-year history of stability.

LITHOLOGY AND STRUCTURE OF THE PRECAMBRIAN BASEMENT

General remarks.—In the area of Texas and southeast New Mexico that concerns this project, Precambrian rocks crop out in four areas: in west Texas in the Van Horn area, the Pump Station Hills, and the Hueco Mountains (King and Flawn, 1953) and in the Llano uplift of central Texas (Paige, 1910, 1912; Stenzel, 1932; Barnes, 1945; Keppel, 1940; and Goldich, 1941). Northeast of the area of study Precambrian rocks crop out in the Wichita and Arbuckle Mountains of southern Oklahoma (Hoffman, 1930; Taff, 1904; Taylor, 1915; Uhl, 1932); west of the area of study Precambrian rocks are exposed in the Franklin Mountains of Texas (Richardson, 1909) and the Organ Mountains, San Andres Mountains, and Oscura Mountains of south-central New Mexico (Lindgren et al., 1910; Dunham, 1935). Much information that aids in the interpretations of the subsurface Precambrian rocks encountered in the basement wells in the Texas—southeast New Mexico region can be gained from examination of reports on these several areas.

The lithologies of the basement rocks as determined by thin section study were plotted on the base map to determine (1) if any lithologic divisions are recognizable, (2) if there is a correspondence between the lithologic divisions and the major structures in the area, (3) if there is correspondence between the lithologic divisions and regional gravity features. It was found that on the basis of the petrographic study seven major divisions can be distinguished in the basement in the Texas—southeast New Mexico area; that in three areas there is a coincidence of a lithologic division and a major structure; and that the regional gravity picture is strongly influenced by these same three lithologic-structural divisions. The seven lithologic and lithologic-structural divisions are herein named (1) Texas craton, (2) Van Horn mobile belt, (3) Red River mobile belt, (4) Panhandle volcanic terrane, (5) Fisher metasedimentary terrane, (6) Swisher gabbroic terrane, and (7) Wichita igneous province (fig. 1). Names of (5) and (6) are proper names taken from Texas counties in which the particular terrane is well developed.

The fundamental basement element is the Texas craton—a northwesterly elongated mass of plutonic igneous rocks with lesser amounts of meta-igneous rocks and metasedimentary rocks that apparently constitutes a stable cratonic mass. To the southwest the craton is bordered by the highly deformed metasedimentary and meta-igneous rocks of the Van Horn mobile belt which have been thrust northward against the craton. To the northeast, control is poor but there are metasedimentary and intrusive igneous rocks, metamorphosed and unmetamorphosed, that occur in a belt south of and more or less parallel to the younger Wichita structure and are essentially congruent with the Red River uplift; this belt is herein called the Red River mobile belt. In the Panhandle and south plains the plutonic rocks of the craton are overlain by wide stretches of essentially undeformed and unmetamorphosed volcanic rocks, mostly rhyolite porphyry and rhyolite tuff, of the Panhandle volcanic terrane. Extending from Nolan County north through Fisher, Kent, and Dickens counties is a belt of low-grade metasedimentary rocks called the Fisher metasedimentary terrane[2] whose relationship to the craton and to the Red River mobile belt is an enigma. The Swisher gabbroic terrane is located in the south plains in the area of Swisher, Briscoe, Bailey, Lamb, Hale, and Floyd counties. These rocks, gabbros and diabases, occur as an irregular subsurface mass occupying part

[2] In an earlier phase of the basement study, at the time of publication of the progress report (Flawn, 1954), the available well data indicated that the Fisher metasedimentary zone was arcuate in shape and hence the name Fisher metasedimentary arc was adopted. Additional well information shows this feature to have an irregular shape. The term *arc* is abandoned in favor of the more noncommittal *terrane*.

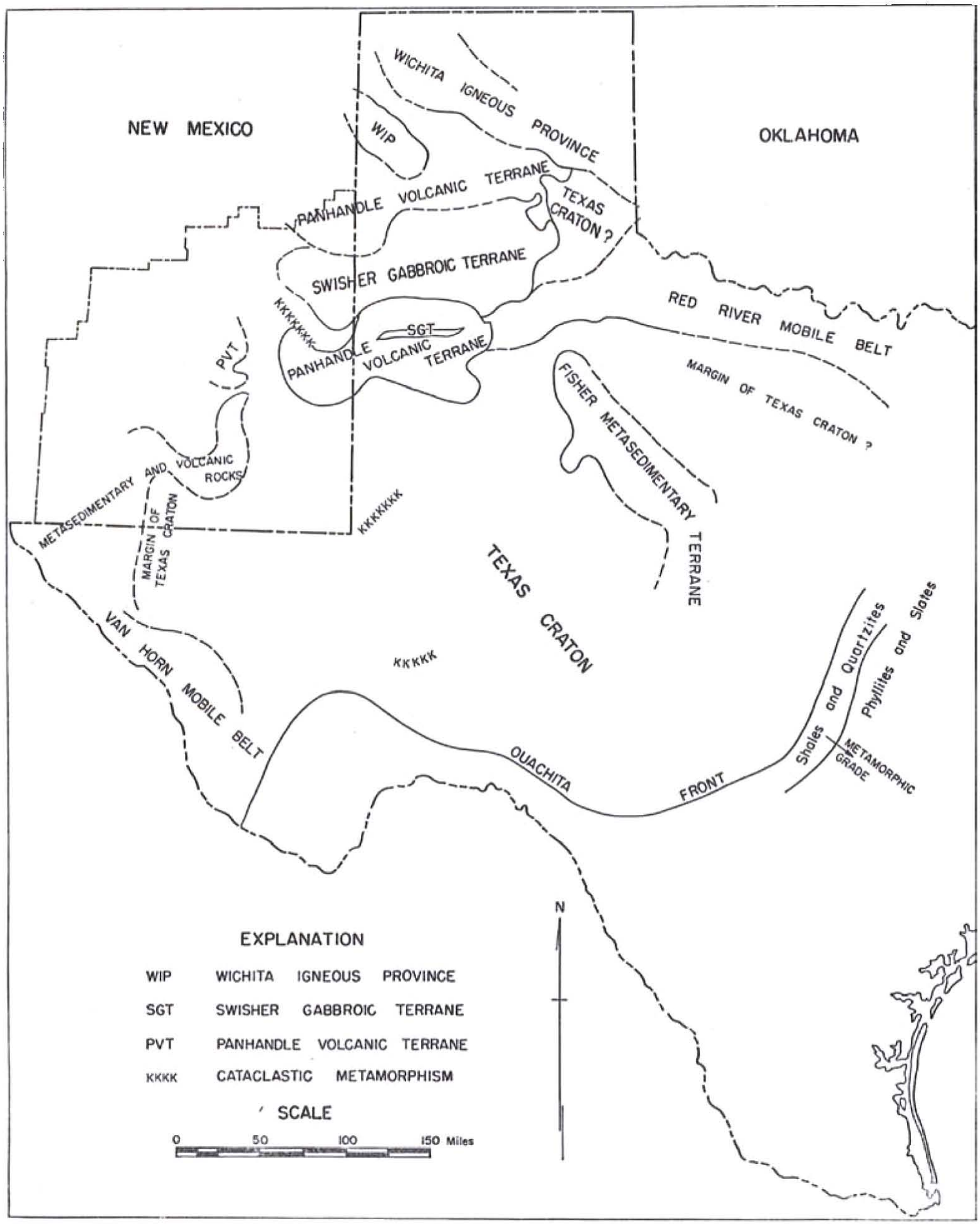

FIG. 1. Index map of basement terranes and provinces.

of the structural low of the Palo Duro basin, as sills in the undeformed late Precambrian volcanic terrane, and as sills intruding and metamorphosing sedimentary rocks of probable late Precambrian age. The Swisher gabbroic terrane is apparently a very late Precambrian feature; possibly it is a large lopolith lying on and intruding the rocks of the Panhandle volcanic terrane along the axis of a major sag or syncline. North of the Red River mobile belt younger Precambrian intrusive igneous rocks crop out in the Wichita Mountains of southern Oklahoma. These rocks are apparently correlative with the subsurface rocks of the Amarillo uplift and they are here grouped together as the Wichita igneous province.

Most of the main structural features familiar to the petroleum geologist in the Texas—southeast New Mexico area are late Paleozoic, Laramide, or Tertiary in age. From this study it appears that major younger structures in several areas are directly related to and controlled by Precambrian elements. First, there is a correspondence between the late Precambrian Red River mobile belt and the later structures of the Red River and Matador uplifts. Possibly the Wichita Mountain structure immediately to the north in Oklahoma is also controlled by this presently ill-defined Precambrian mobile belt. Second, the southeast bulge of the craton in central Texas (marked by the Llano uplift and the Balcones fault zone) seems to have exerted a control over tectonic activity since middle Precambrian time when, with cessation of emplacement of granite batholiths which are in part exposed in the Llano uplift, it became a stable mass. In Paleozoic time it controlled the location of the Ouachita trough or geosyncline which is deflected around it, and it stood as a buttressing foreland against late Paleozoic orogeny during the collapse of the Ouachita geosyncline. The same zone of weakness, the margin of the craton, is responsible for the younger Balcones fault zone and associated igneous activity.

In the Van Horn area the line between the craton and the mobile belt or orogen again appears to have influenced, if not controlled, younger structural trends because the boundary between the more mobile Mexican overthrust province to the south and the stable predominantly basin-and-range structure to the north roughly coincides with the margin of the craton.

Texas Craton

Definition.—The Texas craton needs definition both in space and in time. Geographically, it is a great northwesterly elongated, mostly subsurface, mass of essentially granitic Precambrian plutonic rocks which extends from central Texas into southeastern New Mexico. Its boundaries are marked more precisely by younger geological features (Pl. I). To the southeast the Texas craton is now delimited by the Ouachita foldbelt and the Balcones fault zone which have developed peripherally to it; to the north and west it passes out of the area of study and is partly concealed by the Panhandle volcanic terrane; in the far southwest it is bordered by the Van Horn mobile belt which, eastwardly, through unknown geologic relationships, gives way to the Ouachita foldbelt; to the north and northeast the picture is vague because of poor well control. In north Texas the Red River mobile belt appears to border the craton. To the west, however, an area comprising parts of Hall, Childress, Donley, and Collingsworth counties is composed of rocks of cratonic type, mostly granodiorite, but lies north of the Red River belt, south of the upfaulted rocks of the Wichita igneous province, and east of the volcanic terrane. This is part of a much larger block which to the west constitutes the floor on which the rocks of the Panhandle volcanic terrane were deposited. On the map (Pl. I) this block is labeled "Texas craton?," but there is some doubt in the writer's mind whether the term should include this block between the Red River belt and the Wichita igneous province or whether it should be restricted to the block south of the Red River belt. Throughout this paper the term Texas craton is used in the more extensive, albeit less definitive, sense. The corollary interpretation is that the Red River belt, in its western part, penetrates the stable area. If this Hall-Childress-Donley-Collingsworth County block (and its sub-volcanic extension to the west) is not part of the Texas craton there are two possibilities: (1) it is part of another or independent massif or (2) it is part of the Wichita igneous province. The problem may be resolved when core samples sufficient for absolute age determinations are available.

In time, the existence of the Texas craton dates back about 1 billion years ago when this part of the crust was stabilized by widespread granitic intrusion. It existed as an independent or discrete stable block throughout part of late Precambrian time; by the end of Precambrian time it had lost its position as a separate nucleus and was a part of the larger North American craton.

Llano uplift.—Part of the Texas craton is exposed in the Llano uplift of central Texas where ancient metasedimentary rocks are intruded by granites of several ages. The metasedimentary rocks are divided into two units: (1) Valley Spring gneiss — mostly light-colored pinkish quartzofeldspathic rock and (2) Packsaddle schist—mostly dark-colored mica and amphibole schists, locally graphitic, and amphibolite, with subordinate marble (Paige, 1910, 1912; Barnes, 1945). Very little detailed mapping and petrographic work have been done on these rocks.

Stenzel (1932, 1935) recognized three different granites in the Llano area which, in order of decreasing age, he named Town Mountain granites, Oatman Creek granites, and Sixmile granites. Town Mountain granites make up the bulk of the batholithic intrusions in the area. A lead-uranium age determination on a uraninite sample from the Baringer Hill pegmatite, which cuts the Town Mountain granite, gave an age of 1,100 million years (Holmes, 1931, pp. 330–334, 351). The relationship of the pegmatite to the Oatman Creek and Sixmile granites is open to question; by field relations all are younger than the Town Mountain but they may be differentiates of the Town Mountain.

A magnetite-helium age determination on the magnetite from Iron Mountain, Llano County, Texas, resulted in a figure of 1,050 million years (Hurley and Goodman, 1943, p. 321), a value that corresponds closely to the Baringer Hill pegmatite age determination of 1,100 million years. The geologic significance of the close correspondence of values is not clear. The Iron Mountain magnetite mass is within the Valley Spring gneiss, one of the metasedimentary units in the Llano uplift which is intruded by the Town Mountain granite and which has not been adequately studied. The Valley Spring gneiss is in general very low in iron, and doubtless the Iron Mountain mass is a concentration of iron brought about by some later process. V. E. Barnes (personal communication, 1953) says that he has considered the iron concentration to be the result of processes operating in conjunction with the metamorphism of the Valley Spring gneiss because of the concordant structure of the iron mass and because it is cut by pegmatite and aplite dikes. According to this reasoning the magnetite body should be older than the Baringer Hill pegmatite, but the cross-cutting dikes in the Iron Mountain mass are far from any granite mass and their age and parentage are uncertain. Another possible explanation for the apparently anomalous youthfulness of the Iron Mountain mass (assuming no analytical errors) is that the magnetite recrystallized during the general period of batholithic intrusion of which the Baringer Hill pegmatite was a part. This hypothesis is somewhat weakened in that the only igneous bodies cropping out near the magnetite mass are the cross-cutting pegmatites and aplites, which do not seem to have affected the iron mass to any great degree. Recent zircon age determinations on the granites of the western and central Llano uplift range from 874 to 942 million years, and although these determinations are somewhat younger than the 1,100 million years figure given by Holmes (1931, pp. 330–334, 351), there is reasonably good agreement considering (1) complex geologic relationships involving several periods of granitic intrusion and (2) the limit of accuracy of this relatively new technique of age determination (± 10 percent) [3] (Table 4).

TABLE 4. *Age determinations in the Llano uplift.*

	MILLION YEARS
1. Uraninite from Baringer Hill (Holmes, 1931, pp. 330–334, 351)	1,100
2. Magnetite from Iron Mountain (Hurley and Goodman, 1943, p. 321)	1,050
3. Zircons from Town Mountain and Oatman Creek granites in western and central Llano uplift (unpublished determinations by E. S. Larsen, Jr., U.S. Geological Survey, through the courtesy of R. M. Hutchinson, Kansas State College, personal communication, 1953)	874 to 942
4. Zircons from the Big Branch gneiss in the Blowout quadrangle, western Blanco County (through the courtesy of H. W. Jaffe, U.S. Geological Survey, personal communication, 1955)	910 to 970
5. Zircons from the llanite dike 9 miles north of Llano (through the courtesy of H. W. Jaffe, U.S. Geological Survey, personal communication, 1955)	850

On the basis of these age determinations the batholithic granite exposed in the Llano uplift has an age of about 1,000 million years and the intruded sedimentary rocks are still more ancient.

The gravity picture in the area of the Llano uplift is characterized by irregular or amoeboid anomalies that reflect the complex of granite and intruded metamorphic rocks; this picture changes northward and westward to a more regular pattern, although perhaps this is in part due to the masking effects of the thickening sedimentary cover.

Barnes (personal communication, 1954) has observed a general increase in degree of metamorphism and deformation from northwest to southeast within the Precambrian rocks of the Llano uplift. The Big Branch and Red Mountain gneisses, meta-igneous units showing prominent flowage and sheared structures, are present to the southeast but have no counterpart to the northwest. Sericitic and chloritic members of the Packsaddle schist in the northwest are replaced by amphibolites in the southeast. Garnetiferous rocks are found in the southeastern part of the uplift but are not reported from the northwest area. The Valley Spring gneiss changes from an almost friable rock in the northwest to a very hard siliceous rock in the southeast. Barnes cautions, however, that our lack of knowledge of these rocks precludes long distance correlations and, in the case of the Packsaddle schist for example, the apparently low-grade rocks called Packsaddle schist in the northwestern part of the area may be a separate and younger unit not equivalent to the southeastern Packsaddle schist. Thus the generalization of an increase in metamorphism and deformation from northwest to southeast must be made with reservations. If the generalization stands, however, it is evidence from the rocks themselves to support the concept that the southeast bulge of the craton was the foreland mass against which the forces of the late Paleozoic orogeny, and perhaps similar late Precambrian forces, were concentrated.

Petrographic character of the subsurface Texas craton.—Inspection of Plate I shows that in the vast area from central Texas northwestward into southeast New Mexico most basement wells penetrate igneous rocks—essentially plutonic rocks. There are minor occurrences of metamorphic rocks of sedimentary origin that apparently have been invaded by these plutonic rocks and, locally, the plutonic rocks are gneissic either through cataclastic metamorphism or primary flowage. But the great volume of plutonic rock is composed of granite and granodiorite with subordinate quartz diorite, diorite, syenite, gabbro, and diabase. Petrographically the Texas craton is distinguished by its great volume of granite and granodiorite; vast granitic terrancs exposed in shield or cratonic areas in various parts of the world may be comparable, but modern close scrutiny of the exposed shields reveals a complexity of detail that cannot be observed in a subsurface study.

Some idea of the great preponderance of granite and granodiorite in the craton can be gained from Table 5. These figures are, of course, an approximation based on

[3] Advance information on new zircon age determinations by E. S. Larsen, Jr., of the U. S. Geological Survey, through the courtesy of R. M. Hutchinson, Kansas State College (letter, December 2, 1953).

the almost 300 wells penetrating the cratonic area. The erratic distribution of wells in the area of study results in certain statistical inaccuracies. The high concentration of granite and granodiorite wells in the Brunson and Winkler areas of the Central Basin Platform is partly responsible for the high granite-granodiorite percentages. Close spacing of wells reaching basement in these local areas leads to overemphasis of the importance of the rock type of these areas in the over-all picture. However, even if the Brunson and Winkler areas are discounted, granite-granodiorite is still the predominant rock type of the craton where known elsewhere. Because of the meager control in large areas and the large number of variables not susceptible to evaluation, no attempt is made to develop a statistically accurate picture of the composition of the craton by weighing the rock type with respect to a calculated area.

TABLE 5. *Composition of the Texas craton.*

	PERCENT
Granite	50
Granodiorite	20
Quartz diorite	8
Diorite	5
Syenite and syenodiorite	4
Gabbro and diabase	3
Meta-igneous rocks (mostly granite, granodiorite and quartz diorite gneiss, in that order)	7
Metasedimentary rocks	3
	100

Well control is not complete enough to provide a basis for subdivision of plutonic rocks into their various families. Control is best in the Brunson area of eastern Lea County and in northern Pecos County, both areas on the Central Basin Platform. In the Brunson area there is a rather monotonous repetition of granite and granodiorite with minor quartz syenite —all relatively fine-grained rocks with a large number falling into the microgranite and microgranodiorite range. There are exceptions; in the Continental Oil Company No. 1 Warren A-29 there is an olivine gabbro and in the Sinclair No. 1 Barton there is an olivine-augite syenite. Both these rocks are distinctly abnormal in this area and may represent later intrusions. The augite-andesine microgranite porphyry encountered in the Magnolia No. 1 Shaw-Federal in southeastern Chaves County also belongs to this anomalous clan.

The notable feature of the basement on the Fort Stockton high in Pecos County is that all the major families of igneous rocks are represented from granite through gabbro but without any apparent systematic distribution. Granite and granodiorite are the most common types.

Some generalizations are in order on the petrographic character of the granite and granodiorite that comprise the bulk of the craton. These rocks are rich in alkali elements and poor in iron and magnesium. The potassium feldspar is mostly microcline microperthite and microperthite. The plagioclase ranges from albite to oligoclase and the more calcic andesine variety is uncommon. Ferromagnesian minerals seldom exceed 5 percent of the rock by volume; the mafic varietal minerals are mostly biotite and its alteration product chlorite.

If albite is grouped with the alkali feldspar in classification many of the rocks here called albite granodiorite become granite. If any chemical-mineralogical qualifiers can be applied to the plutonic rocks of the Texas craton as a group, these rocks are leuco-alkali-granites and granodiorites. There are, of course, exceptions which, because they are conspicuous, prove the rule.

Metasedimentary rocks have been penetrated on the craton in the following areas:

(1) the Embar field in Ector County
(2) the Keystone field in Winkler County
(3) the Brunson area of Lea County
(4) the southern part of the Fort Stockton high in Pecos County
(5) north and west of the exposed Precambrian rocks of the Llano uplift.

In addition, along the western margin of the area, metasedimentary rocks apparently associated with volcanic rocks occur in southwestern Chaves County and northwestern Eddy County. The relationship of these rocks to the craton is not clear; probably they are younger rocks and part of another as yet unrecognized province.

In the Embar area of Ector County the common plutonic rock type is quartz microdiorite, but biotite schist was penetrated in the Phillips No. 15 Embar, metaquartzite was encountered in the Phillips No. 23 Embar, and the Texas No. 6 Cowden went into either a granite or an arkose gneiss. Although the geologic relationships of these rocks cannot be determined from the several random well samples available, it is reasonable to suppose that the metasedimentary rocks have been invaded by the unmetamorphosed quartz diorite. This is the common relationship in shield areas where older and commonly fragmentary metasedimentary terranes are engulfed in a sea of younger plutonic rocks or perhaps exist as ungranitized remnants in a great mass of granitized rocks. The metamorphic rocks are thoroughly recrystallized, and although there is a lack of indicator minerals they are apparently of medium metamorphic grade. In the Keystone area of Winkler County the plutonic basement rock shows little variation from well to well and is granite and granodiorite, locally showing gneissic structure. In one well, however, the Phillips No. 5 Walton, the basement rock is a hornblende-biotite-albite-quartz schist. Again, we can only speculate on the geologic relationships. Thin sections were examined from more than 80 basement wells from the Brunson area of Lea County in southeast New Mexico and all save one are composed of plutonic rocks, the great majority of granite and granodiorite composition. The lone exception is the Gulf No. 1 Amanda in which fragments of micro-granite and biotite-quartz-oligoclase schist occur together in cuttings from the 7,332-foot interval. In the Fort Stockton high area of Pecos County, wells have penetrated a variety of plutonic rocks showing varied degrees of alteration. However, the principal rock type again is granite and granodiorite. The most southerly basement well on this high, Stanolind No. 1 Hinyard Cattle Company, apparently penetrates at least 300 feet of metamorphic rocks including metaquartzite, metarkosite, and amphibolite. The statement is qualified because thin section coverage is spotty.

North and west of the Llano uplift in Kimble, Mason, McCulloch, Lampasas, and Coleman counties wells have encountered amphibolite, graphitic biotite schist, hornblende schist, arkose gneiss, scapolite-diopside gneiss, and diopside marble. In metamorphic grade and in mineralogy these rocks are not dissimilar to the rocks which make up the Packsaddle schist and Valley Spring gneiss in the exposed Precambrian rocks of the Llano uplift. In view of their geographic association with the uplift it is reasonable to consider them as part of the Packsaddle—Valley Spring metasedimentary terrane which was invaded by granites about 1,000 million years ago.

On the western margin of the area of study in southern Chaves, southeastern Lincoln, and northwestern Eddy counties, New Mexico, rocks of probable metasedimentary origin occur in a number of wells but control does not permit establishment of a definite trend. These rocks include metaquartzite in the Humble No. 1 Pearson in Eddy County and the Continental No. 1 Lankford in Chaves County; metarkosite in the Stanolind No. 1 Picacho Unit in Lincoln County; a chlorite phyllite of possibly meta-igneous origin in the Magnolia No. 1 Burro Hills Unit in Eddy County; and a rock of indeterminate nature in the Magnolia No. 1 Black Hills Unit in Chaves County. This rock consists of angular quartz grains and biotite flakes in an essentially cryptocrystalline groundmass and possibly is a variety of argillite. An isolated wildcat in the northwest corner of Debaca County (South Basin No. 1 Good) penetrates epidote-biotite-hornblende schist. These rocks probably are not part of the Texas craton.

In certain basement areas the plutonic rocks of the craton show varied degrees of alteration to gneiss; this is predominantly a cataclastic alteration with gneissic structures produced by crushing and shearing. Locally the gneissic structure is apparently a primary flowage phenomenon, and locally it appears to be the result of recrystallization of the parent rock under conditions of regional metamorphism. This latter type cannot with certainty be distinguished from the more ancient and invaded rocks of the craton. The principal areas of development of metamorphosed plutonic rocks are (1) in a more or less linear northwest-trending zone in southwestern Roosevelt County, (2) in the southern part of the Fort Stockton high in Pecos County, and (3) in an irregular area in western Andrews County, northwestern Ector County (Embar area), and northeastern Winkler County (Keystone area). In the Roosevelt County area mylonitized and cataclastically altered plutonic rocks occur along a zone about 50 miles long. Diorite gneiss in northwestern Crosby County and arkose or granite gneiss in Motley County are apparently related to the Red River mobile belt, although it is not clear whether they are metamorphic rocks of the mobile belt or rocks of the bordering craton metamorphosed during the active period of the mobile belt. On Plate I they are included within the mobile belt.

Metamorphic rocks of indeterminate origin (metasedimentary or meta-igneous) are found in Humble No. 1 Bolt in Kimble County (amphibolite) and in Superior No. 1 McDowell in Runnels County (anthophyllite?-albite hornfels).

Except in the southeastern part of the craton in the area of the Llano uplift, metamorphic rocks have been encountered in relatively few of the basement wells of the Texas craton. It seems likely that if metamorphic rocks were as common in the western part of the craton as they are in the Llano uplift area they would have been more frequently penetrated by basement wells. The distinctive amoeboid gravity pattern that characterizes the metasedimentary and igneous complex of the Llano uplift area is not repeated to the west. It seems clear, therefore, that the southeastern part of the craton contains a greater volume of metasedimentary rocks than the northwestern part which is apparently almost entirely composed of plutonic rocks.

The recently completed Shell and Sinclair No. 1 Purcell in Williamson County is the most southeasterly basement well in the area and is probably close to the southeast edge of the Texas craton. The well is reported to have passed through about 4,000 feet of Pennsylvanian black shales of Ouachita facies? into underlying Ellenburger and Cambrian strata of foreland facies before encountering Precambrian granite gneiss. Apparently this well is near or just within the margin of the old Ouachita trough where early Paleozoic foreland sedimentary rocks lie on Precambrian rocks of the Texas craton.

Age of the Texas craton and relation to other Precambrian terranes.—If the exposed and dated batholithic granites of the Llano uplift are correlative with the great mass of concealed granites and granodiorites to the west, the age of the Texas craton is middle Precambrian or older. Such a correlation is, of course, tenuous and must be regarded with reservations, but there are two factors which tend to substantiate the correlation and the age. The granites exposed in the Llano uplift are petrographically similar to those that are concealed to the northwest. This is worthy of mention but very little weight can be given to correlation on this basis alone. Much more significance lies in the relationships of geological features whose Precambrian age can be demonstrated and which are younger than the craton. In the Panhandle, unmetamorphosed and essentially undeformed lava flows lie upon the plutonic rocks of the craton and are overlain by Cambro-Ordovician sedimentary rocks. These lava flows are late Precambrian rocks and the rocks upon which they lie must be older. The craton was the foreland buttress against which the late Precambrian orogeny in the Van Horn area was spent. This orogeny can be stratigraphically dated as late Precambrian, and it is logical to presume that the foreland of that mobile zone has a greater antiquity. In short, this great granitic block behaved as a stable unit in late Precambrian time.

Very recently two additional zircon age determinations became available through the courtesy of H. W. Jaffe, of the U. S. Geological Survey (personal communication, 1955). The age of the granite cored in the Atlantic Refining Company No. 1 Roberts in Schleicher County was found to be 1,000 million years; granite cored in the Phillips Petroleum Company No. 1-C Puckett in Pecos County yielded an age of 910 million years. These age determinations support correlation of dated granites exposed in the Llano uplift with similar buried granites to the west.

During the waning of Precambrian time much tectonic and igneous activity apparently took place on and around the Texas craton. Much of late Precambrian history can only be surmised, but it is known that the southwestern margin was under powerful compressive forces associated with the deformation of the Van Horn mobile belt and that in the northwestern part igneous extrusions were building up a great pile of tuffs and flows. To the northeast and north was a long belt of sedimentary rocks, the Red River mobile belt, which apparently was metamorphosed in late Precambrian time.

Paleozoic and younger structures of the Texas craton.—With the beginning of Paleozoic time a much more complete record of the tectonic history of the craton can be read in the distribution and nature of the younger sedimentary rocks. Cheney and Goss (1952) summarized the post-Precambrian tectonic history of the southeastern part of the craton. Their contours on the top of the Precambrian (Cheney and Goss, 1952, fig. 9) show the Llano uplift as the exposed part of the northwest elongated Concho arch which they believed is controlled by or at least parallels a Precambrian orogenic trend. They indicated that the Concho arch extends northwest to the Texas Panhandle but has subsided beneath the Permian basin (1952, p. 2262) and cited evidence to indicate its repeated upwarping between early Ordovician and late Pennsylvanian time. Subsequent tilting to the west accentuated the Llano uplift, Bend axis, and Concho platform. The Concho arch is thus the result of a warping of the old stable mass—the Texas craton—and the controlling "Precambrian orogenic trend" is the axis of the craton.

Cheney and Goss also suggested that the San Marcos arch is an extension of the Concho arch—Llano uplift structural axis. This is not easily reconciled with the theory of the Texas craton as developed in this study. If the concept of a stable Texas craton is accepted, the San Marcos arch theory of Cheney and Goss means that a northwest-southeast structural axis within the craton and controlled by a more fundamental Precambrian axis extends beyond the margin of the craton into the flanking Ouachita foldbelt—an entirely different structural province. The nature of the San Marcos arch is not thoroughly understood and its existence as a structural feature is doubted by Weaver (1951).

J. E. Adams (1954) has called attention to the existence of a feature he has called the Texas Peninsula. The axis of this feature extends from New Mexico southeastward through the Llano uplift. Analysis of the sedimentary section shows that at the close of Ordovican time an arch (the Texas arch) developed along this axis which effectively separated the west Texas basin from the Oklahoma basin, and its continued rise is shown by the pinch-out of the Siluro-Devonian section against it on both the northeast and southeast sides. At the end of Devonian time this feature ceased to rise and it is covered by Mississippian strata. The Texas Peninsula and the Concho arch are apparently related features. The axis of this backbone corresponds with that of the Texas craton described in this paper and results from mid-Paleozoic arching of the craton along its axis; the two features are congruent, and the Paleozoic arch is a later structure controlled by the axis of the craton.

Westward, the craton was depressed during Paleozoic time to form the west Texas basin (King, 1951, p. 58). This basin was fragmented by the northwest-trending features of the late Pennsylvanian orogeny which formed the Diablo Platform, Central Basin Platform, Midland basin, and Delaware basin (fig. 2). Possibly these structures have an ultimate control in previously established basement trends because their general northwest strike is characteristic of the craton in its shallower and exposed portions to the east (Cheney and Goss, 1952, p. 2262) and parallels the long axis of the craton.

The influence of the southern bulge or cusp of the Texas craton on subsequent geologic events is strikingly shown on the geologic map of the State (Darton et al., 1937), where the outcrop belts of Upper Cretaceous and younger formations sweep around it in broad curves. This outcrop pattern is the direct result of post-Cretaceous movements on the Balcones fault zone and erosion but the fundamental control is the southeast bulge of the craton. This was the foreland mass against which the forces of the late Paleozoic orogeny were dissipated, and there may have been similar late Precambrian forces acting at the same point.

The concept of the buttress nature of the Llano uplift is not new and has been discussed for many years. It was concisely stated by Van der Gracht (1931, p. 1051):

> In south-central Texas the Ouachita Front swings around the foreland buttress of the Llano-Burnet uplift, a massif of pre-Cambrian basement rocks, showing old pre-Carboniferous northwest-southeast axes, *a trend which is maintained in the* Concho Divide farther northwest.

and (p. 1052):

> . . . This important massif, which acted as a sufficiently resistant buttress to deflect the entire course of the Ouachita chains, seems clearly to indicate that a much more primary cause existed in the underlying floor. The Llano Uplift is not *caused* by the pressure of the Ouachita chains against the Concho axis, since it was not deformed along Ouachita trends, as the open foothills folds, and as the Arbuckles were affected by the Wichita push on the Hunton arch. All the Ouachita onslaught may have done to the Llano-Burnet massif was, possibly, an accentuation of the uplift with some north-northeast faulting.

One point in the second quotation deserves clarification. While it is clear that the Ouachita foldbelt was squeezed against and around the southern bulge of the craton or, in Van der Gracht's terms, the Llano-Burnet massif, this buttress did not so much *deflect* the course of the Ouachita chains as it controlled the site of the Ouachita geosyncline.

Van der Gracht (1931, p. 1054) noted the "striking parallelism" of the Balcones fault zone to the Ouachita trend and suggested that position of the fault zone was controlled by a still-active Ouachita Mountain front. Earlier, Udden (1919) linked the Balcones fault zone to the Ouachita foldbelt, although he did not recognize it as such. Foley (1926, pp. 1267–1268) said that the Balcones zone was caused by a downsinking of the Coastal Plain around the Llano uplift and that the Mexia fault zone was a later adjustment due to the Balcones faulting. Sellards (1935, pp. 61–66) related the Balcones fault zone to the "Llanoria geosyncline . . . which acted as a hinge between the rigid foreland region and the subsiding landmass." Moss (1936, p. 948) likewise suggested that the Balcones and Mexia fault zones are over the original zone of weakness that allowed the Ouachita geosyncline to form and that the geosynclinal belt was the hinge for the Gulf Coastal Plain subsidence. All these authors inferred a basement control for the Balcones structure but none of them explicitly stated that the fundamental control for all these features is the margin of the craton, which is suggested from this basement study.

Van Horn Mobile Belt

Definition.—The name Van Horn mobile belt is applied to a deformed and

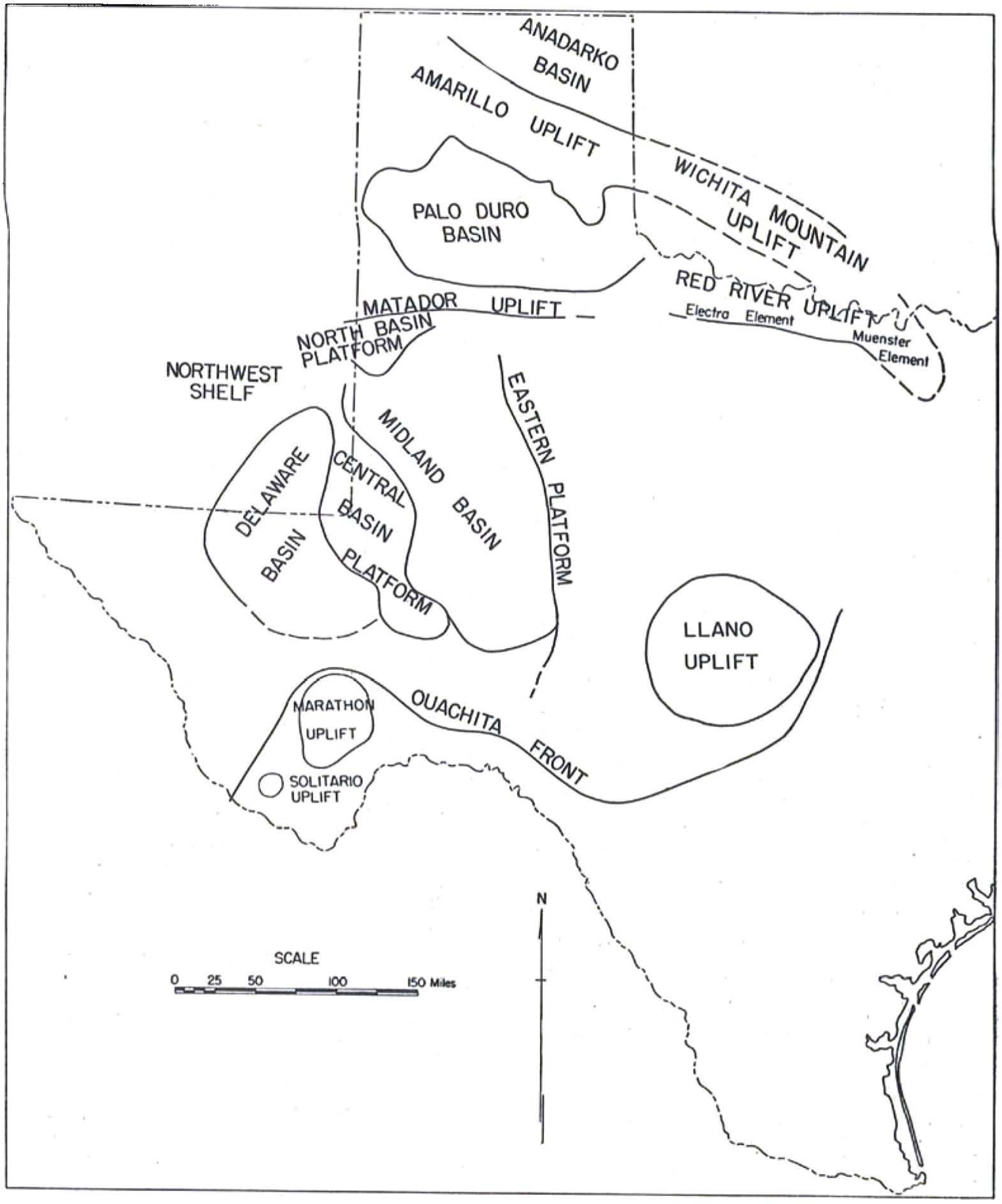

FIG. 2. Index map of regional structural features.

metamorphosed prism of metasedimentary and meta-igneous rocks which lies southwest of the craton in far west Texas. Its subsurface extent is largely unknown but exposures in the Van Horn area of Culberson and Hudspeth counties give some idea of its lithology and structure. The exposed Precambrian rocks have been described in detail by King and Flawn (1953). In brief, they consist of a metamorphosed sedimentary section, largely quartzofeldspathic, about 20,000 feet thick intruded by rhyolite and diorite, also metamorphosed, and thrust northward over a thick sequence of limestone, volcanic rocks, and sandstone that has undergone extreme deformation. The nature of the original sediments, their thickness, and the character of the deformation, all suggest a deformed and collapsed geosyncline or a mobile belt.

Age and possible subsurface extent of the Van Horn mobile belt.—The age of the culminating orogeny in this area can be stratigraphically dated as late Precambrian, although there is evidence of previous orogenic periods (King and Flawn, 1953, p. 129). The youngest Precambrian unit involved in the orogeny is the Hazel sandstone which, under the scarp of the Sierra Diablo north of the locus of maximum deformation along the trace of the Streeruwitz thrust fault, is undeformed and unmetamorphosed. The Hazel sandstone is overlain by the undeformed and unmetamorphosed Van Horn sandstone of Precambrian(?) age which in turn is unconformably overlain by lower Ordovician strata (King and Flawn, 1953).

There is insufficient well control to make it possible to trace the Van Horn mobile belt in the subsurface, and were it not for the Van Horn exposures, its existence would probably not be suspected. To the west in the exposures of the Franklin Mountains the Lanoria quartzite may be equivalent to part of the metasedimentary sequence in the Van Horn area (King and Flawn, 1953, p. 130) but this correlation is tenuous at best. Scattered basement wells between the Van Horn area and the Franklin Mountains have penetrated rhyolite, quartz diorite, and granite; rhyolite is exposed in the Pump Station Hills and granite crops out in the Hueco Mountains. Correlation between the Pump Station Hills rhyolite and that which intrudes metasedimentary rocks in the Van Horn area is suggested but is of little aid in delimiting the boundaries of the Van Horn mobile belt. To the northeast there is a gap of about 200 miles between the outcrop of rocks of the Van Horn mobile belt and the basement wells penetrating the craton on the Central Basin Platform in southern Lea County, New Mexico. Probably the fundamental boundary between the craton and the Van Horn mobile belt is close to the axis of maximum deformation of the mobile belt marked by the trace of the Steeruwitz overthrust fault, because northward the late Precambrian Hazel sandstone, extremely contorted along this deformational axis, flattens out as though it were a foreland deposit on the craton surface. To the east in central Culberson County the Humble No. 1-B Reynolds Cattle Company well bottomed in what is called Bliss sandstone. Thin sections of cuttings from the interval 5,370 to 5,380 feet show that among the fragments of sedimentary rock are some fragments of what appear to be recrystallized arkosic rock very similar to Precambrian metarkosite that crops out in the Wylie Mountains about 20 miles to the west. Little reliance can be placed on the unsatisfactory sample available, but it is possible that the basement terrane in this area is that of the Van Horn mobile belt. Eastward from this well there is a span without basement control to the basement wells in the craton on the Fort Stockton high. South of the Van Horn area in northwestern Presidio County two wells penetrate basement rocks. The Hunt No. 1 Presidio Trust encountered metarkosite beneath Permian strata. The rock is similar to that which crops out in the Van Horn area, except that it shows more indications of introduced feldspathic material; there is little doubt of its Precambrian age. About 20 miles southeast of this well the Welch No. 1 Espy has penetrated granite beneath Ordovician strata. There is no lithologic basis on which to distinguish this rock from the granites of the craton, but its geographic position suggests that this rock may be an intrusion into the rocks of the Van Horn mobile belt. The abundant granite pegmatites in the southernmost exposures of the Van Horn mobile belt in the Van Horn Mountains, about 40 miles to the northwest, and the evidence of granitization in the rock from the Presidio Trust well, 20 miles to the northwest, strongly suggest igneous activity in this part of the mobile belt. Thus, although we are unable to delimit the Van Horn mobile belt, its existence is suspected over a considerable area (Pl. I).

Paleozoic and younger structures of the Van Horn mobile belt.—The later (post-Precambrian) structural history of this part of Texas has been complex and the extent to which the major structure of the old mobile belt influenced younger structures is problematical. Regarding the present-day structure of the area, King (1935, p. 222) writes:

> The northern part of trans-Pecos Texas, north of the Texas and Pacific Railway, is a part of the Basin and Range province. The mountains here are broad blocks of flat-lying or gently tilted Paleozoic rocks which rest on a pre-Cambrian basement. . . .
>
> South of the Texas and Pacific Railway, normal faulting has a conspicuous effect on the topography in only a few areas. The region has been one of greater mobility than that farther north, and the sedimentary and volcanic rocks which form the mountains have been tilted, flexed, and in places strongly folded by post-Mesozoic movements older than the last faulting. . . . The southern part of trans-Pecos Texas, in which these features are displayed, is most closely allied to the mountains and highlands of northeastern Mexico, such as the Sierra Madre Oriental, and it forms their northern end.

This mobility is that achieved by the northwest-trending Mesozoic geosyncline of northern Mexico and was not inherited from the late Precambrian Van Horn mobile belt which was consolidated by orogeny long before.

Baker (1935, pp. 211–212) says:

> . . . the mountainous area of Trans-Pecos Texas is separable structurally into two well-marked divisions. The dividing zone between the two, first noted by R. T. Hill, and called the Texas Lineament by F. L. Ransome, extends from Point Conception on the Pacific Coast of southern California to Cape San Roque, the easternmost point of South America, the zone determining the northeastern coast line of South America and passing through the island of Cuba. . . . It is probably the greatest single structural line of the Western Hemisphere.

Baker says that north of this lineament is the Trans-Pecos rift valley province and south of it is the northeastern Mexican Cordilleran or Overthrust province.

The inter-continental aspects of this structural line noted by Baker are beyond the province of this study, but it is interesting to note that the boundary between two great structural provinces of Mesozoic and Cenozoic age corresponds to the local boundary between the old stable cratonic nucleus and the late Precambrian Van Horn mobile belt as established in this paper. The Mesozoic geosyncline of northern Mexico apparently formed on the hinter side of the late Precambrian mobile belt.

The Precambrian rocks themselves are exposed through block faulting of an old positive domical structure often referred to as the Van Horn dome (King and Flawn, 1953, p. 132). This structure included part of the Van Horn mobile belt and part of the stable area or craton to the north so that it is apparently not affected by the boundary between the two provinces to which such a great structural role is ascribed in the preceding paragraph. Apparently final compressive movements connected with the last stages of the late Precambrian orogeny were able to incorporate both foreland and hinterland elements into a single broad area of high-standing Precambrian rocks which endured until it was broken by Cenozoic faulting. The feature evidently formed in late Precambrian or early Paleozoic time because the Paleozoic sediments which were deposited on it are thin or have been partly or wholly stripped off by erosion. Possibly there was more than one period of uplift.

The line which separates basement rocks overlain by Cambro-Ordovician rocks and basement rocks overlain by Permian rocks corresponds roughly to the boundary between the Van Horn mobile belt and the craton to the north. This raises the question whether the southern part of what has been called the Van Horn dome is not actually a regional uplift of the older Precambrian mobile belt? A Paleozoic high area corresponding to the old mobile belt would have greater geographic extent than that ascribed to the Van Horn dome (Baker, 1935, pp. 182–185) and would certainly affect oil exploration in the area.

Although it was the site of great tectonic and igneous activity in late Precambrian time, the Van Horn mobile belt has not been recognized as an important provenance for early Paleozoic sedimentation. The early Paleozoic clastic sediments in the Ouachita geosyncline where it is exposed in the Marathon area are believed to have a southerly source while the Van Horn mobile belt, passive after its culminating orogeny, assumed a foreland role (King, 1937, pp. 22, 44).

Red River Mobile Belt

Definition.—The name Red River mobile belt is applied to a roughly east-west-trending belt of metasedimentary and meta-igneous rocks which can be traced from Cooke and Denton counties on the east to Floyd and Crosby counties on the west, and possibly extends considerably farther in both directions. It is wholly a subsurface feature, and poor well control in the eastern part of the area, where basement wells are localized in closely spaced groups on the structurally high Muenster and Electra elements of the Paleozoic Red River uplift, makes it impossible to fix boundaries. To the west, boundaries are established but because of the confluence of other Precambrian terranes in this area their validity is in question (Pl. I).

Petrographic character of the Red River belt.—From Denton and Cooke counties west to Foard County the belt is marked by a predominance of metasedimentary types including biotite schist, hornblende schist, garnetiferous schists, metamorphosed conglomerate, metaquartzite, metarkosite, and meta-arkose. In one well, Hollandsworth No. 31 Fette in Cooke County, a long basement core penetrated metaquartzite and sillimanite-biotite schist, the highest grade metasedimentary rock encountered in this study. Thus the belt is characterized by low, medium, and high-grade metasedimentary rocks. On the east end of the zone on the Muenster arch in Denton and Cooke counties, the rocks are medium- to high-grade rocks, commonly containing amphibole and garnet of metamorphic origin, and have been intruded by granite, granodiorite, syenodiorite, and diorite. Their advanced metamorphic grade is the result of a higher degree of deformation and the intrusion of the igneous rocks. In the central part of the belt in Wichita, Archer, and Clay counties the metasedimentary rocks are low grade and composed predominantly (on the basis of scattered samples) of meta-arkose and metagraywacke. To the west in Foard and Wilbarger counties metamorphic grade increases somewhat, and the predominant rock type is biotite schist, although lower grade rocks are also present.

The rocks encountered in 56 wells that penetrate rocks of the Red River mobile belt for which samples are available are grouped by lithologic type in Table 6. Among the metasedimentary rocks which constitute about 56 percent of the total as calculated from available data, the high proportion of metagraywacke and meta-arkose and their more highly metamorphosed equivalents is significant. The graywacke and impure arkose type of sedimentary rocks characterize rapid geosynclinal sedimentation in orogenic belts; graywacke in particular indicates a synorogenic sedimentary environment.

Table 6. *Rock types of the Red River mobile belt.*

	Percent
Metasedimentary rocks (meta-arkose, metarkosite, metagraywacke, and metaconglomerate, 34%; phyllite, metaquartzite, hornblende schist, garnetiferous schist, mica schist, 22%)	56
Meta-igneous rocks (may include some highly metamorphosed paragneisses whose sedimentary origin is difficult to prove)	11
Igneous rocks (granite, quartz diorite, syenite, diorite, syenodiorite, gabbro, rhyolite)	33
	100

The rocks of this terrane are so diverse that generalizations about modal composition are impractical. For petrographic descriptions, refer to Appendix II.

Relation of the Red River belt to other Precambrian terranes and the Texas craton.—The western limit of the Red River mobile belt presents a decided problem because of confluence of a number of other

Precambrian units. Probably the Red River belt continues westward from Foard County into Cottle and Motley counties because metasedimentary rocks, mostly meta-arkose and sericite phyllite, with subordinate higher grade arkose gneiss and metarkosite, have been encountered in that area along the strike of the mobile belt. The uncertainty arises from another metasedimentary belt, the Fisher metasedimentary terrane which trends about north-south in the same area (Pl. I). The north end of the Fisher metasedimentary terrane is separated from the metasedimentary rocks in Cottle and Motley counties by a band of granite about 20 miles wide. The character of the metasedimentary rocks in the Fisher terrane and the Red River belt are so similar that a relationship between the Fisher terrane and the Red River belt should be considered. Problems of the Fisher terrane are discussed in a separate section. Between the low-grade metamorphic rocks of the Red River belt in Cottle and Motley counties and the blanketing volcanic rocks of the Panhandle terrane in Lubbock and Hale counties, several wells have penetrated basement rocks which indicate that the Red River belt continues westward and is covered by the lava flows of the volcanic terrane. The only recognized metasedimentary rocks in this area are a muscovite schist from the Sinclair No. 1 Massie in central Floyd County and a metaconglomerate composed of igneous pebbles in the Humble No. 1 Montgomery in northern Crosby County. The schist in the Massie well is a higher grade metamorphic rock than those in the Red River belt in Cottle and Motley counties. In northwest Crosby County there is a diorite gneiss in the Humble No. 1 Irvin. Because of its position it is reasonable to assume that the metamorphism of this rock was associated with the tectonic activity of the Red River mobile belt, but it is not certain whether this rock is part of the flanking craton or a metamorphosed younger intrusive into the mobile belt. To the north the granite or arkose gneiss in the Amerada No. 1 Birney presents the same problem as the diorite gneiss in the Humble No. 1 Irvin in Crosby County. Farther south in Motley County the Humble No. 1-D Matador encountered rhyolite porphyry, although there is no petrographic evidence to indicate whether it is a flow or intrusive rock. It is too far east to belong to the Panhandle terrane so that it might best be considered as a flow among the weakly metamorphosed sedimentary rocks of the Red River belt (the low-grade metamorphism that has affected the rocks in this area would have had little noticeable effect on a pure quartz-alkali feldspar rock such as rhyolite porphyry). The presence of granodiorite and quartz diorite within the Red River trend in this area further complicates interpretation.

The western end of the Red River mobile belt is of particular interest because it penetrates the stable area as a long finger, and probably a linear zone *in* the craton was mobilized during this late Precambrian activity.

To the north Precambrian igneous rocks are brought to the surface in the Wichita Mountains by late Paleozoic uplift and extend northwestward into the Panhandle in the buried Amarillo Mountains. Possibly these igneous rocks, mostly micrographic granite with some gabbro, are late Precambrian intrusives into the mobile zone. The Sztykgold No. 1 Charles in Montague County penetrated more than 1,000 feet of basement rock consisting of alternating granite and diabase (see Table 1)—perhaps this sequence is related to the granite-gabbro sequence exposed in the Wichita Mountains.

The relation of the Red River mobile belt to the Texas craton is not definitely known because there is a large area south of the belt where control is lacking. Presumably the craton extends north of the widely spaced control points in Shackelford and Comanche counties and the Red River belt is marginal to it. Between the granite penetrated in the Gallagher and Lawson No. 1 Terry in Comanche County and the metasedimentary rocks of the Red

River belt in Denton County, the Garland-Anthony No. 1 Hammons in Parker County penetrated biotite schist. Basement wells in this area are too sparse for other than rank speculation on the significance of this well. However, if this well has encountered rocks of the Red River belt instead of a metasedimentary part of the Texas craton, it means that (1) the southern boundary of the Red River belt on the east should be moved farther south or (2) the eastern end of the Red River belt turns southward and arcs around the Texas craton.

Age and mobility of the Red River belt.—No direct evidence is available on the age of deformation of the Red River mobile belt. Tenuous reasoning suggests that it may have formed in late Precambrian time. The zircon age determination in the Wichita Mountains (670 million years, Larsen et al., 1949, p. 27) is late Precambrian, but the relationship of the Wichita Mountain rocks to the Red River mobile belt is in question; if the Wichita Mountain granites are synorogenic and constitute a core of the mobile belt, the late Precambrian age of the belt is well supported; if the Wichita Mountain rocks are a post-orogenic intrusion we know that the belt was mobile in an earlier period. The Red River belt appears to be marginal to the Texas craton; according to popular geosynclinal theory and the geologic record, younger mobile zones commonly flank older stable elements. The alternative hypothesis is that the Red River belt is an older terrane, possibly part of the craton. This idea, however, is weakened by the long uninterrupted course of the belt. Metasedimentary terranes known to be part of the craton, such as in the Llano uplift area, are fragmented by batholithic intrusion.

The record of mobility of the Red River belt that can be read in the petrographic study of its constitutent rocks is varied. Again, our conclusions are based on scanty data and vulnerable reasoning. If a rock in thin section shows microfolding, microfaulting, contortion, slippage along S planes, and other evidence of penetrative movement, the rock experienced strong deformation and internal movement. Here again application of these data is limited by our sample. We cannot on the basis of a single core chip state that the metasedimentary belt achieved more or less mobility in a certain segment because of the possibility that our sample records only a local mobility in, for example, the rocks of a thrust plate. However, we can apply the lessons learned in the study of regionally metamorphosed terranes exposed in various parts of the world; in general, regionally metamorphosed rocks characterize orogenic belts and higher grade metamorphic rocks mark the parts of the belt that achieved greater mobility; commonly increased mobility and igneous intrusion are associated. The rocks of the Red River element encountered to the east are medium to high-grade metamorphic rocks accompanied by intruded igneous material; to the west (Pl. I) the rocks show predominantly low-grade metamorphism with sporadic areas of medium-grade metamorphic rocks. Mobility of this belt was probably greater to the east and relatively slight to the west.

Paleozoic structures of the Red River mobile belt.—Near the end of Cambrian time or at the beginning of Ordovician time a trough formed within the stable area (the hedreocraton of Paleozoic time) and extended from southwest Oklahoma into the Texas Panhandle. This trough has been called the Wichita geosyncline and its history is concisely described by King (1951, pp. 145–148). This trough or geosyncline was deformed in Pennsylvanian time, and the resulting chain of the Wichita system extends northwestward from the Criner Hills through the Wichita Mountains into the Amarillo uplift of the Texas Panhandle; to the south another part of the system forms the Red River and Matador uplifts which are completely subsurface features. Here is a Paleozoic orogenic belt which is apparently located within the confines of the Paleozoic craton, and which is at least in part coincident with a Precambrian mobile zone—the Red River mobile belt. The Paleozoic structures directly associated with the Red River mobile belt are the Red River uplift, including the Muenster and Electra elements, the Matador uplift, and possibly the Wichita and Amarillo uplifts. It is, of course, these later uplifts that have brought the metasediments of the older belt into prominence, but from the west end of the belt where control is adequate more or less to delimit its boundaries, it seems that the younger structures tend to reflect the trend of the older structure.

The Matador uplift, which extends westward into the area of the Texas craton along the trend of the Red River uplift, supports the idea that the Precambrian Red River mobile belt extends westward, possibly penetrating the Texas craton (Pl. I), although the far western parts of the Matador uplift may reflect only a zone of weakness and not actually a Precambrian mobilized zone. Basement wells along the Matador uplift penetrate rocks of the Panhandle volcanic terrane rather than metasedimentary rocks of the Red River belt, so that we cannot expect to find direct petrographic evidence of the continuation of the Red River belt to the west. The fact, however, that the Matador structures are along the projected trend of the Red River belt is very suggestive.

The anomaly of the late Paleozoic tectonic units of the Wichita system which diverge so sharply from the main late Paleozoic trend of the Ouachita foldbelt, may perhaps be explained by renewed activity on the Red River mobile belt, the Paleozoic stresses being deflected along trends that originated during much earlier deformation.

Fisher Metasedimentary Terrane

Definition.—The name Fisher metasedimentary terrane is applied to a rather irregular area of basement surface in west-central Texas, extending from eastern Nolan and Taylor counties north to Dickens County and including parts of Scurry, Jones, Stonewall, Fisher, and Kent counties. The eastern boundary of the terrane cannot be fixed because of the paucity of basement wells in the area; there is some scanty evidence to indicate that the metasedimentary terrane continues south into Runnels and Coleman counties (Pl. I).

Petrographic character of the Fisher terrane.—To the south in Nolan and Fisher counties the Precambrian rocks are mostly metarkosite, arkose gneiss, and biotite schist, although a metamorphosed dolomite in the Humble No. 1 Nachlinger in Scurry County and a rhyolite in the Hunter & Hunter No. 1 Steele in Jones County are probably part of the same terrane. Northward in Dickens County the rocks are of lower metamorphic grade and consist mostly of meta-arkose and sericite phyllite very similar to those rocks immediately to the north in the Red River mobile belt.

The amounts of various rock types in the Fisher terrane are given in Table 7. These figures are rough approximations based on 23 rock types encountered in 19 wells.

Table 7. *Rock types of the Fisher metasedimentary terrane.*

	Percent
Metasedimentary rocks (metamorphosed arkosic rocks—meta-arkose, metarkosite, arkose gneiss, and minor metaquartzite—52%; mica schist, phyllite, and meta-argillite, 27%; metadolomite, 4%)	83
Volcanic and meta-igneous rocks (granite gneiss, microsyenite gneiss, rhyolite porphyry flows)	17
	100

There are too few wells in the Fisher terrane to provide a sound basis for the tabulations in Table 7. The metadolomite, for example, was encountered in only one well. However, the preponderance of arkosic rocks of varying metamorphic grade shown in the table is probably characteristic of the belt and indicates sedimentary accumulations from a predominantly granitic source.

The arkosic rocks show varied percentages of quartz, alkali feldspar, and plagioclase, any of which may predominate. The common alkali feldspar is microcline; plagioclase ranges from oligoclase-andesine to albite. Quartz and feldspar are commonly accompanied by chlorite, sericite-muscovite, magnetite or ilmenite, leucoxene, calcite, pyrite, epidote, red iron oxide, sphene, apatite, and zircon. In more highly metamorphosed varieties biotite is present. These rocks are in part low-grade metamorphic rocks showing unrecrystallized quartz and feldspar and partly reconstituted intergranular material (sericite, chlorite, epidote) with an essentially clastic fabric, and in part medium-grade metamorphic rocks in which the quartz and feldspar have recrystallized to form a mosaic or granular aggregate (granoblastic fabric) and the intergranular fraction has been reconstituted to plates of mica and chlorite. Where there is an orientation of the mica to impart a rude foliation the rocks are termed arkose gneiss. Grain size is for the most part within 0.05 to 0.2 mm.

Biotite schist and biotite phyllite are the most common representatives of the foliate rocks. These rocks are composed of quartz, plagioclase, and oriented biotite plates. Chlorite, epidote, magnetite or ilmenite, pyrite, calcite, apatite, and zircon are commonly present in minor quantities. The fabric is lepidoblastic to cataclastic; grain size ranges from 0.05 to 0.2 mm.

Other rock types listed in Table 7 are mostly individual samples and generalizations are meaningless. For petrographic description, refer to Table 1 and Appendix II.

Relation of the Fisher terrane to the Texas craton and the Red River mobile belt.—The relation of the Fisher metasedimentary terrane to the Texas craton and to the Red River mobile belt to the north is a major problem. The Fisher terrane seems to lie on or within the craton; its limits, particularly to the south, are vague because of poor well control. To the north the rocks are low grade, show only the beginnings of reconstitution, and do not appear to have attained great mobility; to the south metamorphic grade increases and schists and gneisses are present. The highly sheared dolomite in the Humble No. 1 Nachlinger well suggests mobility. Three hypotheses must be considered: (1) the Fisher terrane is composed of late Precambrian metasedimentary rocks in a basin within the craton, (2) the Fisher terrane is composed of more ancient metasedimentary rocks intruded by the granites of the craton, and (3) the Fisher terrane is related to the Red River mobile belt. The low-grade rocks of the northern part of the terrane do not appear to have been extensively invaded by granite and tend to support the first hypothesis. To the south, however, the metasedimentary rocks resemble the exposed metasedimentary rocks invaded by granite in the Llano uplift. Moreover, metasedimentary rocks encountered in wells north and west of the Llano uplift in Menard and McCulloch counties suggest a possible connection between the Fisher terrane and the Packsaddle—Valley Spring metasedimentary sequence of the Llano uplift. A metamorphic rock penetrated in the Superior No. 1 McDowell in Runnels County between the southernmost limit of the Fisher terrane as now recognized and the northernmost extension of the Llano uplift metasedimentary rocks is a crystalloblastic anthophyllite?-albite rock unlike the common types in either terrane and is not a very convincing link between them.

The only evidence to indicate a relationship to the Red River belt is the similarity of the rocks in the north part of the Fisher terrane in Dickens County to rocks of the Red River belt in Cottle and Motley counties. Such evidence is far from conclusive and certainly the trends of the two belts are widely divergent (Pl. I).

It has been demonstrated many times in the study of metamorphosed terranes that excessively deformed and metamorphosed rocks in one area are correlative with more or less flat-lying weakly metamorphosed rocks in another area. The weakly metamorphosed rocks of the northern part of the Fisher terrane do not preclude the hypothesis of equivalence with the Llano uplift metasedimentary rocks. In the earlier phase of the work (Flawn, 1954) the writer favored the hypothesis of a late Precambrian intracratonic basin for the Fisher terrane, but additional well data from the southern parts of the terrane make it an open question and no definite age can be assigned to these rocks. That they are indeed Precambrian is demonstrated by overlying Cambrian strata in the south part of the area. Solution of the problem awaits additional basement well control in the Coleman-Taylor-Runnels-Concho County area.

Panhandle Volcanic Terrane

Definition.—Volcanic rocks constitute basement in three separated areas in the Panhandle and south plains of Texas and part of eastern New Mexico. The southernmost area of volcanic rocks underlies parts or all of Bailey, Lamb, Hale, Lubbock, Hockley, Cochran, Yoakum, Terry, and Lynn counties in Texas and extends westward into northern Lea County and southern Roosevelt County. A small area of basement volcanic rocks in central Chaves County, New Mexico, is also included in this terrane. Farther north volcanic rocks form the basement in parts of Parmer, Castro, Swisher, Deaf Smith, Randall, Armstrong, and Donley counties in Texas and extend westward into Curry County, New Mexico. Volcanic rocks of this terrane also extend northward to the top of the Panhandle and are encountered in Oldham, Potter, Carson, Gray, Hartley, Dallam, and Sherman counties, Texas. To these separated areas of the basement surface the name Panhandle volcanic terrane is applied (Pl. I).

Petrographic character of the volcanic terrane.—The rocks of the volcanic terrane are composed chiefly of undeformed and unmetamorphosed flows of rhyolite porphyry and associated rhyolite tuff, but rhyodacite, trachyte, trachyandesite, and andesite also have been encountered. The only recognizably metamorphosed volcanic rock in this sequence is the metatuff in the Stanolind No. 1 Fuller in Quay County, New Mexico. The extrusive nature of the bulk of these rocks is indicated by associated tuffs, flow structures, spherulites, and relict perlitic and crystallitic structures, although it is not unreasonable to expect shallow intrusives in association with such an extensive lava terrane.

Considering the diversified suite of rocks that commonly results from a volcanic cycle, the rocks of the Panhandle volcanic terrane show striking uniformity over a wide area (Table 8). The figures in Table 8 are approximated on the basis of about 90 wells penetrating volcanic rocks.

Table 8. *Rock types of the Panhandle volcanic terrane.*

	Percent
Rhyolite porphyry	68
Rhyolite	6
Rhyolite tuff	10
Trachyte porphyry	5
Trachyte tuff	3
Andesite	4
Andesite tuff	1
Rhyodacite tuff	1
Trachyandesite	1
Basalt	1
	100

About half of the volcanic rocks (excluding tuffs) show flow and/or microspherulitic structures which in the light of associated tuffs indicates an extrusive origin. The "average rhyolite porphyry" in the area consists of about 65 to 90 percent quartz-alkali feldspar groundmass which may be microgranular, micrographic, microspherulitic, or cryptocrystalline, or some combination thereof. Although quartz makes up a substantial part of the groundmass of these rocks, it is not everywhere present as phenocrysts. Albite commonly forms the bulk of the phenocrysts;

microperthite phenocrysts are generally subordinate to albite or absent completely. Red iron oxide, magnetite or ilmenite, chlorite, leucoxene, calcite, apatite, and zircon are the common accessory minerals; muscovite or sericite, sphene, biotite, amphibole, epidote, pyrite, rutile, anhydrite, fluorite, and tourmaline are less commonly present. Grain size of the groundmass ranges from cryptocrystalline to 0.1 mm but generally falls below 0.05 mm; phenocrysts rarely exceed 3 mm and for the most part range between 0.5 and 2 mm. Tuffs are distinguished by the presence of rock fragments and relict vitroclastic fabric. For descriptions of subordinate rock types, refer to Plate I and Appendix II.

A well in the volcanic terrane in northern Lea County, the Amerada No. 1 State BTA, penetrated basement rock that has been variously called chert, novaculite, and rhyolite by petrographers who have examined it. In the writer's opinion it is a silicified rhyolite (halleflinta); it shows micrographic structure and is geographically within the area of the volcanic terrane.

The Phillips No. 6 URB on the northern edge of the volcanic terrane in southwestern Gray County is of special economic interest. Between about 3,040 and 3,175 feet this well penetrated a section of brecciated volcanic rocks, trachyte and rhyolite porphyry, brecciated albite diorite, with hard rhyolite tuff at the bottom and was completed as a 104-barrel per day producer from the 3,150 to 3,175 foot zone. The writer believes the interval from 3,040 to 3,175 feet is part of the Panhandle volcanic terrane intruded by diorite sills and not a detrital "arkose" or "wash" resting on the basement. The excessive fracturing and brecciation shown in thin sections of the cuttings from this interval indicates high porosity and was probably the cause of the entrapment of the oil.

Relation of the Panhandle volcanic terrane to other Precambrian rocks.—Within the area of the volcanic terrane several wells have (1) penetrated diabase or gabbro and then encountered rhyolite porphyry;[4(a)] (2) penetrated rhyolite porphyry, then gabbro, and bottomed in rhyolite porphyry; [4(b)] (3) penetrated gabbro and contact metamorphosed sedimentary rocks and bottomed in rhyolite porphyry;[4(c)] (4) bottomed in diabase or gabbro.[4(d)] In addition, one well[4(e)] penetrated rhyolite porphyry, contact metamorphosed sedimentary rock, and bottomed in rhyolite porphyry.

The rocks in these wells explain the relation of the Panhandle volcanic terrane to the Swisher gabbroic terrane which lies between the two separated parts of the volcanic terrane. The gabbroic rocks intrude the volcanic rocks in a number of sills and are related to the main gabbro body of the Swisher terrane which is apparently a great lopolith lying on top of and occupying a synclinal depression in the volcanic terrane which extends beneath. Prior to the intrusion of the gabbro, late Precambrian sedimentary rocks apparently rested on the lava surface and were locally intercalated with the lavas. Where the gabbroic rocks intruded and metamorphosed these sediments they were preserved; elsewhere they were removed in pre-Ellenburger or pre-Mississippian time. The nature of these altered sedimentary rocks is discussed in the section on the Swisher terrane.

In Cochran County the Shell No. 1 Pittman passed from Ellenburger into granodiorite. Apparently this well marks an inlier where the younger volcanic rocks have been stripped away so that plutonic rocks lie directly beneath the Paleozoic rocks. Farther west in Chaves County, New Mexico, in an isolated part of the volcanic terrane, the Honolulu No. 1 McConkey Estate penetrated an anomalous sequence of rhyolite porphyry with granite and microgranodiorite between. There is no ready explanation for this sequence unless there has been an error in labeling the samples and the rhyolite porphyry rests on the granite.

4 (a) Humble No. 1 Hyslop, Deaf Smith County; Humble No. 1 Hobgood, Hockley County.
(b) Colorado Interstate No. 25–A Bivins, Potter County.
(c) Hunt No. 2 Ritchie, Briscoe County.
(d) Humble No. 1 Campbell, Hockley County; Cosden No. 1 Barker, Cochran County.
(e) Hassie Hunt Trust No. 1 Helms, Armstrong County.

Considering the extrusive nature of the volcanic rocks it is apparent that the floor on which they were deposited was composed of older rocks. It is suggested that the rhyolites were extruded, at least in part, on plutonic rocks of the craton. The volcanic rocks of the Panhandle terrane probably overlap and are younger than the metasedimentary rocks of the Red River belt; apparently the rocks of the Red River belt extend westward beneath the volcanic rocks along the line marked by the Matador structures.

About 200 miles to the southwest, rhyolite extrusives are found in the Franklin Mountains and metamorphosed rhyolite is intrusive in the Van Horn mobile belt. Rhyolite whose geologic relationships are concealed crops out at Pump Station Hills in Hudspeth County and has been encountered in the American Land No. 1 Roseborough in Hudspeth County and in the Hunt & Turner No. 1 McMillan in southern Otero County, New Mexico. The association of these rhyolites with micrographic granites or granophyres suggests they may be largely intrusive. King and Flawn (1953, pp. 125–131) discussed the relationships of the west Texas rhyolites and attempted a tentative correlation which here is expanded in Table 12. Rhyolite porphyry is also present in the Wichita Mountains of southwest Oklahoma, but according to Gerald Chase (personal communication, 1953) these rhyolites are part of an intrusive granite series and are not lavas.

Geologic conditions in Precambrian time such as to permit the formation of a terrane of more or less uniform rhyolitic lava over an area about 200 miles long and 150 miles wide must have been quite similar to those responsible for the volcanic activity of Tertiary time which built up great lava accumulations to the southwest. It is further interesting to note that although the Precambrian lavas do not contain the alkaline suite of amphiboles and pyroxenes that distinguish the Tertiary lavas, the persistence of the sodic plagioclase and the high potassium feldspar content show an alkaline affinity.

Age of the volcanic rocks.—A late Precambrian age for the volcanic rocks is indicated by their essentially undeformed and unmetamorphosed state, because they seem to overlie rocks of the Red River belt and plutonic rocks of the craton, and because they are in some wells overlain by Cambrian or Ordovician strata. In general, the rhyolite is overlapped by Cambrian or Ordovician strata to the south and by younger Mississippian, Pennsylvanian, or Permian beds to the north (Pl. I; Table 1).

Paleozoic structures of the volcanic terrane.—Rocks of the volcanic terrane have been involved in Paleozoic tectonic movements along the Matador trend and the Amarillo uplift and have been downwarped in the Plainview or Palo Duro basin[5] where gabbroic rocks of the Swisher terrane occupy part of the structural low of the basin.

Swisher Gabbroic Terrane

Definition and structural character.—The basement rock in northeastern Roosevelt County, New Mexico, and Castro, northern Parmer, northern Lamb, Swisher, northern Hale, western Floyd, Briscoe, and western Donley counties, Texas, is mostly gabbro and diabase and is named the Swisher gabbroic terrane. These mafic rocks comprise the Precambrian surface in the greater part of the area that lies between two separated parts of the Panhandle volcanic terrane and, because several wells in the volcanic terrane (p. 42) have penetrated a gabbroic sequence overlying the volcanic rocks, it appears that the gabbro terrane proper is a great lopolith that occupies a sag or syncline in which the volcanic terrane has been downwarped. Gabbroic rocks have also been penetrated in wells in the volcanic terrane that do not bottom in volcanic rocks (p. 42). Two such wells, together with a third that penetrates gabbro and bottoms in rhyolite, occur along an east-west linear

[5] Totten (1954) discusses the several names applied to this basin and concludes that *Palo Duro basin* has priority and is preferable.

zone in northern Hockley and Cochran counties.[6] The overlying sedimentary rocks are displaced by a major east-west fault of the Matador trend immediately north of the line connecting these wells. Rhyolite porphyry overlain by Permian rocks forms the upthrown block to the north while the gabbroic rocks, overlain by Cambrian strata, are present as a narrow band on the downthrown side. These gabbroic rocks are probably a remnant of the once overlying lopolith preserved on the downthrown side of the fault zone. Movement on the Matador fault zone took place in late Paleozoic (pre-Permian) time, but earlier Paleozoic or Precambrian movements are indicated by preservation of Cambro-Ordovician strata that rest directly on basement in the immediate area (Pl. I) and by removal of the gabbroic rocks on the upthrown side of the fault zone. The gabbroic rocks might have been a talus on the downthrown side of the fault, but this is not supported by the nature of the alteration (pp. 137, 167–169) and the uncontaminated state of the gabbroic material (only cuttings are available for study). Even this interpretation requires Precambrian movement on the Matador fault zone.

Petrographic character of the gabbroic terrane.—The approximate relative abundance of various types of gabbroic rocks in the Swisher terrane is shown in Table 9. These figures are based on 44 rock types encountered in 25 wells. Gabbroic rocks in this area tend to be leuco-varieties, with the ratio of the plagioclase to ferromagnesian minerals higher than is normal.

The plagioclase of the gabbroic rocks shows an indistinct zonation and is commonly altered in varying degree to sericite or sericite and epidote-zoisite. In some the alteration is restricted to the more calcic cores while the more sodic rims or mantles are clear. In some it is clear that the highly sodic nature of the plagioclase is the result of alteration, the calcic plagioclase breaking down to a mixture of sericite, epidote-zoisite, and albite (this type of alteration has been called saussuritization and its product saussurite-gabbro). In others, however, the sodic plagioclase is not associated with alteration products and it seems to be pyrogenic and the result of a selective metasomatic process, perhaps deuteric. In rocks that show plagioclase with calcic cores and albite rims the albite evidently crystallized in the magmatic stage. Although the sodic plagioclase is conspicuous in these gabbroic rocks, it is from a quantitative view subordinate to labradorite which constitutes the plagioclase of most of the rocks of this terrane.

TABLE 9. *Rock types of the Swisher terrane.*

	PERCENT
Gabbro (mostly leuco-gabbro, commonly with sodic plagioclase)	33
Olivine gabbro (more than 50% leuco-olivine gabbro; predominantly normal calcic plagioclase)	33
Diabase (leuco- and sodic varieties are subordinate)	12
Olivine diabase (about one-half are leuco-varieties)	6
Diorite (more than one-half show sodic plagioclase)	7
Basalt	5
Olivine syenogabbro	2
Iron ore	2
	100

On the map (Pl. I) the gabbroic rocks characterized by sodic plagioclase show some local grouping but no over-all trend or pattern. In some wells the sodic varieties are in close association with normal gabbros. Two main groups of wells have penetrated sodic gabbros (although not exclusively sodic gabbros): (1) Three wells within the Panhandle volcanic terrane in Cochran and Hockley counties penetrated gabbroic rocks with sodic plagioclase, all in an advanced stage of alteration to chlorite and sericite; and probably the sodic plagioclase is the result of secondary processes (a deeper and less altered gabbro in one of these wells shows normal calcic plagioclase). (2) Four wells in northeast Briscoe and southeast Armstrong counties penetrate normal and sodic gabbroic rocks interlayered with contact-metasedimentary

[6] Humble No. 1 Hobgood, Hockley County; Humble No. 1 Campbell, Hockley County; Cosden No. 1 Barker, Cochran County. See Table 1.

rocks; the sodic nature of the plagioclase in some of the gabbro is apparently due to secondary processes attendant on alteration but it could not be in others where albite mantles calcic cores. Possibly an interchange of material between sedimentary rocks, their pore solutions, and the magma during intrusion and contact metamorphism caused the end-phase of the magma to become enriched in soda.

The pyroxene of the rocks of the Swisher terrane ranges from colorless augite to deeply tinted lavender to brown augite; orthopyroxenes are rare but in one sample hypersthene accompanies augite. In general the augite occurs as discrete grains between plagioclase laths or as a mantle on olivine, but in a few diabases it occurs as large continuous host grains. Olivine is commonly partly altered to iddingsite or brownish chlorite. Magnetite and/or ilmenite is commonly present in discrete scattered grains more or less overgrown by red-brown biotite, but locally it shows plumose structures. Chlorite and to a lesser degree sericite are ubiquitous as secondary alteration products. Secondary green amphibole and primary green-brown amphibole are widely distributed in small amounts. Apatite and sphene are the common accessory minerals. Minor quantities of leucoxene, epidote, alkali feldspar, pyrite, calcite, serpentine, talc, rutile, quartz, and nontronite are also present.

Grain size ranges from 0.05 mm in basalt and fine-grained diabase upward through the microgabbros to 1 or 2 cm in very coarse gabbros. Fabric is hypidiomorphic granular in gabbro and microgabbro; ophitic to subophitic in diabase; and porphyritic-microgranular in basalt.

In two wells within the area of the gabbro terrane, Anderson-Prichard No. 1 Gettys in Lamb County and Sunray No. 1 Kimbrough in Parmer County, basement rocks penetrated are albite syenodiorite and micrographic granite, respectively. This apparently anomalous occurrence within the gabbro terrane is perhaps best explained by the hypothesis that these rocks are differentiation products of the gabbroic magma. The association is not uncommon in exposed gabbro complexes.

None of the conspicuous differentiation types found in the Wichita Mountains (anorthosites, norites, troctolites) have been observed in Swisher terrane rocks, but locally the leuco-gabbros approach anorthosite and in one well a zone high in magnetite-ilmenite occurred within the gabbro section (Colorado Interstate No. 25-A Bivins, Potter County). The writer has also included in this terrane some outlying occurrences of apparently related diorite (Pl. I).

Contact metasedimentary rocks in the gabbroic terrane.—In some wells in the gabbro terrane proper, and in wells penetrating gabbro and bottoming in rhyolite, the gabbroic rocks are associated with sedimentary rocks which have been metamorphosed by them. These wells are El Paso Natural Gas No. 1 West Texas Mortgage-Loan, Bailey County; Lion No. 1 Bridwell, Bailey County; Hunt No. 1 Ritchie, Briscoe County; Hunt No. 2 Ritchie, Briscoe County; Sun No. 1 Haberer, Castro County; Sun No. 1 Herring, Castro County; Hunt No. 5 Ritchie, Donley County; Placid No. 1 Kelly, Donley County (Table 1). In addition, the Hassie Hunt Trust No. 1 Helms in Armstrong County penetrated serpentinized dolomite between rhyolite layers without encountering gabbro.

The sedimentary rocks are carbonate rocks and argillaceous or arkosic siltstones. The carbonate rocks, whatever their original character, are now dolomites which show three overlapping stages of alteration: (1) individual grain boundaries lose their sharpness and there is incipient development of serpentine and/or talc; (2) dolomite remnants are completely enveloped by talc and/or serpentine; (3) tremolite and diopside form and the rock is a diopside - tremolite - dolomite hornfels. The clastic rocks, which were originally calcareous argillaceous siltstones, were more resistant to metamorphism than the carbonate rocks, and the effect of metamorphism is indicated mainly by a finely fibrous mineral, probably an amphibole, which penetrates the other mineral constituents. In some slides there is recrystallized chert and some slides contain small porphyroblastic muscovite grains, but these are rare. For the most part the silt-sized quartz and feldspar grains have not recrystallized. The fabrics are of a static or hornfels type, without preferred directional orientation of mineral constituents. Most of these weakly metamorphosed clastic rocks may be classified as argillites or meta-argillites (Flawn, 1953a). They appear to be the metamorphosed remnant of what once may have been an extensive sedimentary terrane lying on and partly intercalated with the volcanic rocks. Except where they were intruded by gabbro and involved in the general downwarp of the Palo Duro basin, they were removed by pre-Ellenburger erosion.

Age of the gabbroic rocks.—The gabbroic rocks are younger than the volcanic rocks as they intrude both them and overlying sedimentary rocks and metamorphose the latter. They are Precambrian and not Paleozoic, as Cambrian or Ordovician strata overlie them in the more southerly wells (Bailey, Cochran, and Hockley counties). Farther north the gabbroic rocks, like the associated volcanic rocks, are overlapped by Mississippian, Pennsylvanian, and Permian strata. The late Precambrian age is also supported by correlation with the rocks in the Wichita Mountains (Table 12).

Emplacement and structural history of the gabbroic rocks.—The sills and sheets of gabbro and diabase include medium to coarse-grained varieties and must have had a more deep-seated environment of emplacement than the host lavas and overlying sedimentary rocks. From this we can deduce the following late Precambrian structural history:

(1) Surficial deposits of rhyolite lava and tuff laid down on rocks of the craton and Red River mobile belt.

(2) Subsidence and accumulation of sedimentary rocks—carbonates and siltstones.

(3) Continued subsidence with intrusion of gabbroic rocks in the deeper parts of the Precambrian basin.

(4) Pre-Ellenburger? removal of the greater part of the Precambrian sedimentary cover to form a basement surface of rhyolite lava and gabbro including contact-metamorphosed remnants of sedimentary rocks.

Gabbroic rocks of the Swisher terrane occupy part of what is now the structural low of the Palo Duro basin. Either the accumulated mass of gabbro in and on the lavas of the Panhandle volcanic terrane was sufficient to cause crustal subsidence and initiated the downwarp of the basin in late Precambrian time, or the emplacement of the gabbro lopolith was controlled by the axis of a broad synclinal downwarp caused by more fundamental tectonic forces. Gravity measurements in this area do not show a conspicuous gravity-high and tend to confirm the interpretation of the Swisher terrane as a relatively thin straliform body of gabbro without sufficient mass to cause crustal subsidence.

Because Mississippian strata now rest on basement rocks over a large part of the Palo Duro basin, the concept of a mid-Paleozoic high area transecting this basin and exposing basement rocks in pre-Mississippian time is supported. Cambro-Ordovician rocks rest on basement only on what were the flanks of the former high area. The structural history of this general basin area is then (1) downwarping and basin formation in late Precambrian time (east-west trend?) following extrusion of the lavas, (2) mid-Paleozoic uplift along a northwest-southeast trend to form a high backbone, and (3) late Paleozoic subsidence along a more or less east-west trend to form the basin as it is known today.

Wichita Igneous Province

General remarks and definition.—North of the Red River in southern Oklahoma, and beyond the boundary selected for the subsurface study, late Paleozoic uplift has brought Precambrian rocks to view in the Wichita and Arbuckle Mountains. The name Wichita igneous province is applied to the late Precambrian intrusive igneous rocks which crop out in the

Wichita Mountains and extend northwestward in the subsurface to form a large part of the Amarillo Mountains. Whether the Precambrian rocks of the Arbuckle Mountains belong to this province or an older igneous cycle is not yet known. No complete study is available on the Precambrian rocks of the Arbuckle Mountains, and the principal references on the area are still the reconnaissance and partial studies of Taff (1904), Taylor (1915), and Uhl (1932). The Precambrian rocks of the Wichita Mountains have been reported on by Hoffman (1930). Subsequently, Gerald Chase of the Oklahoma Geological Survey has been studying the Precambrian rocks; he has amassed a wealth of carefully organized field, petrographic, and chemical information but a paper has not yet been published. The writer profited greatly by discussions and field conferences with Chase and from examination of the large collection of thin sections in the files of the Oklahoma Geological Survey.

Arbuckle Mountains.—Taff (1904) reports that the principal rock type in the Arbuckle Mountains is biotite granite with associated phases of quartz monzonite and dikes of basic rock, aplite, and granite porphyry; in addition there are masses of aporhyolite and granite porphyry. Taylor (1915) and Uhl (1932) describe two apparently related granites, the Tishomingo and the Troy granites, and a number of subordinate plutonic types and dike rocks. Uhl (1932, pp. 34–46) also describes extrusive rocks, mainly rhyolite porphyry, from the Timbered Hills area. These descriptions do not suggest any distinctive rock types that would be convincing in correlating the Arbuckle Precambrian rocks with those to the northwest in the Wichita and Amarillo uplifts, but it is interesting to note that the Troy granite, like the Mount Scott granite in the Wichita Mountains and many samples from the buried Amarillo ridge, is micrographic (micropegmatite of Uhl, 1932, p. 11). The rhyolite porphyry from the Timbered Hills merits comparison with the vast terrane of late Precambrian rhyolite porphyry flows in subsurface to the west. Although not mentioned by previous geologists, metasedimentary rocks are present in the Arbuckle Mountains but their nature and extent are not known (Chase, personal communication, 1953). One sample examined by the writer is a biotite-hornblende schist and indicates a regionally metamorphosed terrane.

Wichita Mountains.—The oldest Precambrian rock and the only metasedimentary rock in the Precambrian exposures of the Wichita Mountains is the Meers quartzite which occurs as xenoliths in the Mount Sheridan gabbro,[7] the oldest igneous unit in the area. Samples of the Meers quartzite show varied degrees of alteration, but the typical altered rock consists of grains of finely rutilated quartz closely set in a sponge of albite-oligoclase and both penetrated by sillimanite needles. Sillimanite ranges from a trace to about 20 percent of the rock. Locally the rock contains quartz that occurs as round grains with the appearance of original detrital constituents. This poses a problem because the sillimanite indicates an advanced metamorphic grade; in contact metamorphic processes quartz recrystallizes at lower temperature than that necessary for the formation of sillimanite. The round quartz grains are deceptive; the writer believes that their apparent "clastic" nature is due to close packing in a sponge of plagioclase of nearly equal relief and that they are actually round inclusions in a feldspar host. Metamorphism of the rock, although not everywhere equal, is in general advanced. The most significant feature of the quartzite is that it does not appear to have been regionally metamorphosed to any great degree before intrusion of the gabbro, indicating the gabbro intruded a sedimentary terrane.

Gerald Chase (personal communication, 1953) has distinguished many different igneous phases in seven major

7 Name is that proposed by Gerald Chase, manuscript, 1953.

igneous rock series but the major divisions are an older differentiated gabbroic sequence comprising about 6 percent of the exposed area and a younger granite and granite porphyry sequence. Age determinations on the youngest granite series show an age of 670 million years; the younger igneous rocks of the area are thus dated as late Precambrian (Larsen et al., 1949, p. 27).

The gabbroic rocks of the Wichita Mountains are characterized by a diallage[8] pyroxene. The olivine is very fresh without pronounced development of alteration products. Red-brown biotite, a prominent constitutent of many gabbros, is virtually absent. The Wichita rocks are a differentiation series and the more common gabbro is associated with troctolite, norite, anorthosite, and magnetite-ilmenite concentrations. Although gabbro outcrops in the Wichita Mountains are very conspicuous they comprise only a small part of the total area of Precambrian exposures.

The granite series in the Wichita Mountains consists mostly of alkali granites with a very low ferromagnesian mineral content. There is little plagioclase in these rocks other than that which is perthitically intergrown with potassium feldspar (Chase, personal communication, 1953). The micrographic granite (Mount Scott granite of Chase) is the most extensive unit in the area.

Rhyolite porphyry forms limited outcrops in the Wichita Mountains. This rhyolite is intrusive and part of the younger granite porphyry series (Chase, personal communication, 1953); it is probably not equivalent to that of the Panhandle volcanic terrane farther west.

Comparison of Wichita Mountains gabbro with gabbro of the Swisher terrane.—Differences betwen the Wichita Mountain gabbroic rocks and the gabbroic rocks of the subsurface Swisher gabbroic terrane farther west are summed up as follows:

[8] The term *diallage* used in this paper refers to a closely spaced parallel ruled structure and does not connote a particular mineral species.

(1) The purple-tinted titaniferous pyroxene of the Swisher terrane is markedly different from the colorless diallage pyroxene of the Wichita Mountains.

(2) Olivine in Swisher terrane rocks is typically altered to iddingsite or chlorite while the Wichita Mountain olivine is characteristically fresh.

(3) Red-brown biotite, a prominent accessory mineral in the Swisher terrane rocks, is rare in Wichita Mountain gabbros.

(4) Products of magmatic differentiation common in the Wichita Mountains (anorthosite, troctolite, norite, and magnetite-ilmenite concentrations) have not been encountered in the rocks of the Swisher terrane, with the possible exception of magnetite-ilmenite concentrations in the Colorado Interstate No. 25-A Bivins in Potter County.

In the writer's opinion the mineralogic differences in these rocks do not preclude the possibility that they are products of the same igneous cycle acting over a wide area. August Goldstein, Jr., and H. D. Wenland (personal communication, 1954) report that they have studied subsurface gabbroic rocks encountered in wells in the Wichita Mountain area which contain tinted pyroxene and altered olivine, and are in many ways similar to gabbroic rocks of the Swisher terrane farther west.

Although no correlation is warranted it is interesting to note that diallage pyroxene occurs in syenodiorite in the Continental No. 1 Berry in Cooke County and in leuco-microgabbro in the Barkley-Meadows No. 14-A Stephens in Wilbarger County; both of these wells penetrate intrusions in the Red River mobile belt just south of the Wichita Mountain rocks. The only other occurrence of a diallage pyroxene in the area studied is in gabbro encountered in the Standard of Texas No. 1 Heard-Federal in Lincoln County, New Mexico.

Subsurface Wichita igneous province.—The Amarillo Mountains consist of a basement ridge extending northwestward from Oklahoma through Wheeler, Gray, Carson, and Potter counties, Texas, and turning northward into Moore and Sherman counties, Texas. To the west in Oldham County another basement high (Bravo dome) seems to be the northwestern limit of a series of basement peaks south of the main Amarillo ridge in Childress, Hall, Donley, Armstrong, and Oldham counties.

In the basement terrane of the Panhandle there are two main rock types: the lavas and the tuffs of the Panhandle volcanic terrane and the intrusive igneous rocks, mostly granite (commonly micrographic) with subordinate gabbro, of the Wichita igneous province. In the eastern part of the Amarillo trend in Collingsworth and Wheeler counties the ridge is composed entirely of intrusive rocks of the Wichita igneous province; northwestward in Gray and Carson counties the ridge proper is composed of Wichita igneous province rocks but volcanic rocks of the Panhandle terrane comprise the south side of the ridge; farther northwest in Potter County most of the Amarillo ridge is composed of volcanic rocks and the intrusive Wichita province rocks are restricted to the north side; at the northwestern extremity of the buried ridge in Hartley County, Wichita igneous province rocks again form the topographic high. North of the Amarillo Mountains in Dallam, Sherman, Moore, Hutchinson, Roberts, and Hemphill counties basement wells are very widely spaced and boundaries cannot be drawn. A well in southeast Sherman County penetrated rhyolite porphyry and suggests that rocks of the volcanic terrane are also present north of the buried ridge; in northwest Sherman County a well encountered a metamorphosed arkosic rock which may represent a remnant of the terrane invaded by the rocks of the Wichita igneous province (Pl. I). In Oldham County south of and separated from the Amarillo ridge proper a basement high, the Bravo dome, is composed almost entirely of micrographic granite. This granite high is surrounded by volcanic rocks of the Panhandle terrane. Plate I shows that there is no definite correspondence between rock type and topography of the basement—the late Paleozoic structures of the Wichita system have uplifted both the rocks of the Wichita igneous province and the Panhandle volcanic terrane together. In general, the granites of the Wichita igneous province seem to correspond only to topographic and structural highs whereas the volcanic rocks occur in both high and low areas.

A rough approximation of the amounts of various types of rock in the subsurface Wichita igneous province is shown in Table 10. These figures are based on approximately 40 basement wells for which samples are available.

TABLE 10. *Rock types of the Wichita igneous province.*

	PERCENT
Granite (about 30% is micrographic granite from the Oldham County Bravo dome)	56
Diabase	14
Granodiorite	12
Quartz diorite	7
Gabbro	7
Diorite	2
Rhyolite porphyry	2
	100

Granites predominate and are in general characterized by low plagioclase content and low ferromagnesium mineral content. The micrographic granites in the Oldham County area are practically devoid of plagioclase. The alkali feldspar is commonly microperthite or, to a lesser degree, microcline microperthite. Biotite, chlorite, magnetite or ilmenite, calcite, apatite, zircon, sphene, and fluorite are present in minor amounts. Three wells (Holt No. 3 Bailey, Gray County; Humble No. 1-F Matador, Oldham County; and Smith No. 2 Farren, Wheeler County) encountered granite containing alkali amphibole or pyroxene. This indicates an alkaline tendency in harmony with the alkali-rich granites in the Wichita Mountains and the associated riebeckitic pegmatite phases. Grain size of the granitic rocks ranges from 0.5 to 8 mm; fabric is hypidiomorphic granular to micrographic with definite areal grouping of the micrographic rocks in the Oldham County area.

Correlation of Precambrian rocks in the Amarillo, Wichita, and Arbuckle uplifts.—Correlation of the Precambrian rocks exposed in the Wichita Mountains with the subsurface Precambrian rocks in the Amarillo Mountains to the northwest on the same late Paleozoic structure is probable but not proved. There is no absolute petrographic evidence for the correlation other than a generally similar granite which commonly shows micrographic texture (granophyre) and an alkaline tendency. Granites of the Texas craton are only sporadically micrographic. The granite in the Humble No. 1-E Matador in Oldham County is reported to contain a distinctive alkali amphibole (riebeckite) similar to that occurring in pegmatitic phases of a late granite series in the Wichita Mountains (Robert Roth, personal communication, 1953.) Alkali amphibole and pyroxene also occur in granite encountered in the Holt No. 3 Bailey (Gray County) and the Smith No. 2 Farren (Wheeler County.) The occurrence of these alkaline ferromagnesium minerals in outcrop and subsurface supports the correlation. Moreover, there is good well control from the Wichita Mountains into the Texas Panhandle and there seems to be no major change in basement rock type.

The relation between the Precambrian rocks of the Wichita and Arbuckle Mountains has recently been critically examined by W. B. Hamilton of the U. S. Geological Survey (manuscript, 1953). He points out that the Wichita Mountain granites occur as an alkaline to sub-alkaline complex of sheets and funnels, whereas the Arbuckle granites are coarse-textured calc-alkaline rocks typical of a batholithic complex. He concludes that the Wichita Mountain rocks, in view of the typical granophyre-gabbro association, are probably part of a lopolith emplaced in a static or tensional tectonic environment while the Arbuckle rocks are batholith type, much older, and probably intrusive into a mobile belt. The dissimilarity of the Precambrian rocks of the two areas suggests to Hamilton that the Paleozoic trend is unrelated to a basement structure. If Hamilton is correct, the batholithic granites of the Arbuckle Mountains might be part of a stable or foreland area north of the Red River mobile belt and associated Wichita igneous province, as was suggested by Van der Gracht (1931, p. 1007.) One other possibility occurs to the writer: the northern limit of the Red River mobile belt is not established and it may be that the batholithic Arbuckle granites are part of a deep synorogenic intrusion into the Red River belt. The older synorogenic Arbuckle granites and the younger granites of the Wichita system might be of different ages but still be related to the same basement structure, the Red River mobile belt.

Age of the Wichita igneous province and relation to other Precambrian rocks.—An age determination of 670 million years on a younger granite of the Wichita Mountains (Larsen et al., 1949, p. 27) shows that the granitic rocks of the Wichita Mountains are considerably younger than the granites of the Texas craton as exposed in the Llano uplift (1,000 million years).

In this study the Precambrian rocks of the Wichita Mountains and their subsurface continuation into the Texas Panhandle are grouped together as the Wichita igneous province; they are a late Precambrian complex of granites, commonly micrographic, and gabbroic rocks. If these rocks are post-orogenic intrusions emplaced in a static or tensional environment, as suggested by Hamilton, they must, in view of their very late Precambrian age, be considered with the Swisher gabbroic terrane and the Panhandle volcanic terrane as parts of one great late Precambrian igneous cycle. If the rhyolite eruptions, the gabbro intrusions, and the granite intrusions are related phenomena, a certain age sequence may be worked out by some tenuous correlations. The gabbroic rocks of the Swisher terrane intrude and are younger than the rhyolite porphyry of the Panhandle volcanic terrane. The rhyolite porphyry of the volcanic terrane is younger than the metasedimentary rocks of the Red River mobile belt which pass beneath them (Pl. I). The gabbro and associated differentiated rocks of the Wichita Mountains rocks are older than the granites of the Wichita Mountains—Amarillo Mountains trend. If the sequence is matched by equating the gabbros of the Swisher terrane with the gabbros of the Wichita Mountains, the rhyolite porphyry lava-tuff series is older than the gabbro-granite series. Moreover, the rocks of the volcanic terrane are surficial deposits while the gabbro that intrudes them is commonly a medium to coarse-grained rock. Therefore a period of subsidence is indicated between the rhyolite eruptions and the gabbro-granite intrusive period. Whether or not the granite ever intruded the rhyolite cannot be definitely established because the granite may be a more deep-seated rock brought into juxtaposition with the rhyolite flows by Paleozoic tectonic movements. The subsidence may well have been the first phase in the development of the Paleozoic basin of the area. The sheetlike nature of the gabbro and granite intrusions in the Wichita Mountains and the sheetlike nature of the gabbro of the Swisher terrane have been discussed; as suggested by Hamilton these may all be parts of a great lopolith intruded at the close of Precambrian time.

Whether the Arbuckle Mountains are a part of the Wichita igneous province or older does not affect the concept of the Wichita igneous province.

The general parallelism and geographic coincidence of the Red River mobile belt, Wichita igneous province, and late Paleozoic uplift suggests all are controlled by a major tectonic feature of the basement. Although divergences of structural trend are recognized, they emphasize rather than invalidate the parallelism. In dealing with great prisms of rocks of varied physical properties involved in tectonic adventures over a long period of time, drawing-board parallelism should not be expected. Eastward, the subsurface rocks of the Red River mobile belt are directly south of the Wichita igneous province exposures in the Wichita Mountains, and rocks similar to those in the Wichita Mountains have been penetrated in the Red River trend (Sztykgold No. 1 Charles, Montague County). Here, the inference that the Wichita igneous rocks intrude the Red River mobile belt seems well founded. To the west, however, the trends of the Red River belt and the Wichita igneous province diverge as if split by the block of plutonic rocks tentatively considered to be part of the Texas craton (Pl. I). The more southerly Red River trend, composed of metasedimentary, meta-igneous, and igneous rocks, is lithologically quite different from the unmetamorphosed igneous rocks of the Wichita province. Only one well, Lubbock Machine & Supply No. 1 Alexander in Collingsworth County, penetrated metasedimentary rocks along the Wichita province trend. This divergence of trend weakens the theory that the Wichita igneous province is intrusive into the Red River belt. Even with more well control the problems will not be easily solved because of the concealing blanket of volcanic rocks of the Panhandle terrane.

Final settlement of these problems will be materially aided by detailed study of the Arbuckle Mountain igneous rocks and by publication of the work on the Wichita Mountains. The writer inclines toward Hamilton's suggestion that the Precambrian rocks of the Wichita Mountains are post-orogenic intrusions, perhaps part of a lopolith. A tentative correlation of igneous-structural events in various parts of the area of study is attempted in Table 12.

Paleozoic structures of the Wichita igneous province.—During late Paleozoic time the Precambrian rocks of the Wichita igneous province were raised in the Wichita and Amarillo uplifts. These uplifts are related in time and trend to the

Red River—Matador uplifts, the Criner Hills uplift, and the Arbuckle uplift. They are all elements of the Wichita system (Van Der Gracht, 1931, p. 999; King, 1951, pp. 147-148.) The general trend of the Paleozoic uplifts is west to northwest; in the broad view they are subparallel but in detail, projected axes of individual uplifts are diverging or intersecting.

There is a parallelism of Paleozoic and Precambrian trends in this area. The known trend of the metasedimentary rocks of the Red River mobile belt parallels the late Paleozoic Red River—Matador uplifts. Where the granites of the Wichita igneous province have been separated from the volcanic rocks in the Panhandle, the granites fall into northwesterly elongated areas whose axes parallel the Paleozoic axes of the Amarillo—Wichita Mountains uplifts. Although no direct relationship between a Precambrian trend and the Arbuckle or Criner Hills uplifts has been established, there is a strong indication that the entire Wichita system has a Precambrian ancestor. Late Paleozoic tectonic forces applied to an incompletely stabilized Precambrian orogenic zone composed of relatively incompetent metasedimentary prisms, large and small intrusive masses, and established planes of weakness resulted in a series of subparallel and *en echelon* folds, faults, and uplifts.

THE BASEMENT SURFACE

Configuration of the surface.—The topography of the basement surface is partially shown by 500-foot structure contours on Plate I. These contours are based on wells actually penetrating basement and no attempt is made to utilize estimated basement elevations from wells bottoming in Ordovician or Cambrian rocks. In the deep basins and in the basin-and-range country of far west Texas where basement wells are lacking, no basement contours are shown.

Most of the major near surface structural features in the Texas and southeast New Mexico area are reflected in the configuration of the basement surface. The major late Paleozoic uplifts elevated the basement surface several thousands of feet on the Central Basin Platform, the Amarillo uplift, the Matador uplift, and the Red River uplift (fig. 2). Until 1953 the depressed basement surface in the deep basins of west Texas and southeast New Mexico had not been encountered by the drill. However, recently the Richardson & Bass No. 1 Cobb-Federal in Eddy County in the Delaware basin encountered granite at 16,396 feet (–12,881). There are still no basement wells in the Midland basin proper. Basement rocks lie at the surface in the Llano uplift of central Texas, the Van Horn area, Pump Station Hills, Hueco Mountains, and Franklin Mountains in west Texas, and in the Wichita and Arbuckle Mountains of southern Oklahoma.

West of the Llano uplift the basement surface slopes more or less evenly toward the Midland basin. North of the Llano uplift there is only a slight basement expression of the late Paleozoic north-south feature which Cheney and Goss call the Bend axis (Cheney and Goss, 1952, fig. 9; Sellards, 1933, pp. 91–93). Northwest of the Llano uplift there is a prominent northwest-trending nose which corresponds to the Concho Platform of Cheney and Goss (1952, fig. 9) and whose axis parallels the more extensive mid-Paleozoic Concho or Texas arch.

North of the uplifted Matador structures (basement elevation –3,500 to –4,000 feet) the basement surface dips rather sharply into the Palo Duro basin (about –7,000 feet) and then rises more or less evenly toward the Amarillo uplift and the Oldham County high. The Amarillo uplift proper is marked by an abrupt topographic discontinuity. The basement surface on higher parts of the Amarillo uplift attains elevations in excess of +1,000 feet.

The regional configuration of the basement surface is due mostly to Paleozoic and younger structural movements and is well known; detailed information on the topography developed in Precambrian time and during subsequent emergences of the basement surface is sparse. V. E. Barnes (personal communication, 1953) has determined that about 800 feet of relief existed on the Precambrian surface in central Texas at the time the lowest Cambrian rocks were deposited. The rounded granite domes on this surface are very similar to those known in the Missouri lead district. Recent exploration of the so-called Cambrian trend from Coke County north to Cottle County indicates that hills or peaks of hard granite or arkose gneiss protrude above a metasedimentary surface of mica schist and phyllite. In the Van Horn area the surface on which the late Precambrian? Van Horn sandstone was deposited was a hilly, deeply eroded terrain; the surface of Precambrian rocks on which Permian rocks were deposited in this same area was a rolling one with perhaps 300 feet of relief.

Weathering of the basement surface.—It would be interesting to study the degree of weathering of the basement rocks where they are overlain by Paleozoic rocks of different ages. Unfortunately, however, the writer had little control over the interval of the basement samples contributed to the project. For such an investigation it would be necessary to study the entire basement suite of samples from the top of the basement to total depth or to fresh rock. Only for a few wells was such a suite of samples available, and the study of the alteration characteristics of the basement rocks was not attempted.

Paleozoic Sedimentary Rocks Resting on the Basement Surface

General remarks.—In the Texas and southeast New Mexico area, basement rocks are in direct sedimentary contact with strata representing all Paleozoic periods. The formation now resting on the basement is either (1) the original cover deposited from a Paleozoic sea lapping on the exposed basement surface or (2) a deposit by an overlapping or overstepping Paleozoic sea on an uncovered basement surface following tectonic dislocation and stripping of older Paleozoic formations from the uplift by erosion. Boundaries between formations of different ages which overlie the basement are shown on Plate I. This is an areal geologic map of the underside of a surface. Analysis of the relationships of the overlying formations to the basement rocks and to each other yields a broad picture of the paleogeography of this area during Paleozoic time.

Throughout this study of basement rocks the writer has relied on geologists practicing in the various districts for basic well information, including identification of the formation resting on basement. In some areas there is divided opinion on whether a formation is Permian or Pennsylvanian, Silurian or Devonian, or Cambrian or Ordovician; in order to abstain from this controversy, which is beyond the bounds of the study, and because the regional picture can be satisfactorily developed by using a combined nomenclature, the terms Permo-Pennsylvanian, Siluro-Devonian, and Cambro-Ordovician are herein employed. Although not satisfactory to the paleogeographer, these combined-time terms provide a general index of basement positive and negative areas during the Paleozoic and are as good as the data permit.

Cambro-Ordovician rocks. — Cambro-Ordovician rocks lie on the basement in a great arc extending from southern Oklahoma and north Texas through central Texas into west Texas and southeast New Mexico. These strata lap on to a basement high that was present in Paleozoic time in northern New Mexico and Colorado; a nose of this positive feature extended southeastward into central Texas. To the southeast a thin Cambro-Ordovician section is present over this feature which subsequently became positive in Silurian and Devonian time; northwestward, in the area of Dickens County, Cambro-Ordovician strata pinch out and Mississippian rocks lie directly on basement (Pl. I).

The designation Cambro-Ordovician does not include rocks of the same age throughout the area of study. To the east of a north-south line through western Schleicher County, a line which approximately delimits the Eastern Platform, Cambro-Ordovician rocks include the Upper Cambrian Riley and Wilberns formations as well as the Ellenburger group. To the west in the Midland and Delaware basins Wilberns and Riley equivalents cannot be positively identified, and possibly no Cambrian rocks are present. Facies changes in the Cambrian rocks of central Texas support the concept of a limited Cambrian basin. One should bear in mind, therefore, that although the designation Cambro-Ordovician in central and north Texas includes Upper Cambrian rocks, the same designation in the western part of the area refers to a unit in which the older rocks present in the east are missing and which may not include any Cambrian rocks.

Within the area where Cambro-Ordovician rocks rest on the basement, tectonic movements have produced local highs in Sutton, Schleicher, and Coke counties where older Paleozoic beds have been removed and Pennsylvanian rocks rest directly on basement rocks. Likewise on major late Paleozoic uplifts, such as the

Fort Stockton high, Central Basin Platform, Red River uplift (including Muenster and Electra elements), and Matador uplift, older Paleozoic strata were removed by erosion following uplift and the highs are capped by overstepping late Pennsylvanian or Permian rocks. The Matador structures in Floyd, Motley, and Hale counties transect the northwest-trending arch, and it is not certain whether Cambro-Ordovician rocks were ever deposited in that area.

In the northern part of the Texas Panhandle Cambro-Ordovician rocks are present in the Anadarko basin on the north flank of the Amarillo uplift; presumably, by analogy with the Wichita Mountains of Oklahoma, Cambro-Ordovician rocks were removed by erosion from the uplifted basement of the Amarillo Mountains prior to the overstepping late Pennsylvanian and Permian seas.

Much of what is called the Palo Duro basin was an upwarped part of the middle Paleozoic backbone and in this area Mississippian rocks lie directly on basement. However, in the northwestern and southwestern parts of this basin, on what used to be the flanks of the old positive area, Cambro-Ordovician rocks rest on basement. The Cambro-Ordovician contact with the basement is lapped over by Mississippian rocks.

Siluro-Devonian rocks.—Except for a local high on the east flank of the Central Basin Platform in Gaines County, Siluro-Devonian rocks in sedimentary contact with basement rocks are found only in southeast New Mexico. Siluro-Devonian rocks rest on the old basement surface in Chaves and Roosevelt counties, New Mexico, as part of a progressive Paleozoic overlap which includes Cambro-Ordovician, Siluro-Devonian, Mississippian, and Pennsylvanian strata. In addition, Siluro-Devonian rocks rest on basement in extreme southwest Chaves and northwest Eddy counties. In this ill-defined area Siluro-Devonian rocks lap over the Cambro-Ordovician-basement boundary and lie directly on the basement on an isolated early Paleozoic high area.

Mississippian rocks. — Mississippian rocks rest directly on basement in Chaves County, New Mexico, and in the southern Panhandle of Texas in an elongated area that corresponds to the Texas Peninsula. The extent to which Ordovician strata covered this backbone is unknown, and possibly some Ordovician rocks were removed from it prior to Mississippian deposition. The area was positive during Silurian and Devonian time. Rocks of this age show an off-lapping relationship and are restricted in Texas to smaller pockets in the larger Ordovician basins. Mississippian rocks lap over the Cambro-Ordovician-basement contact. Farther west in Chaves County, New Mexico, the Siluro-Devonian sea was more extensive and overlapped the limit of Cambro-Ordovician deposition.

Within the area of Mississippian-basement contact are local areas where Pennsylvanian and Permian rocks rest directly on the Precambrian surface. These highs are for the most part structural uplifts along the Matador trend where Mississippian rocks have been stripped off by erosion.

Permo-Pennsylvanian rocks. — Except for the Debaca County, New Mexico, area where Pennsylvanian rocks rest on the basement as a result of progressive overlap on a northwestern positive mass, Pennsylvanian and Permian rocks are in contact with basement rocks where late Paleozoic uplift resulted in stripping off of older Paleozoic rocks to expose the basement. Late Pennsylvanian and Permian rocks rest on uplifted basement in the following areas: (1) southwest of Van Horn in Hudspeth, Culberson, and Presidio counties, (2) Fort Stockton high, (3) Central Basin Platform, (4) Matador uplifts, (5) Red River uplift, (6) Amarillo uplift of the Texas Panhandle, and (7) Otero, southwest Chaves, and Lincoln counties, New Mexico. In the Van Horn area the area of uplift, as defined by the boundary between Cambro-Ordovician rocks on basement and Permian rocks on basement, approximately corresponds to the boundary between the Van Horn mobile belt and the Texas craton.

In addition to these areas where the Pennsylvanian-Permian contact with basement is clearly the result of uplift, there is a northwesterly-elongate area in eastern Roosevelt County, New Mexico, and western Cochran and Bailey counties, Texas, where Pennsylvanian and Permian rocks lie directly on basement. This area is on strike with the Matador trend to the east but the area of contact is not lineated parallel to that trend. The controlling structure here is a northwest-trending fault in southwest Roosevelt County, New Mexico. The basement rocks along this fault show extensive cataclastic alteration and mylonitization. The upthrown side on the northeast is capped by a Cambro-Ordovician remnant which indicates (1) that the area was at one time covered by Cambro-Ordovician rocks which are in extensive contact with the basement on the downthrown side of the fault and (2) post-Ordovician and pre-Silurian uplift did not altogether effect a removal of the Cambro-Ordovician rocks. Northwest of the Cambro-Ordovician rocks on the upthrown side of the fault Siluro-Devonian and Mississippian rocks rest directly on the basement, although they appear in part to have been stripped off by post-Mississippian (probably Pennsylvanian) uplift. Permo-Pennsylvanian rocks blanketed the area and rest on the basement surface uncovered by the post-Mississippian uplift. Contacts of basement terranes, Cambro-Ordovician strata, Siluro-Devonian strata, and Mississippian strata are displaced by the northwest-trending fault (Pl. I).

Faults or Fault Zones in Basement Rocks

Three major basement faults or fault zones and a number of smaller basement faults are shown on the map, Plate I. Study of the overlying sedimentary rocks no doubt reveals many more such dislocations which probably involve displacement of the basement rocks; however, in this paper only those faults revealed by a study of the basement rocks themselves or their immediate sedimentary mantle have been plotted. The faults shown on Plate I are indicated by: (1) abrupt rectilinear discontinuity in the configuration of the basement surface, (2) more or less straight-line boundaries between formations of different ages resting on basement rocks or offset boundaries between formations of different ages resting on basement, and (3) the character of the basement rocks themselves (cataclastic alteration and mylonitization) or interpretation of the trace of boundaries between basement terranes or provinces. Most of the minor faults and the major fault on the northeast side of the Central Basin Platform are indicated by abrupt changes in elevation of the basement surface and/or late Paleozoic sedimentary rocks resting on basement adjacent to Cambro-Ordovician rocks in contact with basement.

The presence of the northwest fault zone in southwest Roosevelt County, New Mexico, was first suspected when petrographic examination of the basement rocks showed extensive cataclastic alteration and partial mylonitization along a more or less northwest-trending linear zone. Contours on the basement surface support the hypothesis of a fault zone in this area and indicate that the upthrown side is on the northeast. Contacts between formations of different ages resting on the basement and between the Texas craton and the overlying volcanic rocks of the Panhandle terrane are offset by the fault—the northeast side of the fault has an apparent displacement in a southeast direction. The relationships of the Cambro-Ordovician, Siluro-Devonian, and Mississippian strata which lie on basement rocks on the upthrown side of this fault indicate more than one period of activity.

The major east-west-trending fault zone whose trace coincides approximately with the southern borders of Floyd, Hale, Lamb, and part of Bailey counties marks the southern limit of the Matador uplift. There is a major discontinuity in the topography of the basement surface along this line; the elevated side to the north is 2,000 to 4,000 feet higher than the basement surface on the south. Moreover, there is a distinct change in the "grain" of the topography. To the south there is a broad, even slope into the Midland basin; to the north there is a series of discontinuous high areas that in general show an east-west lineation. These highs drop off sharply into the Palo Duro basin farther north. On summits of the high areas Permian or Pennsylvanian rocks rest directly on basement and overstep the Ordovician-basement contact or the Mississippian-basement contact. These older Paleozoic strata were stripped off of the elevated basement areas following uplift and prior to deposition of late Pennsylvanian and Permian strata on the denuded hills. To the west a sliver of the Swisher gabbroic terrane is preserved on the downthrown side of the fault (Pls. I and II). To the north of the fault gabbroic rocks have been removed from the uplifted block so that volcanic rocks of the Panhandle volcanic terrane form the basement surface. However, the Mississippian and Cambro-Ordovician capping on the basement in part of this area shows that this relationship between the Panhandle volcanic terrane and the Swisher gabbroic terrane is the result of Precambrian movements along the fault zone. The basement rocks could not have been affected by Pennsylvanian erosion where they were mantled by older Paleozoic rocks. The idea of a Precambrian movement along this fault zone is supported by its east-west trend and coincidence with the east-west-trending Red River mobile belt. The eastern part of the fault lies wholly within the Red River mobile belt.

Farther north in the Panhandle in Collingsworth, Donley, and Carson counties a west-northwest-trending fault delimits the southern margin of the Amarillo uplift. There is perhaps a maximum of 2,000 to 2,500 feet of displacement of the basement by this fault or fault zone. It separates rocks of the Wichita igneous province on the upthrown side to the north from volcanic rocks of the Panhandle terrane and what are probably older rocks of the craton on the south. The fault zone also bounds Permo-Pennsylvanian rocks on basement to the north and Cambro-Ordovician rocks on basement to the south. This feature was probably displaced only in Pennsylvanian time.

THE OUACHITA FOLDBELT

History of the problem.—For many years it has been known that wells drilled in the general area of the Balcones fault zone encounter beneath the Cretaceous a sequence of steeply dipping clastic sedimentary rocks showing varying degrees of weak metamorphism. The first published reference to these rocks was made in a paper by Udden (1919) who speculated briefly on their age. As additional wells provided control, Sellards (1930, 1931), Cheney (1929), Miser (1929), Miser and Sellards (1931), and Van der Gracht (1931) showed the distribution of these rocks and relationship between them and folded rocks of Paleozoic age exposed in the Ouachita Mountains and the Marathon area. With acceptance of the idea that the buried rocks are Paleozoic rather than Precambrian in age, there came an attempt to delimit this "Ouachita facies" and separate it from the hypothetical land mass of Llanoria that presumably provided the sediments to fill the Paleozoic trough. The concept of Llanoria is the result of stratigraphic studies that indicate that the bulk of the sediments in the Ouachita geosyncline came from the south and dates to before the turn of the century (Branner, 1897). Miser (1921) and Sellards (1933, p. 21) give a summary of the old literature pertaining to this hypothetical landmass. At this time (1932) and for some years thereafter, higher grade metamorphic rocks called "schists" encountered beneath Cretaceous rocks in the Luling field, Caldwell County, and near Boquillas south of the Marathon region were thought to be Precambrian and to mark the eastern and southern limits of the Paleozoic geosyncline (Sellards, 1933, p. 132).

In recent years following a great deal of research by many geologists on the nature and behavior of geosynclines, new ideas have been formulated concerning the Ouachita foldbelt. Barnes (1948) demonstrated by a study of well cores and cuttings in central Texas that there is a progressive increase in metamorphism of these Paleozoic rocks from northwest to southeast. He outlined a belt of folded shales and quartzites, a belt of phyllites and quartzites, and a belt of schists (Pl. I). This latter belt includes the metamorphic rocks (here called phyllites) from the Luling area of Caldwell County that previously had been considered to be Precambrian in age. Following this reasoning, the metamorphic rocks in the Luling area are a more highly metamorphosed hinter facies of a Paleozoic geosyncline whose southern and eastern boundary is completely unknown. After a detailed petrographic study of Ouachita facies rocks, Goldstein and Reno (1952) subscribed to Barnes' hypothesis, and extended it to include all metamorphosed sediments encountered in wells along the Luling-Mexia-Talco fault system.

Likewise the old concept of Llanoria as an ancient crystalline landmass has suffered through geologic progress. Van der Gracht (1931, p. 1084) suggested that the Ouachita trough, instead of an *intra*-continental geosyncline between a continental Llanoria mass on the south and the North American continental foreland on the north, was a wide and complex inter-continental geosyncline composed of several distinct troughs separated by ridges. Morgan (1952), like Van der Gracht, does not believe in the existence of Llanoria as a continental landmass, but he differs from Van der Gracht in that he considers the Ouachita geosyncline a relatively narrow trough. Morgan says (p. 2266):

> . . . Llanoria, instead of being a Paleozoic landmass of continental size separated from a northwestward continent by a narrow geosyncline, was simply a bundle of mountain ranges possessing a long linear but limited lateral extent. It is further suggested that these mountains originated in a narrow geosyncline which formed early in Paleozoic time along the seaward belts of what had been the foreland of the northwestern continent. During their periods the mountains served as the source for the clastic sediments in the geosyncline which they partly occupied.

These concepts are in line with recent theories on the role of island arcs in geosynclinal development. The picture of the Ouachita geosyncline, then, ranges from a narrow trough between continental landmasses, to a narrow trough along the southeast edge of the continent, to a geosyncline of considerable width comparable to the Appalachian geosyncline.

Igneous and metamorphic exotic boulders in the Haymond boulder bed of the Marathon area.—Although it is unlikely that the full story of Llanoria will ever be known, we are not entirely ignorant about the nature of that terrane. (The term Llanoria is herein used to refer to a source area, whether it be an ancient crystalline landmass, older Paleozoic rocks—possibly metamorphosed and intruded—or both.) Exotic cobbles and boulders in the Haymond boulder bed (lower Pennsylvanian) are composed of igneous and metamorphic rocks that represent the most resistant rocks of the source area (King, 1937, pp. 21–22). The igneous rocks are for the most part muscovite granite and granodiorite, in part rudely gneissic, distinct from the biotitic granitic rocks of the craton to the north. Possibly some of these rocks are muscovite paragneisses (recrystallized arkosic sedimentary rocks); lacking the opportunity for examination of *in situ* field relations, it is difficult to distinguish an arkose gneiss from a gneissic granite where no diagnostic fabric elements can be observed. There are certain similarities between these muscovite granites or gneisses and the Precambrian rocks of the Van Horn mobile belt exposed in the Van Horn Mountains (King and Flawn, 1953, pp. 27–40), so that the hypothesis that these rocks came from the Van Horn mobile belt to the northwest rather than Llanoria to the south must be considered. General stratigraphic studies of the Paleozoic rocks of the Marathon area indicate a southern source (King, 1937, pp. 19–22), but King (personal communication, 1954) points out that well-worn round cobbles may be second cycle material whose original source lay in a different direction.

The metamorphic rocks of the Haymond boulder bed can be divided into a higher grade or Llanoria type and a lower grade or Ouachita type. The most common Llanoria types are highly sheared porphyries, generally of intermediate composition, in various stages of reduction to mylonite. Sheared metaquartzite is less common and one specimen of a distinctive tourmaline-garnet gneiss was collected. The common Ouachita type is a weakly metamorphosed orthoquartzite which shows authigenic silica overgrowths on unrecrystallized quartz grains and intergranular material reconstituted to chlorite and sericite.

The above comments on the petrography of the boulder bed material are generalizations, and a thorough study of these rocks is reserved for a future project.

Metamorphic rocks in Boquillas Canyon.—Metamorphic rocks are exposed in Boquillas Canyon which opens onto the Rio Grande in the sparsely settled country along the Rio Grande south of Big Bend National Park in Coahuila, Mexico. The area is poorly accessible and little is known about these rocks except that they are overlain by Cretaceous limestone (Edwards?). Samples of these metamorphic rocks examined by the writer were very highly sheared and deformed sericite phyllites and sericitic metaquartzites.

Without any concrete evidence these rocks were for many years considered to be Precambrian in age. Originally this conception was probably based on little besides their metamorphic state. With the recognition that metamorphosed Paleozoic rocks of the hinterland of the Marathon exposures of the Ouachita foldbelt might logically occur in this area, the age of the Boquillas metamorphic rocks was placed in question.

Subsurface Ouachita Foldbelt

Petrographic character and correlation problems. — The petrographer studying the metamorphic rocks encountered in wells in south-central and southwest Texas is immediately struck with some over-all similarities. The highest grade rocks in the more hinter parts of the Ouachita foldbelt as known through oil exploration are phyllites; these are found in the Luling area in south-central Texas and in the Kinney—Val Verde County area. Possibly phyllites have been penetrated in the intervening area but samples were not studied by the writer. A possible exception is the garnetiferous schist? reported by Goldstein and Reno (1952, p. 2289) from the Quintana No. 1-A Moore in Wilson County, but they consider this rock of low metamorphic grade (chlorite zone) because the garnet is spessartite. The common denominator of these rocks is that they have all experienced strong dynamic cataclastic metamorphism. Crushed zones, comminution, crinkling, contortion, microfaulting, fracture cleavage, and slaty cleavage are characteristic. Most of the rocks were originally fine-grained arenaceous shales and argillaceous sandstones, more or less calcitic or dolomitic.

Correlation of separated bodies of rock. exposed or concealed, on the basis of lithologic similarities is a dubious measure at best; if the rocks have experienced the same type of alteration the correlation is somewhat strengthened but the procedure is still hazardous, as is illustrated by the case in point.

If the petrographic study of the subsurface metamorphic rocks of the Ouachita foldbelt proceeds from the Ouachita Mountain area of Arkansas and Oklahoma[9] south to central Texas and thence westward to the Kinney—Val Verde County area there is a repetition of sheared slates and phyllites that, in conjunction with studies of outcropping rocks of the foldbelt, might be thought characteristic of the Paleozoic metamorphic rocks. Farther west in the Boquillas area, a similar sheared phyllite fits nicely into the sequence. However, to the northwest in the Van Horn area the Precambrian Carrizo Mountain group is in large part composed of the same type of sheared phyllites and slates so that if the study had started in the Van Horn area and moved eastward, the same rocks that fit so well into the Paleozoic metamorphic trend might on the basis of similarity to the Van Horn section be regarded as Precambrian rather than Paleozoic. One of the great unsolved problems of correlation in southwest Texas is the relationship of the southeastern extension of the late Precambrian Van Horn mobile belt to the western part of the late Paleozoic Ouachita foldbelt.

Igneous rocks in the Ouachita foldbelt in Medina County.—One exception to the prevailing slate-phyllite metamorphic sequence of the Ouachita foldbelt is in the Medina County area where two wells encountered cataclastically altered igneous rock beneath Mesozoic strata. The Moore No. 1 Wurzback penetrated partly mylonitized albite granodiorite. The Humble No. 1 Wilson penetrated altered andesite porphyry and brecciated granite; unfortunately a confusion of sample intervals makes it difficult to ascertain which of these rock types was encountered highest in the well. The amygdaloidal andesite porphyry is perhaps a lava flow intercalated with the Paleozoic sediments of the foldbelt; the granite is either (1) intrusive into the Paleozoic section (which does not appear in the well), (2) Precambrian basement, or (3) a thrust block of rock either Paleozoic or Precambrian age. Future prospectors in the area should endeavor to preserve cores of igneous rock for the zircon method of age determinations.

The Ouachita foldbelt as basement.—In southeast New Mexico, the Texas Panhandle, west Texas, and north-central Texas the study of the basement is a study of the Precambrian. In the area of the Ouachita foldbelt the problem is complicated. If wells penetrating Ouachita facies have no economic potential these

[9] See Miser (1943) for a report on metamorphism of rocks cropping out in the Ouachita Mountains.

rocks can, from the point of view of the petroleum geologist, be considered basement. The geologist concerned purely with structure of continental magnitude would probably not agree to this. Moreover, many geologists have considered the possibility of drilling through Ouachita facies rocks along a theoretical overthrust front and encountering unmetamorphosed and essentially undeformed foreland Paleozoic rocks with possible economic potential. One or two wells in the Kinney-Val Verde-Terrell-Brewster counties area may possibly have encountered more or less unaltered Paleozoic rocks of normal facies beneath rocks of the Ouachita facies.[10] Such information is, of course, very significant, generally restricted, and difficult to confirm.

South and east of the established Ouachita foldbelt it is impossible to make definite distinctions between highly metamorphosed Paleozoic rocks and Precambrian rocks where both are overlain by the Mesozoic rocks. If Llanoria consisted of Paleozoic "source ranges" or island arcs rather than a continental landmass, it is possible that cores of Precambrian rocks were exposed in these tectonic lands. (Kay, 1951, suggested the name *tectonic land* for area raised by tectonic movements.) It may be that today, beneath the Mesozoic cover, long belts of Precambrian rocks that formed the cores of these foundered mountain chains are flanked by metamorphosed Paleozoic rocks—that rocks widely separated in age were fused to a single metamorphic mass during late Paleozoic orogeny. It is Morgan's thesis (1952) that Mesozoic rocks do not everywhere rest on metamorphic rocks because in some areas evidence from wells shows that these old mountains are flanked by flat-lying and undeformed late Paleozoic rocks.

The old concept of Llanoria as a positive mass of continental proportions leads to a more simple picture. According to this idea it is theoretically possible to establish a more or less linear boundary between the metamorphic rocks of the Ouachita facies and the Precambrian rocks of the old crystalline landmass. Of course, in practice the thick cover of Mesozoic and Cenozoic rocks makes it unlikely that there will ever be enough well control to draw such a boundary in the Gulf Coast region even presuming there was some method of distinguishing the rocks of the different eras.

In the writer's opinion it is very unlikely that the old concept of Llanoria as a single continental landmass is still tenable in the light of recent studies on geosynclines and island arcs. More probably, the hinter portions of the Ouachita geosyncline and the hinterland or source area are composed of Paleozoic and Precambrian rocks fused by tectonic and igneous activity into a complex of metamorphic rocks.

[10] Magnolia No. 1 Wardlaw, Kinney County; Freeman No. 1 Barksdale, Terrell County; Woods No. 1 Decie, Brewster County. The writer has not studied these wells personally. Geologists working in the area differ on interpretations of the geological relations.

Summary

Despite increasing data from exploratory wells, many problems still remain in the Ouachita foldbelt. Its fundamental nature is still in question; the major hypotheses are:

(1) The Ouachita foldbelt is a narrow prism of folded and thrust-faulted Paleozoic rocks derived from a more southerly or southeasterly continental landmass composed of Precambrian igneous and metamorphic rocks.

2) The Ouachita foldbelt is a narrow prism of folded and thrust-faulted Paleozoic rocks derived from island arcs or tectonic lands thrown up in a narrow Paleozoic geosyncline, and that rocks of the foldbelt are covered on the south and southeast by relatively flat-lying and undeformed Paleozoic rocks.

(3) The Ouachita foldbelt is comparable to the Appalachian chain and consists of a northern or northwestern front of folded and thrust-faulted Paleozoic sedimentary rocks which, to the south and southeast, become progressively more altered and grade into metamorphosed and intruded Paleozoic rocks that at one time constituted the keel of a major geosyncline.

Geologic opinion is divided and resolution of the problem depends on further study with new data and a round-up of all the old data.

YOUNGER IGNEOUS ROCKS

In many places in the region, especially in tectonically active parts, igneous rocks of Paleozoic or younger age intrude the sedimentary rocks above the basement. In places these intrusions may be mistaken for basement. Thus, in oil exploration, it is important to know whether igneous rock encountered beneath, say, Pennsylvanian or Permian rocks is part of a basement ridge from which earlier Paleozoic rocks had been removed, or whether it is a later intrusion such as a sill, dike, or laccolith. A number of wells in the area are known to have passed through such tabular intrusive bodies (Table 11), but many more may have been drilled into them and abandoned on the assumption that the rock was basement.

In west Texas and eastern New Mexico there was widespread Tertiary igneous activity including emplacement of many small stocks, plugs, dikes, sills, and laccoliths and large volumes of extrusive and pyroclastic rocks. Some of these rocks are characterized by distinctive alkalic mineralogy, and a number of igneous bodies encountered in subsurface can be recognized as very probably Tertiary on the basis of these distinctive alkalic minerals (Flawn, 1952). However, many of the exposed Tertiary rocks do not contain these distinctive minerals and if such rocks are encountered in subsurface as intrusions in Paleozoic rocks, they could not be recognized as of Tertiary age. Moreover, alkalic rock types occur in the Precambrian rocks of the Wichita igneous province in the Wichita Mountains and in the subsurface in Oldham, Gray, and Wheeler counties so that alkalic rocks are not an absolute indication of Tertiary age. The Tertiary age which was assigned to the alkalic igneous rock in the Smith No. 2 Farren in Wheeler County (Flawn, 1952) is apparently in error and this aegirine granite is properly part of the late Precambrian Wichita igneous province.

Some of the younger intrusions may have been emplaced before the Tertiary, in Mesozoic or Paleozoic time. Intrusive and pyroclastic rocks of Tertiary and Cretaceous age are present along the Balcones fault zone (Lonsdale, 1937). Field evidence of Paleozoic igneous activity is scanty but wide areas of Paleozoic rocks are concealed by younger rocks. The single occurrence that has been reported to the writer was found by J. L. Wilson (personal communication, 1953) in the southeast part of the Marathon uplift about 30 miles southwest of Sanderson, where basic igneous rocks intrude Ordovician strata and are beveled by the Cretaceous strata.

ANALYSIS OF GRAVITY DATA

General remarks.—The gravity data available for the basement study were generalized regional bouguer anomaly maps by Nettleton (1949, fig. 1, p. 276) and Logue (1954, insert map) and detailed bouguer anomaly maps of a large part of the area by the Brown Geophysical Company of Houston. The latter are, however, not available for reproduction.

Gravity anomalies of the Texas craton.—The margin of the craton is well defined to the east, southeast, and south by an arcuate but narrow belt of gravity minima (–10 to –20 milligals) that reflect the Ouachita foldbelt. In the far southwest is a series of northwesterly elongated maxima and minima along the margin of the craton which give way southward to a pronounced minimum that reflects the Van Horn mobile belt and the younger Mesozoic geosyncline of northern Mexico. For the purpose of gravity analysis the Texas craton can be divided into two major areas, a southeastern "amoeboid" area and, northwest of it, a pronounced northeasternly elongated negative belt.

The "amoeboid" pattern of the southeastern part of the craton is a reflection of density differences between metasedimentary rocks and the numerous separated granite masses which intrude them. The pattern can be directly related to changes in rock type in the Llano uplift, and the same conditions probably prevail off the flanks of the uplift where the basement rocks are concealed by sedimentary rocks (Barnes et al., 1952).

A prominent gravity feature of the Texas craton is a long belt of northeast-trending minima which extend from Martin County (–113 mg) northeast through Howard County (–105 mg), Fisher County (–111 mg), Palo Pinto County (–88 mg), to Tarrant County. Part of this trend is named the Abilene Minimum by Logue (1954, pp. 134–135). At its northeastern end this negative belt is interrupted by the northwest-trending maximum of the Wichita system; however, the trend of the belt can be projected across the Wichita trend to coincide with the northeast-trending negative belt that marks the McAlester basin of Oklahoma. The problem of the southwestern terminus of the negative belt is susceptible to alternative solutions: (1) the trend can be projected southwestward across a saddle in the interrupting maximum of the Fort Stockton high—Central Basin Platform into the negative area of Loving County (–160 mg) and Culberson County (–152 mg) finally to terminate against the maximum of the Diablo Plateau or (2) the axis of the minima belt can curve southward along the Central Basin Platform and join a negative belt in Upton (–98 mg) and Crockett counties.

No apparent correspondence exists between this negative belt and a particular basement lithology; however, much of the belt falls within Paleozoic basins (Fort Worth basin, Midland basin, and Delaware basin) where there is no basement control; control is sparse where the trend crosses areas where the basement is shallower and has been penetrated (Bend arch and Eastern Platform). The negative belt cuts the Precambrian Fisher metasedimentary terrane. The cause of this negative trend is not definitely known; but if the southwestern end of the belt curves southward into Upton and Crockett counties, it forms a northwestern arc around the "amoeboid" part of the craton. The pattern suggests that the belt of minima might represent an old mobile belt or orogen welded around a smaller version of the Texas craton. Logue (1954, p. 135) believes this minima trend represents a "fossil basin of probable pre-Cambrian age." The Fisher metasedimentary terrane appears to cross this older trend. Possibly the granites intruded into this suggested orogen are younger than the granites of the Llano uplift, which area

TABLE 11. *West Texas and southeast New Mexico wells that penetrate post-Precambrian igneous rocks.*

COUNTY	OPERATOR and FARM	LOCATION Sec–Block–Surv	YEAR COM-PLETED	ELEVA-TION	TOTAL DEPTH
Texas—					
Brewster—1P[1]	Dodson (Hinton) #1 Tex-Amer Synd.	66 – 10 – GH&SA	44	4233	9046
Culberson—1P	Magnolia #1-A Cowden	12 – 63 – T&P	52	3917	11651
Hudspeth—1P	Magnolia #1-39881 State	19 – C – UL	54	ni	5420
Hudspeth—2P	Seaboard & Shamrock #1-C Univ.	45 – C – UL	48	4981	3117
Jeff Davis—1P	Continental #1 McCutcheon	18 – 11 – GH&SA	52	4170	9563
Presidio—1P	Gulf #1 Mitchell	40 – 1 – TWNG	54	5338	15996
Presidio—2P	Presidio #1 Conring	102 – 4 – GH&SA	41	4497	4523
Ward—1P	Tex-Oil #1 Redman	162 – 34 – H&TC	30	2717	5078
New Mexico—		Sec—Tsp—Range			
Chaves—17	Humble #1-N State	35 – 14S – 17E	44	3615	4014
Lea—1P	Texas #1 Moore	21 – 20S – 32E	35	3508	3019
Otero—1P	Flynn et al. #1 Donahue	28 – 24S – 15E	35?	4550 (est.)	1688

[1] Numbers are location numbers on Plate I.

TABLE 11. *West Texas and southeast New Mexico wells that penetrate post-Precambrian igneous rocks.*

IGNEOUS ROCK INTERVAL	AGE OF FORMATION INTRUDED	LITHOLOGY OF IGNEOUS ROCK	INTERVAL and MATERIAL STUDIED		AGE OF INTRUSION
4455–4710	Permian	analcite microsyenite	4513–4650	cuttings	Tertiary?
6078–6458	Ordovician	aegirine-arfvedsonite microgranite	6100–6400	cuttings	Tertiary?
8735–9120	Pennsylvanian	syendiorite	8760–8770	core	?
ni	Permian and Pennsylvanian	ni	nsl		?
±1300 (70′ sill)	Mississippian-Pennsylvanian	analcitic aegirine trachyte	±1300	cuttings	Tertiary?
7625–7635	Ordovician	olivine microsyenogabbro	7620–7630	cuttings	Tertiary?
ni	Devonian	ni	nsl		?
4020–4410	?	aegirine-riebeckite-arfvedsonite microgranite	4020–4410	cuttings	Tertiary?
4270–4362	Permian	diabase?	nsl		?
4440–4455	Permian	diabase?	nsl		?
4585–4617	Permian	diabase?	nsl		?
2730–2950 3350–TD	Permian-basement?[2]	diabase diabase	3500–3939	cuttings & core	Tertiary?
2110–2170	Permian	basalt?	nsl		?
1685–TD	Permian?	analcite-aegirine microsyenite	1685–1688	cuttings	Tertiary?

nsl—no samples located.
ni—no information.
[2]This rock may be Precambrian but its "high" position and the presence of analcite in small quantity (alkaline affinity) suggest it may be Tertiary.

plays the role of an older original nucleus. This indicates two cycles of growth of the Texas craton, a smaller ancient core including the rocks of the Llano uplift and a younger but still ancient northwestern increment. This phase of Precambrian history perhaps resulted in the formation of the larger Texas craton shown on Plate I which behaved as a stable unit in late Precambrian time.

The most prominent gravity feature of the craton is the maximum corresponding to the Fort Stockton high—Central Basin Platform which shows a maximum of −41 mg near Hobbs on the Platform and a −160 mg minimum in the flanking Delaware basin in western Loving County. The density contrast between the granites of the Platform and the sedimentary rocks in the flanking basins (largely carbonate rocks) and the degree of elevation of the basement are not sufficient in themselves to account for an anomaly of this magnitude (R. K. DeFord, personal communication, 1953). Evidently this part of the crust is in strong disequilibrium through downwarping of the sial in the basins and upwarping of the sima between them.

Two conspicuous circular maxima occur within the northwestern part of the craton: (1) a −11 mg maximum centered at the intersection of the northwest corner of Throckmorton County and the southeast corner of Knox County and (2) a −15 mg maximum centered at the intersection of the northeast corner of Garza County and the southwest corner of Dickens County (Crosbyton dome). As there are no basement wells in the first area and basement wells in the general area penetrate normal cratonic granite and granodiorite, there is no ready explanation for these phenomena.

Gravity anomalies of the Van Horn mobile belt.—Only generalized gravity data are available to the writer for the area of the Van Horn mobile belt. A northwest-trending minimum over the area reflects the metasedimentary prism of the mobile belt; the area immediately northeast and east is marked by a series of northwest-trending maxima in Brewster, Jeff Davis, Culberson, and Hudspeth counties that perhaps delineate the margin of the craton.

Most of these features reflect structures in the sedimentary rocks above the basement, rather than Precambrian structures, although the former may, in turn, have been influenced by Precambrian structure. The series of northwest-trending maxima in Brewster, Jeff Davis, Culberson, and Hudspeth counties, for example, probably extends southwest of what was the limit of the craton of late Precambrian time. By Mesozoic time the craton had been enlarged by the welding-on of the Ouachita foldbelt which, like the older craton, acted as a stable foreland for the Mesozoic Mexican geosyncline.

Gravity anomalies of the Red River mobile belt.—Although dwarfed by the prominent maximum of the Wichita system, a series of east-west elongated positive and negative areas extends, with interruptions, from Montague County west into Roosevelt County, New Mexico, and coincides with the trend of the Precambrian Red River mobile belt and the younger Matador structures. As in the Central Basin Platform problem, the elevations of the basement rocks in the Matador structures and the density contrast between the basement rocks in the uplifts and the flanking sedimentary rocks are insufficient to account for the magnitude of the anomalies along the trend. Apparently these east-west elongated anomalies are a reflection of the prism of metasedimentary and intrusive rocks that constitute the Red River belt; as interpreted, the anomalies tend to support the extension of the Red River belt beneath volcanic rocks of the Panhandle volcanic terrane.

Gravity anomalies of the Fisher metasedimentary terrane.—No obvious correspondence exists between the metasedimentary rocks of the Fisher terrane as delimited and the gravity trends of the same area. The roughly north-south-trending Fisher belt is almost at right angles to the northeast-trending negative belt that extends across the entire craton. The metasedimentary rocks encountered in Fisher County (the Abilene Minimum of Logue, 1954, pp. 134–135 and map) fall into one of these minima; the northern part of the Fisher belt corresponds to a vague minimum that exists as a saddle between two maxima. A possible explanation is that the Fisher metasedimentary rocks are relatively rootless while the northeast-trending negative belt is the result of deep-seated crustal phenomena.

Gravity anomalies of the Panhandle volcanic terrane and the Swisher gabbroic terrane.—The Panhandle volcanic terrane is an essentially stratiform mass of lavas and tuffs which conceals underlying basement rocks so that interpretation of gravity anomalies is uncertain at best. Because there is no conspicuous gravity maximum marking the subsurface extent of the dense gabbroic rocks of the Swisher terrane, evidence from drill records that they are a stratiform rootless pluton or series of plutons is confirmed. The general area underlain by gabbroic rocks is marked by gravity minima; but as the gabbroic rocks coincide with the structural low of the Palo Duro basin, the minima are probably related to subcrustal adjustments in connection with the formation of the basin.

Gravity anomalies of the Wichita igneous province.—By far the most conspicuous feature of the gravity picture of Texas and Oklahoma is the series of maxima which coincides with the Muenster, Wichita, and Amarillo uplifts; these maxima begin rather abruptly in northwest Collin County, Texas, and extend northwestward through Oklahoma to Potter County in the Texas Panhandle. An offset to these northwest-trending maxima is indicated in Deaf Smith, Oldham, and Hartley counties but it cannot be evaluated because of lack of coverage on the Matador Land & Cattle Company property in this area. The maximum of +35 mg on the Wichita trend in Kiowa and Greer counties of Oklahoma, is contrasted to a –81 mg minimum to the south in Wilbarger County, Texas. Again the amount of basement uplift and the density contrast between granite and flanking sedimentary rocks is inadequate to account for the magnitude of the anomaly. Either there is a greater amount of gabbroic rocks in the Precambrian rocks of the Wichita-Amarillo trend than is apparent from examination of surface exposures and drilling records or the answer lies in the distribution of sialic and simatic material in the subcrust.

Summary

Major lithologic-structural divisions of the basement in general agree well with regional gravity trends. The margin of the craton and the two principal Precambrian mobile belts are well expressed, whereas rootless stratiform terranes are not separately reflected. The regional gravity picture is controlled largely by basement phenomena, but in some areas it is difficult to separate the effects of older Precambrian structural trends from younger Paleozoic features. The northwesterly elongated maxima that mark the Muenster, Wichita, and Amarillo uplifts cut across other gravity trends and are a reflection of a Paleozoic structure, notwithstanding a more or less coincident Precambrian ancestral belt of tectonic and igneous activity.

PRECAMBRIAN HISTORY OF THE TEXAS—SOUTHEAST NEW MEXICO AREA

SUMMARY

The Precambrian history of the Texas—southeast New Mexico area is summarized in Table 12. The oldest known rocks in the area are exposed in the Llano uplift of central Texas and constitute part of the Texas craton. Our observations on the age of these rocks are confined to their relatively latter-day history when, about 1 billion years ago, a sequence of metasedimentary and meta-igneous rocks was extensively invaded by granite. However, the existence of the craton or stable area probably dates from that time. The granite and granodiorite that are exposed in the Llano uplift and have been encountered in many wells to the north and west effectively consolidated this part of the continent into a relatively immobile block in middle Precambrian time. Although the dated granites of the Llano uplift cannot be positively correlated with the great expanse of granite and granodiorite that extends beneath the sedimentary cover to the west, the mineralogy of the granitic rocks and evidence that this great granitic block as a unit influenced later Precambrian developments in the north and west suggest the correlation. The correlation is further substantiated by new zircon age determinations on granites encountered in wells west of the Llano uplift (p. 31).

The concept of the Texas craton as a stable area formed in middle Precambrian time is based not upon its great volume of granites, although these are suggestive—and dated as about 1,000 million years old in the Llano uplift area—but upon its relationship to late Precambrian rocks. The behavior of the Van Horn mobile belt indicates a stable mass to the north in late Precambrian time; the great expanse of late Precambrian lava flows in the northern part of the area seems to have had a stable floor; and the probably late Precambrian Red River mobile belt, although its relations are obscure, is at least geographically marginal to the central granitic terrane. The pattern of late Precambrian igneous and tectonic events around the granitic terrane tends to confirm its stable role during late Precambrian time.

In late Precambrian time there was extensive tectonic activity and associated igneous activity along the margins of the craton, both to the north in the area of the Red River mobile belt and to the far west in the Van Horn area. In these areas great prisms of sedimentary rocks were deformed and metamorphosed; in the Van Horn area where the rocks are exposed the thrust came from the south and the geosyncline was squeezed against the craton; the nature of the orogenic activity in the Red River belt is unknown. The metasedimentary rocks encountered in southern Chaves and Eddy counties of New Mexico probably also mark the margin of the craton in late Precambrian time.

Following the orogenic activity in north-central Texas, southern Oklahoma, and west Texas, or perhaps in part contemporaneous with it, floods of rhyolitic lava were erupted on the surface of the craton in the Texas Panhandle and eastern New Mexico. A profusion of rhyolitic rocks, both intrusive and extrusive, was also emplaced in the Van Horn—El Paso area. Rhyolite that has been cataclastically metamorphosed intrudes the older metasedimentary rocks of the Carrizo Mountain group in the Van Horn area; unmetamorphosed rhyolite crops out in the Pump Station Hills in Hudspeth County and in the Franklin Mountains; rhyolite has been encountered in two wells in the same area (p. 43).

The last major period of igneous activity in the Texas-Oklahoma area consisted of intrusion of the gabbro lopolith of the Swisher terrane in the southern Panhandle and the possibly correlative gabbro-granite intrusions of the Wichita igneous province which are partly exposed in the Wichita Mountains.

TABLE 12. *Tentative correlation*[1] *of Precambrian rocks and structural events in Texas, southern Oklahoma, and southeast New Mexico.*

	CENTRAL TEXAS	NORTH TEXAS	TEXAS PANHANDLE	WICHITA MOUNTAINS—BURIED AMARILLO MOUNTAINS	ARBUCKLE MOUNTAINS	VAN HORN AREA	WEST MARGIN OF TEXAS CRATON; FRANKLIN MOUNTAINS; SOUTHEAST NEW MEXICO
						sedimentary rocks (Van Horn sandstone)	
			SWISHER GABBROIC TERRANE emplacement of gabbro (lopolith?); contact metamorphism of sedimentary rocks	WICHITA IGNEOUS PROVINCE gabbro-granite (670 m.y.) intrusion; contact metamorphism of sedimentary rocks (Meers quartzite)		local orogeny—cataclastic metamorphism; diorite intrusion	
			subsidence; sedimentary rocks (carbonate rocks and siltstones)	sedimentary rocks Meers quartzite)		sedimentary rocks (Allamoore and Hazel formations)	
LATE PRECAMBRIAN			PANHANDLE VOLCANIC TERRANE lavas, tuffs, shallow intrusives—mostly rhyolite		rhyolite intrusions? (East and West Timbered Hills porphyries)	rhyolite intrusions	rhyolite intrusions and extrusions
	FISHER METASEDIMENTARY TERRANE regional metamorphism of sedimentary rocks	RED RIVER MOBILE BELT regional metamorphism of sedimentary rocks; intrusion			synorogenic? granite intrusions	VAN HORN MOBILE BELT regional metamorphism (Carrizo Mountain group pre-rhyolite)	regional metamorphism of sedimentary rocks (Lanoria quartzite?)
	TEXAS CRATON granitic intrusions (about 1000 m.y.)	Texas craton to south	TEXAS CRATON granitic intrusions			Texas craton to north and northeast	Texas craton to east
MIDDLE PRECAMBRIAN	regional metamorphism and intrusion (Valley Spring gneiss, Packsaddle schist, older gneissic meta-igneous rocks.						

[1] Based primarily on correlation of rhyolite extrusive and intrusive activity in the separated areas.

Subdivision of Precambrian Time

There are great differences in the state of our knowledge of Precambrian rocks in their separated exposures on the North American continent. In some areas where there have been thorough geologic studies, notably the Lake Superior region, a formal time scale has been established; in many other areas the terms *early, middle,* and *late* are used in a relative sense. Thus, the early Precambrian rocks in one area may be equivalent to middle or late Precambrian rocks in other areas.

In addition to the determinations of relative ages of rocks in outcrop by conventional geologic methods, there is a growing body of data on the absolute ages of rocks by various methods of radioactive age determination. One day these data will be sufficient to assign definite spans of time to the *early, middle,* and *late* divisions so that Precambrian rocks in separated areas can be fitted into an overall scheme. The oldest dated rocks are in the neighborhood of 2,500 million years (some allegedly older rocks from South Africa are still in question), and the youngest known Precambrian rocks range between 600 and 700 million years. Assuming that the beginning of Precambrian time dates from the oldest known rocks and not from the theoretical age of the formation of the crust, Precambrian time includes a span from ±500 million years to 2,500+ million years, but there has yet been no attempt by a responsible committee to give numerical significance to the early, middle, and late divisions.

In this paper the term middle Precambrian is applied to the granites of the Llano uplift whose ages are about 1,000 million years, and late Precambrian is applied to the 670 million-year old granite in the Wichita Mountains. It is likely that the late Precambrian designation will stand but possibly in future years, in a general Precambrian time classification, an age of 1,000 million years will be considered late Precambrian.

Growth of the North American Continent

Any regional study of ancient Precambrian rocks encounters fundamental geologic problems on the composition of the ancient earth and the origin of continents. In the Texas and southeast New Mexico area we have evidence of a craton of considerable antiquity, though not of such great age as the interior part of the Canadian shield. Theories that explain the origin of the North American continent by accretion and growth around the Canadian shield as a single nucleus are hard put to explain the origin of this ancient Texas stable area hundreds of miles to the south of Precambrian rocks of the same age in the Canadian shield. (Compare radioactive age determinations; Holmes, 1931, pp. 321–351; Hurley, 1950; Collins et al., 1954.)

A valuable discussion of ideas on continental growth has been included by Kay (1951) in his memoir on North American geosynclines. He states that if continents have grown by accretion from a central cratonic nucleus, the age of batholithic intrusions should be progressively less from the center outward and that there is, in fact, such a progression in the rocks of the Canadian shield area. He states further that the presence of very old intrusions in areas such as the Black Hills, central Colorado, Great Bear Lake, and *central Texas* indicates that the problem is more complex and that there may have been several cratonic nuclei of the sort suggested by J. T. Wilson (1949, p. 180). Evidence presented herein supports the idea of continental growth through coalescence of cratonic nuclei; the craton of central and west Texas qualifies as such a nucleus. The presence of peripheral mobile belts crowded against this nucleus is in accord with modern theory, but there are insufficient data to determine the extent to which these mobile belts have been rigidified by batholithic intrusion. The Red River late Precambrian mobile belt seems, for example, to have remained a zone of weakness throughout much of later geologic time. It strongly influenced the Paleozoic orogenic development in the area and, to a limited extent, regained a degree of mobility although without Paleozoic metamorphism and intrusion. The 12 000 or more feet of Ordovician, Silurian, Devonian, and Mississippian in the Wichita trough are geosynclinal and their accumulation was followed by folding, thrust-faulting, and uplift in Pennsylvanian time. This northwest-trending Paleozoic orogenic belt which penetrates the enlarged Paleozoic craton and coexisted with the marginal Ouachita geosyncline may have been controlled by a not entirely stabilized Precambrian orogen and occupied the site of a fundamental "continental joint"; probably the general crustal instability attending the development and deformation of the marginal Ouachita geosyncline contributed to the development of the Wichita system.

The Precambrian Van Horn mobile belt lies between the craton and the exposure of the Ouachita foldbelt in the Marathan uplift, but the relationship of the two orogens is uncertain. Granite of the craton was encountered in southern Pecos County in the deep Puckett wells drilled by Phillips Petroleum Company about 20 miles north of the Ouachita front. There seems little possibility that the Van Horn mobile belt occupies this narrow zone. More probably the Van Horn mobile belt is limited in its eastward extent and was welded to the craton in late Precambrian time to form a more or less stable southwestern cusp or bulge of the craton in Paleozoic time. This stable addition to the craton caused the Ouachita geosyncline to depart from the broad arc it formed around the Llano buttress and again swing southwest, as indicated by the Marathon-Solitario trend. The Van Horn mobile belt, then, seems to have achieved greater post-Precambrian stability than its northern counterpart, the Red River belt. Possibly this was due to more extensive batholithic intrusion in its hinter reaches. The pegmatites in the southern Van Horn Mountains, the granitized rock in the Hunt No. 1 Presidio Trust, and the granite in the Welch No. 1 Espy in Presidio County suggest an extensive granite terrane in the southern part of the Van Horn belt.

According to the multiple-nucleus theory of continental origin and growth, the Texas craton was one of several nuclei apparently considerably younger than the nucleus or nuclei that constituted the south-central parts of the Canadian shield. Probably the Texas continental nucleus was separated from the main continental nucleus of the Canadian shield throughout early and middle Precambrian time. These continental nuclei continued to grow by dynamic tectonic processes and concomitant batholitic intrusion; mobile belts formed peripherally to the nuclei and were welded to them by tectonic and igneous activity. In late Precambrian time mobile belts studied in this project were in existence in what is now southwest and north-central Texas; how many similar belts were incorporated into the Texas craton in earlier Precambrian time is unknown. By the end of the Precambrian time or at least by the beginning of Cambrian time, the North American continent had been welded into a stable mass from Texas to northern Canada, and new mobile belts had begun to form in the areas of what is now the Appalachian-Ouachita trend and the Cordilleran trend (Kay, 1951, pp. 7–15). This stable continental mass that existed at the beginning of Cambrian time is the hedreocraton of Kay (1951, p. 4), and the Texas craton discussed herein is the southwestern part of this feature and was added to it at some period in the latter part of Precambrian time.

To some geologists the picture of a stable continental mass at the beginning of Cambrian time consisting of coalesced continental nuclei is somewhat marred by the presence of the late Paleozoic orogenic belt, the Wichita system, trending northwest and west within the so-called stable region. King (1951, p. 4) has commented on the occurrence of orogenic belts within the stable region:

> *The broad tendency* has, . . . *been for the stable* region to be extended outward by growth and final immobilization of the surrounding orogenic belts, but during this process the stable region has from time to time been modified, and even temporarily mobilized. The edges have served as forelands of the adjacent orogenic belts; during growth and deformation of these belts the edges have been downwarped, faulted and moderately folded. Some branches of the orogenic belts have also penetrated and fragmented the southwestern corner of the stable region, thereby isolating from the main body such outlying bastions as the Colorado Plateau.

Possibly the analysis of the control of the Paleozoic Wichita system by an incompletely stabilized Precambrian orogen can be extended to the continent as a whole. Major trends or zones of tectonic movement in the sedimentary mantle might serve to define some of the fundamental joints of the post-Precambrian craton along which the older nuclei were welded together.

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TABLE I

PART 1—DATA ON TEXAS BASEMENT WELLS

Numbers affixed to county names are location numbers on the map, Plate I. Rock names and sequences shown in this table are commonly condensed on Plate I. Page numbers refer to petrographic reports on individual wells in Appendix II. DF, derrick

COUNTY	OPERATOR and FARM	LOCATION Sec-Block Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev
Andrews—1	Gulf #9 E University "Z"	42–13–UL	49	3299	11110	11078	−7779
Andrews—2	Humble #3 Lineberry	8–A40–PSL	51	3334	10668	10665	−7331
Andrews—3	Humble #1 Pinson	13–A40–PSL	47	3335	10861	10830	−7495
Andrews—4	Humble #1 Scarborough	7–A40–PSL	44	3423	10929	10905	−7482
Andrews—5	Phillips #38 University	30–10–UL	43	3255	8005	7974	−4719
Andrews—6	Phillips #45 University	19–10–UL	43	3256	8015	8004	−4748
Andrews—7	Phillips #50 University	29–10–UL	44	3247	7857	7846	−4599
Andrews—8	Phillips #57 University	29–10–UL	44	3239	8045	8034	−4795
Andrews—9	Phillips #58 University	29–10–UL	44	3242	7926	7877	−4635
Andrews—10	Phillips #60 University	29–10–UL	44	3249	7867	7839	−4590
Andrews—11	Phillips #61 University	20–10–UL	45	3247	7902	7860	−4613
Andrews—12	Phillips #5-M University	31–13–UL	48	3269	10828	10724	−7455
Andrews—13	Phillips #10-M University	31–13–UL	48	3247	10790	10714	−7440
Andrews—14	Phillips #16-M University	31–13–UL	49	3262	10826	10807	−7545
Andrews—15	Phillips #18 M University	31–13–UL	49	3279	10980	10945	−7666
Andrews—16	Phillips #19-M University	31–13–UL	49	3271	11011	10991	−7720
Andrews—17	Phillips #20-M University	31–13–UL	50	3262	10957	10930	−7668
Andrews—18	Shell #1 Cox	5–A31–PSL	44	3437	11061	11050	−7613
Andrews—19	Shell #1 Nelson	8–A40–PSL	46	3335	10606	10585	−7250
Andrews—20	Shell #1-A Nelson	3–A40–PSL	51	3342	10335	10314	−6972
Andrews—21	Shell #1-E Scarborough	11–A31–PSL	46	3385	9714	9703	−6318
Andrews—22	Shell and Texas #1 Collins	4–A40–PSL	48	3350	10380	10376	−7026
Andrews—23	Sinclair-Prairie #1 Grisham-Hunter	14–73–PSL	44	3242	11322	11315	−8073
Andrews—24	Stanolind #1 McCrea	24–A39–PSL	47	3380	10479	10472	−7092
Andrews—25	Stanolind # 1 Sims	16–A39–PSL	47	3385	10960	10876	−7491
Andrews—26	Stanolind #1 Stiles	8–A38–PSL	50	3414	11500	11475	−8061
Andrews—27	Stanolind #3-AE University	31–13–UL	48	3262	10601	10590	−7328
Andrews—28	Stanolind #4-AE University	31–13–UL	48	3268	10500	10498	−7320
Andrews—29	Stanolind #5-PP University	31–13–UL	49	3261	10687	10685	−7424
Andrews—30	Stanolind #6-PP University	31–13–UL	50	3249	10893	10855	−7606
Archer—1	Phillips #1 Bullington	M. Doyle	44	1032	7915	7913	−6881
Armstrong—1	Hassie Hunt Tr. #1 J. L. Cattle Co.	125–G5–B&P	51	2774	7012	6930	−4181
Armstrong—2	Hassie Hunt Tr. #1 Helms	2–2–H&GN	52	3174	6574	6070	−2896
Armstrong—3	Hunt #4 Ritchie	122–G6–A&G	52	2691	7072	6810	−4119
Armstrong—4	Placid #1 Matheson	173–B3–H&GN	49	3195	4675	4673	−1478
Armstrong—5	Standard of Texas #1-A Palm	141–B4–H&GN	52	3509	6140	6115	−2606
Armstrong—6	Stanolind #1 Corbin	275–B4–H&GN	43	3383	6120	6118	−2735

floor; b'32, well completed before 1932, exact date unknown; ni, no information; nsl, no samples located; –X affixed to volcanic rock name means that microstructures and fabric indicate an extrusive origin. The absence of –X, however, does not necessarily indicate an intrusive origin. See Table 11 (pp. 64–65) for wells numbered with P (*e.g.*, Brewster—1P).

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL		PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	granite	11100–05		Texas craton	cuttings	119
Cambro-Ord	granite	10665–68		Texas craton	cuttings	120
	microgabbro	10665–68			cuttings	120
Cambro Ord	microgranite	10855–60		Texas craton	cuttings	120
Cambro-Ord	granite	10910–26		Texas craton	cuttings	120
	albite diorite	10926–29			core	120
Cambro-Ord	microgranite	8000–05		Texas craton	cuttings	120
Cambrian	nsl					
Cambrian	granite gneiss	7854–57		Texas craton	core	120
Permian	microgranite	8030–35		Texas craton	cuttings	120
Cambro-Ord	granite	7922–26		Texas craton	core	121
Cambro-Ord	nsl					
Cambro-Ord	nsl					
Cambro-Ord	quartz diorite	10820–25		Texas craton	cuttings	121
Cambro-Ord	nsl					
Cambro-Ord	nsl					
Cambro-Ord	nsl					
Cambro-Ord	nsl					
Cambro-Ord	nsl					
Cambro-Ord	microgranite	11030–40		Texas craton	cuttings	121
	granite	11057–61			core	121
Cambro-Ord	leuco-diabase	10600–06		Texas craton	cuttings	121
Cambro-Ord	syenite	10330–35		Texas craton	cuttings	121
Cambro-Ord	leuco-albite-quartz diorite	9711–14		Texas craton	core	121
	leuco-albite diorite	9711–14			core	121
Cambro-Ord	syenite	10370–80		Texas craton	cuttings	122
Cambro-Ord	granite	11315–22		Texas craton	cuttings	122
Ordovician	syenite	10475–79		Texas craton	core	122
Ordovician	syenite	10871–83		Texas craton	core	122
	syenite	10924–42			core	123
	syenite	10942–60			core	123
Cambro-Ord	leuco microdiorite	11500		Texas craton	core	123
Cambro Ord	leuco-quartz microdiorite	10590–95		Texas craton	cuttings	123
Cambro-Ord	granite	10490–500		Texas craton	cuttings	123
Cambro Ord	nsl					
Cambro-Ord	quartz diorite gneiss	10885–93		Texas craton	cuttings	123
Cambro-Ord	metagraywacke	7913–15		Red River mobile belt	core	123
Mississippian	rhyolite tuff	6930–70		Panhandle volcanic terrane	cuttings	124
	rhyolite porphyry-X	6970–7000			cuttings	124
Mississippian	rhyolite X	6070–6180	Suite 1	Panhandle volcanic terrane	cuttings	124
	rhyolite porphyry X	6070–6180	Suite 1		cuttings	124
	rhyolite tuff?	6070–6180	Suite 1		cuttings	124
	serpentinized dolomite	6180–6280	Suite 1		cuttings	124
	trachyte porphyry X	6300–6570	Suite 1		cuttings	124
	rhyolite tuff	6300–6570	Suite 1		cuttings	125
					cuttings	125
	tremolite-talc hornfels	6080–6180	Suite 2		cuttings	124
	rhyolite porphyry	6080–6180	Suite 2		cuttings	124
	serpentinized dolomite	6180–6280	Suite 2		cuttings	124
	siltstone	6180–6280	Suite 2		cuttings	124
Mississippian	leuco microgabbro	6810–7070		Swisher gabbroic terrane	cuttings	125
	microgabbro	6810–7070			cuttings	125
Pennsylvanian	rhyolite porphyry-X	4650		Panhandle volcanic terrane	cuttings	125
Pennsylvanian	rhyolite porphyry-X	6140–41		Panhandle volcanic terrane	core	125
Pennsylvanian	rhyolite porphyry-X?	6118–19½		Panhandle volcanic terrane	core	125

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev
Bailey—1	El Paso Nat. Gas #1 W. Tex. Mtge. Loan	55– A –MB&B	45	3945	9127	8710	–4765
Bailey—2	Lion #1 Bridwell	78– A –MB&B	52	3892	8953	8810	–4918
Bailey—3	Phillips #1-A Stevens	24– B –MB&B	51	4025	8244	8130	–4105
Bailey—4	Shell #1 Nichols	Lab 13–Lge 212–Crosby CSL	51	3810	9051	8988	–5178
Borden—1	Sinclair #1 Bryan	40–32–ELRR	49	2961	10804	10789	–7843
Briscoe—1	Amerada #1 Hamilton	41– 3 –T&P	51	2474	8775	8742	–6268
Briscoe—2	Hunt #1 Ritchie	68– –R. F. Stevenson	51	2492	7900	7475	–4983
Briscoe—3	Hunt #2 Ritchie	54–G5–ELRR	51	2597	7764	7130	–4533
Briscoe—4	Hunt #10 Ritchie	74–G6–A&G	52	2411	8165	7910	–5499
Briscoe—5	Midstates #1 Hickok & Reynolds	39– A –C. L. Craig	51	2362	8299	8085	–5723
Briscoe—6	Standard of Texas #1 Owens	142–M10–D&SE	51	3295	8393	8340	–5045
Brown—1	McDonald & Campbell #1 Smith	G. A. Parker		1433	3434	3395	–1962
Carson—1	Cities Service #1 Whittemore	14– 7 –I&GN	52	3416	3326	3312	+104
Carson—2	Dunnigan (Cabot) #1 Ellis	127– 7 –I&GN	49	3369	5365	5315	–1946
Carson—3	Empire Gas & Fuel #1 Lane	72– 4 –I&GN	b'32	3188	2980	2550	+638
Carson—4	Phillips #1 Ardis	3–B4–H&GN	53	3417	6257	6185	–2768
Carson—5	Reiger #1 Forster	93– 7 –I&GN	34	3324	3327	3326?	–2?
Carson—6	Shamrock #1 Thompson	15– 7 –I&GN	b'32	3383	3404	3045	+338

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL		PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambrian	gabbro	8710–20		Swisher gabbroic terrane	cuttings	126
	diabase	8720–90			cuttings	126
	serpentinized dolomite	8790–8800			cuttings	126
	gabbro	8800–8950			cuttings	126
	leuco-olivine gabbro	8960–9050			cuttings	126
	metasiltstone	9050–90			cuttings	126
	olivine gabbro	9090–9100			cuttings	127
Cambro-Ord	leuco gabbro	8810–8950		Swisher gabbroic terrane	cuttings	127
	leuco-olivine gabbro	8951–53			core	127
Permian?	rhyolite porphyry-X	8190–8200		Panhandle volcanic terrane	cuttings	127
Cambro Ord	rhyolite	9030–40		Panhandle volcanic terrane	cuttings	128
	rhyolite porphyry	9030–40			cuttings	128
Cambro Ord	nsl					
Mississippian	quartz diorite	8775		Texas craton	cuttings	128
Mississippian	leuco-gabbro	7475–7590	Suite 1	Swisher gabbroic terrane	cuttings	128
	dolomite-talc rock	7590–7635			cuttings	129
	meta-arkose	7590–7635			cuttings	129
	meta arkose	7635–7730			cuttings	129
	tremolite-dolomite hornfels	7730–7745			cuttings	130
	diorite	7790–7890			cuttings	130
	leuco-gabbro	7510–7590	Suite 2		cuttings	128
	metadolomite	7590–7610			cuttings	129
	metadolomite	7610–7650			cuttings	129
	volcanic rock	7610–7650			cuttings	129
	metasandstone	7610–7650			cuttings	129
	argillite	7650–7710			cuttings	129
	metasiltstone	7650–7710			cuttings	129
	diopside tremolite-dolomite hornfels	7710–7720			cuttings	129
	metasiltstone and argillite	7720–7760			cuttings	129
	serpentinized talc-dolomite rock	7760–7770			cuttings	130
	metasiltstone	7770–7790			cuttings	130
	leuco albite gabbro	7790–7890			cuttings	130
Mississippian	leuco-olivine gabbro	7130–7560	Suite 1	Panhandle volcanic terrane	cuttings	130
	serpentinized dolomite	7590–7710			cuttings	130
	trachyte porphyry	7710–7720			cuttings	131
	tuff and flow fragments	7720–7760			cuttings	131
	leuco-olivine gabbro	7630–7640	Suite 2		cuttings	130
	argillite	7640–7660			cuttings	131
	meta argillite	7640–7660			cuttings	131
	serpentinized diopside-dolomite hornfels	7660–7700			cuttings	131
	trachyte porphyry	7700–7720			cuttings	131
	trachyte? tuff	7720–7750			cuttings	131
Mississippian	leuco-olivine gabbro	7920–8165		Swisher gabbroic terrane	cuttings	132
	leuco albite diabase	7920–8165			cuttings	132
Cambro Ord	leuco-gabbro	8120–8150		Swisher gabbroic terrane	cuttings	132
Mississippian	leuco-gabbro	8380–8390		Swisher gabbroic terrane	cuttings	132
Cambrian	nsl					
Pennsylvanian	granodiorite	3267–3326		Wichita igneous province	cuttings	132
Pennsylvanian	rhyolite porphyry	5320–5365		Panhandle volcanic terrane	cuttings	132
ni	nsl					
Pennsylvanian	nsl					
Permo-Penn	nsl					
Permian	gabbro	3110–3115		Wichita igneous province	cuttings	132
	diabase	3130–3135			cuttings	133
	albite granodiorite	3156–3159			cuttings	133

COUNTY	OPERATOR and FARM	LOCATION Sec Block Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev
Carson—7	Stanolind #1 Griffin	9-2-AB&M	42	3528	5648	5595	-2067
Carson—8	Tipton & Waggoner #1 McConnell	201-3-I&GN	b'32	3302	3084	2685	+617
Carson—9	Travis #1 Harrell	162-7-I&GN	29	3324	3761	3750	-426
Castro—1	Anderson-Prichard #1 Fowler McDaniel	12-9T-T&NO	51	3668	9650	9516	-5848
Castro—2	Sun #1 Haberer	8-2-Halsell Subd	48	3836	9125	8870	-5034
Castro—3	Sun #1 Herring	46-T4-T. A. Thompson	48	3799	10500	9750?	-5951?
Childress—1	Stanolind #1 Owens	81-1-SP	50	1680	7384	7373	-5693
Clay—1	Bridwell #26 Edrington	37- -H&TB	51	983	3281	3273	-2290
Clay—2	Bridwell #1-A Edrington	F. W. Grassmeyer	48	929	2184	2120	-1191
Clay—3	British-American #1 Stine	-2-Parker CSL	40	994	2329	2325	-1131
Clay—4	Goldsmith #1 Republic Nat Gas	-14-Parker CSL	40	981	2572	2530	-1549
Clay—5	Perkins #1 Stine	-62-Bacon Subd	45	986	2993	2930?	-1944?
Clay—6	Texas #41 Byers	19- -W R Gaston	b'32	978	4289	4240	-3262
Cochran—1	Cosden #1 Barker	2-V-PSL	52	3774	9061	8590	-4816
Cochran—2	Humble #1 Masten	Lab 1-Lge 146-Armstrong CSL	49	3837	10788	10770	-6918
Cochran—3	Humble #1 Westheimer	Lab 1-Lge 146-Stonewall CSL	39	3862	7414	7355	-3491
Cochran—4	McElroy #1 Ausmus	26-141-Hansford CSL	53	3862	8080	8040	-4178
Cochran—5	Shell #1 Pittman	1-Y-PSL	51	3994	11494	11480	-7486
Cochran—6	Stanolind #5 Edwards	13-L-PSL	51	3808	13641	12560	-8752
Cochran—7	Stanolind #1 Reed	19- -Harrison & Brown	52	3770	12681	12677	-8904
Cochran—8	Stanolind #1 Slaughter	Lab 49-Lge 101-Jeff Davis CSL	45	3776	10840	10770	-6994
Cochran—9	Superior #1 Cameron	Lab 9-Lge 86-Greer CSL	50	3722	11214	11185	-7463
Coke—1	Barnsdall #2 Davenport	Lge 475-Seth Clark	50	2012	5728	5720	-3710
Coke—2	Hickok & Reynolds #1 Rawlings	453-1A-H&TC	51	1823	5802	5620	-3797
Coke—3	Humble #9 Odam	Lge 475-Seth Clark	51	2015	5525	5314	-3299
Coke—4	Humble #10 Odam	-431-Jose M. M. Y. Perez	50	2039	6709	6708	-4669
Coke—5	Humble #1 Rawlings	397-1A-H&TC	52	1893	5820	5792	-3899
Coke—6	Sun #1 Central National Bank	80-2-H&TC	51	2114	7949	7929	-5785

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Pennsylvanian	rhyolite porphyry-X	5602–5604	Panhandle volcanic terrane	core	133
	rhyolite porphyry-X	5613–5614		core	133
	rhyolite porphyry-X	5646–5647		core	133
ni	leuco-microgabbro	3060	Wichita igneous province	cuttings	133
Permo-Penn	nsl				
Permian	leuco-olivine gabbro	9650	Swisher gabbroic terrane	cuttings	134
Mississippian	diabase	8890–8900	Swisher gabbroic terrane?	cuttings	134
	leuco-microgabbro	8900–8910		cuttings	134
	volcanic rock?	9124–9125	Panhandle volcanic terrane?	core	134
Mississippian?	metasandstone and sandstone, meta-arkose and arkose	9730–9790	Swisher gabbroic terrane	cuttings	134
	clay slate	9730–9790		cuttings	134
	gabbro	9730–9790		cuttings	134
	gabbro	9790–10065		cuttings	135
	hornfels	10065–10135		cuttings	135
	siltstone	10065–10135		cuttings	135
	serpentinite	10114–10128		cuttings	135
	altered ferromagnesian-rich rock	10128–10133		core	135
	olivine gabbro	10135–10500		cuttings	135
	diabase	10135–10500		cuttings	135
	leuco olivine gabbro	10447–10459		core	135
	gabbro	10460–10500		core	136
Cambrian	rhyolite porphyry-X?	7380–7384	Wichita igneous province? Panhandle volcanic terrane outlier?	core	136
Cambrian	phyllitic metagraywacke	3273	Red River mobile belt	cuttings	136
Cambrian	meta arkose	2183–2184½	Red River mobile belt	core	137
Cambrian	nsl				
Cambrian	granodiorite	2560–2565	Red River mobile belt	cuttings	137
Cambrian	metagraywacke	2935	Red River mobile belt	core	137
Cambrian	granite	4250–4255	Red River mobile belt	cuttings	137
Cambro-Ord	leuco-albite gabbro	8660–8610	Swisher gabbroic terrane	cuttings	137
Permian	rhyolite porphyry-X?	10775–10788	Panhandle volcanic terrane	cuttings	137
	rhyolite porphyry-X?	10788		core	137
Permian	rhyolite porphyry-X	7393–7394	Panhandle volcanic terrane	core	138
Permian	nsl				
Cambro-Ord	granodiorite	11490–11494	Texas craton?	cuttings	138
Cambro-Ord	rhyolite X?	12620–12630	Panhandle volcanic terrane	cuttings	138
Cambro-Ord	rhyolite porphyry	12678	Panhandle volcanic terrane	core	138
Cambro-Ord	rhyolite	10770	Panhandle volcanic terrane	cuttings	138
	rhyolite porphyry	10820–10839		cuttings	138
	rhyolite porphyry	10839–10840		cuttings	138
Cambro-Ord	rhyolite tuff	11205–11214	Panhandle volcanic terrane	core	139
Pennsylvanian	granodiorite	5716–5728	Texas craton	core	139
Pennsylvanian	microgranite	5630–5635	Texas craton	cuttings	139
	microgranite	5670–5675		cuttings	139
Pennsylvanian	granodiorite	5517–5525	Texas craton	core	139
Cambro-Ord	granodiorite	6708–6709	Texas craton	core	139
Cambro-Ord	nsl				
Cambro-Ord	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec. Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT DEPTH	ELEV
Coleman—1	Chandler (Killam) #1 Gill	-5-Wm. York	54	1428	4395+	3230	-1802
Coleman—2	Naylor #1 Stone	73- -Childress	53	2129	5348	5338	-3209
Collingsworth—1	Bridgeport #1-E Hughes	78-11-H&GN	46	2052	4150	4120	-2068
Collingsworth—2	Continental #1 McDowell	107-22-H&GN	26	2346	2830	2760	-414
Collingsworth—3	Lubbock Machine & Supply #1 Alexander	4-16-H&GN	54	2200	4100	4570	-1900
Collingsworth—4	Obrien & Cline #1 Fairbanks	23-23-H&GN	49	2551	2087	2076	+475
Collingsworth—5	Superior of Cal #1 Brown	75-22-H&GN	51	2343	5710	5645	-3302
Collingsworth—6	Union #1 Glenn	87-11-H&GN	47	2092	4183	4180	-2086
Comanche—1	Davis #1 Hanson	Sam Bowers	48	1183	4040	4036	-2853
Comanche—2	Gallagher & Lawson #1 Terry	N. H. Kuykendall	38	1334	5259	5257	-3923
Cooke—1	Continental #1 Berry	J. M. Culp	52	1008	6043	5738	-4730
Cooke—2	Continental #1 Whaley	W. C. Winters	52	1082	4282	4243	-3161
Cooke—3	Dufly et al #1 Bailey-English	E. Fains	b'32	877	2273	2273	-1396
Cooke—4	Gulf Prod. #1 Donald	J. Gufley	b'32	906	3135	2900	-1994
Cooke—5	Hollandsworth #31 Fette	Hrs of Cyrus Underwood	51	926	5196	4986	-4060
Cooke—6	Hollandsworth #1 Thomason	T. Bell	49	745	2391	2385	-1614
Cooke—7	Hollandsworth #2 Thomason	T. Bell	49	745	2467	2461	-1716
Cooke—8	Kadane & Sons #1 Coursey	W. F. Shaw	45	1052	2962	2962	-1908
Cooke—9	Maguire #1 F. S. Bundy	W. Phelps	48	790	2106	2085	-1295
Cooke—10	McElreath & Suggett #1 Whaley	SA&MG	b'32	916	2340	2312	-1396
Cooke—11	Muenster #1 Yosten	G. Ivy	b'32	1059	3790	2750	-1691
Cooke—12	Phillips #1-CT Atcheson	J. Davis	47	960	2271	2258	-1298
Cooke—13	Phillips #3 Atcheson	J. Davis	47	970	2176	2166	-1196
Cooke—14	Phillips #3 Dangle	E. Langford	44	1062	2519	2517	-1443
Cooke—15	Phillips #1 Fielder	E. Langford	44	1027	2940	2926	-1899
Cooke—16	Phillips #1 Reitar	J. M. Culp	44	1070	3218	3204	-2134
Cooke—17	Phillips #2 A Reitar	E. Langford	45	1087	3256	3230	-2143
Cooke—18	Texas #1 C Hutson	SPRR	45	961	4240	4130	-3169
Cottle—1	Anderson Prichard #1 Lynch	66-1-J. Poitevent	46	2001	5834	5825	-3824
Cottle—2	General Crude #13 1 Swenson	13-B-J. H. Stephens	54	2066	5724	4810	-2744
Cottle—3	General Crude #33-1 Swenson	33-B-J. H. Stephens	54	2137	5460	5410	-3273
Cottle—4	Humble #1 J Matador	15-E-Matador Land & Cattle Co.	51	1748	8087	8055	-6307
Cottle—5	Jones & Stasney #1 Wiley	6-B-J. H. Stephens	52	2038	5245	4740	-2702
Cottle—6	Merry Bros. & Perini #1 Pursell	40-B-J. H. Stephens	33	2012	4740	4650	-2638
Cottle—7	Ramsey #1 Lynch	66- -J. Poitevent	40	2020	5694	5670	-3650
Cottle—8	Seaboard and Shamrock #1 Tapper	6- -AB&M	48	1992	6656	6635	-4618
Cottle—9	Signal #1 Swenson	28-B-J. H. Stephens	51	2087	5601	5585	-3498

[1] Robert Roth (personal communication, 1954) reports garnetiferous schist; no thin section studied

[2] Personal communication, Robert Roth, 1953 No thin section studied.

[3] Lithology determined too late for inclusion on map, Plate I

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambrian	granodiorite gneiss	3445–3450	Texas craton	cuttings	139
	biotite schist	3515–3520		cuttings	139
	scapolite-diopside gneiss	3575–3580		cuttings	140
	scapolite-diopside gneiss	3765–3770		cuttings	140
	scapolite diopside gneiss	3940–3945		cuttings	140
	diopside-calcite gneiss	4045–4050		cuttings	140
	diopside marble	4195–4200		cuttings	140
	calcite-scapolite-diopside gneiss	4285–4290		cuttings	140
	scapolite-diopside gneiss	4390–4395		cuttings	140
Cambrian	granite	5338–5348	Texas craton	core	140
Pennsylvanian	nsl				
Permian	nsl				
Cambrian	garnetiferous schist[1]				
ni	granite[2]	?	Wichita igneous province?		
Cambrian	quartz diorite	5685–5710	Wichita igneous province?	cuttings	141
Cambrian	nsl				
Cambrian	nsl				
Cambrian	granite	5255–5257	Texas craton	cuttings	141
Pennsylvanian	syenodiorite	6032–6033	Red River mobile belt	core	141
Pennsylvanian	biotite-quartz-albite gneiss	4277–4287	Red River mobile belt	core	141
Pennsylvanian?	nsl				
Pennsylvanian?	metaquartzite	3010–3015	Red River mobile belt	cuttings	142
	hornblende-oligoclase schist	3010–3015		cuttings	142
Cambro-Ord	metaquartzite	±5000	Red River mobile belt	core	142
	sillimanite biotite schist	±5105		core	142
ni	nsl				
ni	nsl				
ni	hornblende schist	2960–2962	Red River mobile belt	core	142
Pennsylvanian	nsl				
Pennsylvanian?	biotite garnet schist	2312–2340	Red River mobile belt	core	142
Cambrian	hornblende schist	3160	Red River mobile belt	cuttings	143
	biotite schist	3165		cuttings	143
	hornblende schist	3578–3652		cuttings	143
Pennsylvanian	metagraywacke	2263–2271?	Red River mobile belt	core	143
Cambro-Ord?	metaquartzite	2165–2170	Red River mobile belt	cuttings	143
Cambro-Ord	granite	2517–2519	Red River mobile belt	cuttings	143
	granite	2517–2519		cuttings	143
Pennsylvanian	granite	2935–2940	Red River mobile belt	cuttings	144
Pennsylvanian	granite	3216	Red River mobile belt	core	144
Pennsylvanian	granite	3253–3256	Red River mobile belt	core	144
Pennsylvanian	granite[2]	4240	Red River mobile belt		
Cambro Ord?, Mississippian?	leuco-albite-quartz microdiorite	5810–5820	Texas craton	cuttings	144
	microgranodiorite	5820–5830		cuttings	144
Pennsylvanian	quartz diorite	5410–5423	Red River mobile belt	core	144
	sericite phyllite	5719–5722		core	144
Mississippian	metarkosite[3]	5449–5452	Red River mobile belt	core	145
Cambrian	sericite phyllite	8082–8087	Red River mobile belt	core	145
Pennsylvanian	meta-arkose	4850–5000	Red River mobile belt	cuttings	145
	meta-arkose and diabase	5000–5005		cuttings	145
	meta-arkose	5005–5245		cuttings	146
Pennsylvanian	meta-arkose	4659–4740	Red River mobile belt	cuttings	146
	metarkosite	4659–4740		cuttings	146
Cambro-Ord	microgranodiorite	5670–5680	Texas craton	cuttings	146
Cambrian	meta arkose	6655	Red River mobile belt	core	146
Cambrian	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev
Crane—1	Atlantic #2-A University	33–31–UL	48	2553	11645	11623	–9070
Crane—2	Loffland #3 Tubbs	9–B27–PSL	37	2540	7168	7115	–4575
Crockett—1	Amerada #1-D Shannon	Lot 2–Lge 3–Archer CSL	48	2881	7835	7825	–4944
Crosby—1	Continental #1 Swenson L&C	75–2–H&GN	48	2454	8413	8385	–5931
Crosby—2	Deep Rock #2 Morgan Jones	11–1–WCRR	52	2659	8771	8765	–6106
Crosby—3	Gulf #1 Martin	–5–A. D. Meyer	50	2519	8435	8420	–5901
Crosby—4	Humble #1 **Irvin**	889–C3–ELRR	53	3165	9947	9922	–6757
Crosby—5	Humble #1 Montgomery	21– –B&B	47	3108	9707	9700	–6593
Crosby—6	Ohio #1 Morgan Jones	140–2–H&GN	48	2579	8638	8630	–6051
Dallam—1	Pure #1 Federal Land Bank	17–7–FDW Subd	42	4335	6863	6860	–2522
Dallam—2	Pure #1 Sneed Heirs	13–18–Cap Synd	44	4013	6779	6768	–2755
Dallam—3	Texas #1 Cap Freehold Land Trust	10–7–Cap Synd	45	4563	6169	6110	–1547
Deaf Smith—1	Honolulu #1 Ponder	Lge 436–St Cap Lands	49	3991	10191	9980	–5989
Deaf Smith—2	Humble #1 Hyslop	18–Lge 418–St Cap Lands	45	4448	7805	7750	–3302
Denton—1	Hunt #1 Forester	W. Nelson	42	749	2520	2290	–1541
Denton—2	Hunt #1 Martin	J. Parks	44	809	2978	2976	–2167
Denton—3	Hunt #2 Martin	J Stewart	49	747	2136	2119	–1365
Denton—4	Jenkins, Kelsey, Jones & Eubanks #1 Waide	T Carpenter	b'32	797	1913	1870	–1691
Denton—5	Stanolind #1 Dunn	J Parks	44	813	3416	3408	–2595
Denton—6	Texas #1 Yeatts	W J Hendrix	b'32	771	2026	2013	–1242
Dickens—1	Humble #3 Matador	2–J–W Jackson	48	2404	7737	7645	–5241
Dickens—2	Humble #2-F Matador	27–AS–J S. Callaway	52	2196	7542	7455	–5259
Dickens—3	Humble #1-G Matador	8–C–C U Connellee	47	2732	8248	8232	–5500
Dickens—4	Livermore # Bird	288–1–H&GN	45	2560	8390	8322	–5828
Dickens—5	Magnolia #1 Wiley	305–1–H&GN	48	2307	7716	7697	–5390
Dickens—6	Natl. Petr Assoc. #1 Blackwell	5–C–C U Connellee	50	2722	8387	8370	–6548
Dickens—7	Norsworthy #1 Burleson	5–WC–J. C Keller	50	2027	7511	7480	–5453
Dickens—8	Placid #1 Emery	262–1–H&GN	52	2284	7852	7798	–5568
Dickens—9	Placid #1 Goess	3– –AB&M	51	2744	8474	8442	–5698
Dickens—10	Placid #1 Huges	187–1–H&GN	50	2311	7950	7936	–5625
Dickens—11	Placid #1 Swenson	226–1–H&GN	51	2253	7796	7737	–5484
Dickens—12	Union Cal. #1 Elliott	177–1–H&GN	49	2309	8117	8115	–5806
Dickens—13	Woodward #1 Williamson	189–1–H&GN	47	2263	7787	7781	–5518
Donley—1	Doswell #1 McMurtry	40–C3–GC&SF	50	2763	5375	5245	–2482
Donley—2	Honolulu #1 Ozier	55–C6–GC&SF	48	2848	5893	5850	–3002
Donley—3	Humble #1 Roach	5–C4–TTRR	49	2955	5265	5230	–2275
Donley—4	Hunt #5 Ritchie	108–G5–J Myers	ni	2560	6503	6460	–3900
Donley—5	Placid #1 Kelly	47–G7–A&G	51	2520	7070[4]	6955	–4435
Donley—6	Shamrock #1 Adair	15–A–J. G. Adair	43	2566	5358	5345	–2779
Donley—7	Stanolind #1 Broome	46–20–H&GN	44	2445	6756	6748	–4303

[4] Information from Stanolind Oil & Gas Company's sample log No thin section studied

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	metagranodiorite	11642–11645	Texas craton	core	146
Cambrian	granite	7120–7160	Texas craton	cuttings	147
Cambro-Ord	microgranite	7825–7835	Texas craton	cuttings	147
Cambro-Ord	nsl				
Cambro-Ord	granite?	8760–8770	Texas craton	cuttings	147
Pennsylvanian	nsl				
Cambrian	diorite gneiss	9947	Texas craton?, Red River mobile belt?	core	147
Mississippian	metaconglomerate	9700–9707	River mobile belt?	core	147
Mississippian	granite	8635–8638	Texas craton	cuttings	148
Cambro-Ord	nsl				
Cambro-Ord	granite	6775–6779	Wichita igneous province?	cuttings	148
Cambro-Ord	rhyolite porphyry	6168–6169	Panhandle volcanic terrane	core	148
Mississippian	nsl				
Pennsylvanian	diabase	7750–7800	Panhandle volcanic terrane	cuttings	149
	rhyolite porphyry-X?	7803–7805		core	149
Pennsylvanian	nsl				
Pennsylvanian	microdiorite	?	Red River mobile belt	core	149
Pennsylvanian	nsl				
Pennsylvanian?	garnet biotite quartz-oligoclase gneiss	1882	Red River mobile belt	core	149
Pennsylvanian	hornblende schist?[4]	3414–15	Red River mobile belt	core	
Pennsylvanian?	hornblende andesine gneiss (amphibolite)	2013	Red River mobile belt	core	149
Mississippian	quartz diorite	7735–7737	Texas craton	core	149
	micrographic granite	7735–7737		core	149
Mississippian	meta arkose and meta argillite	7735–7742	Fisher metasedimentary terrane	core	150
Mississippian	granite	8230–8240	Texas craton	cuttings	150
	quartzose granite	8246–8248		core	150
Mississippian	quartzose granite	8390	Texas craton	core	150
Mississippian	biotite phyllite	7700–7716	Fisher *metasedimentary* terrane	cuttings	150
	metaquartzite	7710–7716		cuttings	150
	metarkosite	7710–7716		cuttings	150
Mississippian	granite	8370–8380	Texas craton	cuttings	151
	albite syenodiorite	8380–8384		cuttings	151
Cambro Ord	nsl				
Mississippian	nsl				
Mississippian	nsl				
Mississippian	nsl				
Mississippian	nsl				
Cambro-Ord	leuco albite-quartz diorite	8110–8117	Texas craton	cuttings	151
Mississippian	meta arkose	7780–7787	Fisher metasedimentary terrane	cuttings	151
Cambro-Ord	trachyte porphyry	5370–5375	Texas craton? Wichita igneous province?	cuttings	151
Cambrian	granite	?	Panhandle volcanic terrane	core	152
	granodiorite	5890–5893		core	152
Cambrian	micrographic porphyry	5265	Texas craton?	core	152
Cambro-Ord	rhyolite porphyry	6465–6485	Panhandle volcanic terrane?	cuttings	152
	sandy dolomite	6485–6495		cuttings	152
	rhyolite porphyry	6495–6503		cuttings	152
Mississippian	olivine gabbro	6960–7050	Swisher gabbroic terrane	cuttings	152
	olivine gabbro	7053–7068		cuttings	152
	hornfels (metasiltstone)	7053–7068		cuttings	152
Cambrian	albite granodiorite	5345–5350	Texas craton?	cuttings	153
	albite granodiorite	5349–5358		cuttings	153
Cambrian	quartz diorite	6748–6753	Texas craton?	core	153
	granodiorite	6751–6753		core	153

COUNTY	OPERATOR and FARM	LOCATION Sec Block Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev
Donley—8	Stanolind #1 Lewis	81-E-D&P	45	2538	4092	4060	-1522
Donley—9	Welch #1 Lazy G Ranch	150-E-D&P	51	2300	7110	5160	-2860
Eastland—1	Bilsky #1 Mitchum	476- -SPRR	48	1587	5426	5424	-3837
Eastland—2	Hopkins #1 Davis	54-4-H&TC	28	1449	5646	5479	-4010
Ector—1	Coronet #3 Cummins	12-45-T1N-T&P	49	3217	8780	8740	-5523
Ector—2	Phillips #11 Embar	17-44-T1N-T&P	48	3185	8515	8505	-5320
Ector—3	Phillips #12 Embar	17-44-T1N-T&P	48	3191	8505	8479	-5288
Ector—4	Phillips #15 Embar	17-44-T1N-T&P	48	3195	8505	8490	-5295
Ector—5	Phillips #23 Embar	17-44-T1N-T&P	51	3185	8570	8410	-5225
Ector—6	Phillips #1-J TXL	9-45-T1S-T&P	46	3288	11218	11145	-7857
Ector—7	Texas #3 Cowden	8-44-T1N-T&P	48	3200	8525	8502	-5302
Ector—8	Texas #6 Cowden	8-44-T1N-T&P	48	3202	8591	8547	-5345
Ector—9	Texas #13 Cowden	8-44-T1N-T&P	49	3203	8462	8448	-5345
El Paso—1	Jones #1 Sorely	17-5-PSL	47	4368	2220	2200	+2168
Erath—1	Continental #1 Wiley	W. B. Whittaker	48	1416	6069	6046	-4630
Erath—2	McCarthy #1 Hedricks	99- -J. Benton	46	1051	7165	7145	-6094
Fisher—1	General Crude #1 Aiken	214-3-H&TC	47	2227	7505	7502	-5275
Fisher—2	General Crude #12 Flanagan	200-1-BBB&C	41	1808	6746	6560	-4752
Fisher—3	Humble #1 Crowley	42-2-H&TC	48	1961	7085	7050	-5089
Fisher—4	Lion #1 Huddleston	10-K-T&P	50	1973	5941	5924	-3951
Fisher—5	Skelly and Lion #1 Lanning	10-20-T&P	51	1953	6160	6130	-4177
Fisher—6	Texas #7 Stephens	77-1-H&TC	49	1986	6151	6108	-4122
Fisher—7	Texas #1-C Stephens	82-1-H&TC	45	1924	6326	6100	-4176
Fisher—8	Texas Crude #1 Huddleston	9-K-T&P	54	ni	6162	ni	ni
Floyd—1	Chiles #1 Strickler	19-K-TTRR	48	3233	7757	7730	-4497
Floyd—2	Houston #1 Lackey	11-D2-GC&SF	51	3174	10395	10304	-7166
Floyd—3	Livermore #1 Krause	29-K-TTRR	46	3196	7843	7834	-4638
Floyd—4	Sinclair #1 Massie	7-T-BS&F	53	3203	10358	10352	-7149
Floyd—5	Standard of Texas #1 Daniel	A. B. Duncan	48	3041	7001	6600?	-3559?
Foard—1	Humble #1 Johnson	37-L-SPRR	29	1678	5000	4880	-3202
Foard—2	Phillips #1 Clemmie	26-8-H&TC	48	1332	4566	4475	-3143
Foard—3	Roxana #1 Mathews	3-3-GC&SF	28	1384	2585	2305	-921
Foard—4	Shell Petr Corp and Fain & McGaha #3 Mathews	-3-GC&SF	b'32	1377	2550	2465	-1088
Foard—5	Texas #3 Johnson	36-L-SPRR	44	1628	4568	4560	-2931
Gaines—1	Amerada #2-A Jones	3-A6-PSL	46	3697	12924	12887	-9190
Gaines—2	Amerada #1-D Jones	2-A7-PSL	46	3674	13025	13009	-9335
Gaines—3	Stanolind #1 Alley	22-A7-PSL	50	3415	11187	11175	-7760
Gaines—4	Texas #1 Jenkins	4-A25-PSL	48	3418	11705	11633	-8215
Garza—1	Gulf #1 B Swenson	25-2-H&GN	39	2275	8104	8090	-5815
Garza—2	Honolulu #1 Altman	1225- -TTRR	46	2967	9603	9595	-6628
Garza—3	Humble #1-G Fee	136-5-H&GN	48	2355	8357	8350	-5995
Garza—4	Stanolind #1 Bird	82-5-GH&H	54	2466	8542	8493	-6032
Garza—5	Union and Cities Service #1-A Davies	7-4-K Aycock	48	2603	8855	8785	-6182

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	granodiorite	4085–4086	Texas craton?	cuttings	153
	granite	core–"top"		core	153
	granite	core–"middle"		core	154
	quartz diorite	core–"bottom"		core	154
Cambro Ord	albite granodiorite	5160–7020	Texas craton?	cuttings	154
Cambrian	nsl				
Cambrian	nsl				
Cambro-Ord	nsl				
Cambro Ord	nsl				
Cambro Ord	nsl				
Cambrian	biotite schist	8503	Texas craton	cuttings	154
Cambro-Ord	metaquartzite	8550–8555	Texas craton	cuttings	154
Ordovician	leuco quartz microdiorite	11170–11180	Texas craton	cuttings	154
	leuco albite quartz microdiorite	11190–11215		cuttings	154
	quartz microdiorite	11210–11215		cuttings	154
Ordovician	nsl				
Cambrian	granite gneiss	8560–8570	Texas craton	cuttings	154
Cambrian	nsl				
Cambro-Ord	quartz diorite	2213–2220	Texas craton?	cuttings	155
Cambrian	nsl				
Cambrian	nsl				
Cambrian	granite	7505	Texas craton	cuttings	155
Cambrian	epidote biotite schist	6743–6746	Fisher metasedimentary terrane	cuttings	155
Cambrian	biotite schist	7805	Fisher metasedimentary terrane	core	155
Cambrian	arkose gneiss	5920–5940	Fisher metasedimentary terrane	cuttings	155
Cambrian	arkose gneiss	6140–6160	Fisher metasedimentary terrane	cuttings	155
Cambrian	arkose gneiss	6151	Fisher metasedimentary terrane	cuttings	156
Cambrian	arkose gneiss	6280–6290	Fisher metasedimentary terrane	cuttings	156
Cambrian	nsl				
Mississippian	leuco-microdiorite	7730–7735	Texas craton	cuttings	156
	leuco microdiorite	7755–7757		cuttings	156
Mississippian	gabbro	10390–10395	Swisher gabbroic terrane	cuttings	156
Mississippian	leuco-quartz diorite	7834–7836	Texas craton	core	156
	leuco-quartz diorite	7836–7838		core	156
	leuco-quartz diorite	7838–7843		core	157
Mississippian	muscovite schist	10353–10358	Red River mobile belt	core	157
Pennsylvanian	granodiorite	6910–6920	Texas craton	cuttings	157
	granodiorite gneiss	7001		core	157
Pennsylvanian	nsl				
Pennsylvanian	biotite schist	4475	Red River mobile belt	core	157
Pennsylvanian	arkose gneiss	2410–2420	Red River mobile belt	cuttings	157
	biotite-chlorite schist	2585	Red River mobile belt	cuttings	158
nr	nsl				
Cambrian	meta arkose	4558–4560	Red River mobile belt	cuttings	158
	meta-arkose and quartz diorite	4565–4567		cuttings	158
Ordovician	microgranite	12929	Texas craton	cuttings	158
Ordovician	microgranite	13020–13025	Texas craton	cuttings	158
Cambro-Ord	nsl				
Devonian?	granodiorite	11699	Texas craton	core	158
Cambro-Ord	granodiorite	8100–8104	Texas craton	cuttings	158
Cambro Ord	granite	9600–9606	Texas craton	cuttings	159
Cambro-Ord	granodiorite	8351–8358	Texas craton	cuttings	159
Cambro-Ord	granite	8450–8542	Texas craton	cuttings	159
Cambro-Ord	granodiorite	8850–8855	Texas craton	cuttings	159

COUNTY	OPERATOR and FARM	LOCATION Sec-Block Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev
Gillespie—1	Gillespie #1 Dickey	2 mi N Stonewall	b'32	1600	660	304	+1296
Gillespie—2	Lewis #1 Kott	N. side Fredericksburg	b'32	1725	418	168	+1557
Gillespie—3	Thousand Islands #1 Hayden	Surv 144	b'32	1850	1505	1182	+668
Glasscock—1	Shell #1 Clarke	5-32-T4S-T&P	46	2663	10970	10964	-8301
Gray—1	Ama Gray #1 Mathers Trust	63-25-H&GN	48	2511	2385	2385	+236
Gray—2	Bock Anderson #1 Beavers	124-B-2-H&GN	b'25	3144	3800	3305	-161
Gray—3	Danciger #1 Bradford	123-B-2-H&GN	b'32	3091	2741	2670	+421
Gray—4	Gerber #1 Stubbs	9-3-B&B	33	2777	3100	2885	-108
Gray—5	Graham et al (Taconian Oil) #1 Sullivan	136-3-I&GN	b'32	3273	2990	2900	+373
Gray—6	Graywash #1 A Carpenter	22-25-H&GN	49	2622	2305	ni	ni
Gray—7	Graywash #1 B Carpenter	23-25-H&GN	49	2438	2696	2571?	-33?
Gray—8	Hickman #1 Brown	15-30-H&GN	48	2713	2718	2264	+449
Gray—9	Holt #3 Bailey	58-52-H&GN	52	2596	2801	2413	+183
Gray—10	Magnolia #4 Latham	153-3-I&GN	b'32	3276	3434	2875	+401
Gray—11	Operators' Oil #1 Bowers	93-B-2-H&GN	b'32	3038	3090	2800	+238
Gray—12	Phillips #1 Bralley	7-C2-CCSD&RGNG	51	3058	3114	3027	+35
Gray—13	Phillips #2 Keahey	220-B2-H&GN	54	3275	ni	2616	+659
Gray—14	Phillips #6 URB	189-B2-H&GN	54	3279	3175	3040	+239
Gray—15	Phillips #1 Worley	129-B2-H&GN	50	3247	2833	2825	+422
Gray—16	Shamrock #1 McCracken	31-25-H&GN	52	2886	2602	2525?	+361?
Gray—17	Shamrock #1 Taylor	6-2-H&GN	30	2839	3039	ni	ni
Gray—18	Sidwell #1 Bowers	92-93-B2-H&GN	49	3100	3293	3250?	-150?
Gray—19	Skelly #1 Heitholt	153-3-IGN	b'31	3275	2860	2835	+440
Gray—20	Smith #1-E Johnson	189-E-D&P	44	2847	2861	2860?	-13?
Gray—21	Texas #15-A Chapman	8-26-H&GN	48	2555	2342	2340?	+215?
Gray—22	Texas #6 B McLarty-Lester	10-1-ACH&B	35	2727	3038	2400	+327
Gray—23	Warner #1 Moise	68-25-H&GN	47	2562	2830	ni	ni
Hale—1	Amerada #1 Kurfees	6-N-H&OB	44	3308	10250	10225	-6917
Hale—2	Honolulu and Sinclair #1 Clements	19-D7-ELRR	51	3349	10162	10000	-6651
Hale—3	Humble and Stanolind #1 Byrd	17-K-T&P	41	3251	6760	6750	-3494
Hale—4	Standard of Texas #1 Kellehor	Lge 3-Callahan CSL	51	3280	10895	10050	-6770
Hale—5	Stanolind #2 Fisher	5-CL-ELRR	47	3314	8394	8042	-4728
Hale—6	Stanolind #1 Hegi	7-5-C F Stevenson	47	3264	9974	9275	-6011
Hall—1	Amerada #1 Hughes	101-S5-D&P	51	2095	8121	8100	-6005
Hall—2	Humble #1 Moss	119-1-SPRR	42	1987	4886	4885	-2898
Hall—3	Humble #1 Weaver	51-1-SPRR	40	1950	4840	4820	-2870

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cretaceous	nsl				
ni	nsl				
Cambrian	granite	1446	Texas craton	cuttings	159
Cambrian	granite	10969	Texas craton	cuttings	159
Permian	nsl				
Permian	granodiorite	3200–3205	Wichita igneous province	cuttings	159
	analcite diabase	3200–3205		cuttings	159
ni	nsl				
ni	nsl				
ni	nsl				
ni	nsl				
Permian	nsl				
Permian	nsl				
Permian	granite	2290–2721	Wichita igneous province	cuttings	160
ni	granite	2991–2995	Wichita igneous province	cuttings	160
	granite	3418–3431		cuttings	160
ni	nsl				
Permian	nsl				
ni	rhyolite porphyry	2618–2628	Panhandle volcanic terrane	cuttings	160
Permian	volcanic rocks and albite diorite	3043–3110	Panhandle volcanic terrane	cuttings	160
	rhyolite tuff	3175		cuttings	161
	rhyolite porphyry	3175		cuttings	161
Permian	granite	2824–2833	Wichita igneous province	cuttings	161
Permian	leuco-gabbro	2520–2590	Wichita igneous province	cuttings	161
Permian	diabase	2410–2550	Wichita igneous province	cuttings	161
Permian	granite	3253–3293	Wichita igneous province	cuttings	161
ni	granite	2935–2948	Wichita igneous province	cuttings	161
	granite	2984–2990		cuttings	161
Permian	leuco-quartz diorite?	?	Wichita igneous province	cuttings	162
Permian	nsl				
Permian	nsl				
Permian	nsl				
Mississippian	olivine gabbro	10245–10250	Swisher gabbroic terrane	core	162
	leuco-olivine syenogabbro	10245–10250		core	162
Mississippian	leuco olivine gabbro	10060–10070	Swisher gabbroic terrane	cuttings	162
	olivine gabbro	10140–10150		cuttings	162
Mississippian	granodiorite	6750–6760	Texas craton	cuttings	162
Mississippian	granite	10080–10090	Texas craton?	cuttings	163
	leuco-albite-quartz diorite	10080–10090		cuttings	163
	albite granodiorite	10140–10170		cuttings	163
	leuco-albite diabase	10140–10170		cuttings	163
	leuco-albite diabase	10220–10300		cuttings	163
	albite granodiorite	10220–10300		cuttings	163
	albite granodiorite	10300–10400		cuttings	163
	albite granodiorite	10400–10500		cuttings	163
	albite granodiorite	10500–10600		cuttings	163
	albite granodiorite	10600–10780		cuttings	163
Mississippian	rhyolite flow-breccia	8045–8050	Panhandle volcanic terrane	cuttings	163
	rhyolite flow-breccia	8048		core	164
	rhyolite tuff	8300–8305		core	164
	rhyolite tuff-breccia	8370–8380		cuttings	164
	rhyolite porphyry & tuff	8370–8390		cuttings	164
Mississippian	rhyolite porphyry	9974–9974½	Panhandle volcanic terrane	core	164
Cambrian	granodiorite	8108	Texas craton	cuttings	165
Cambrian	nsl				
Cambrian	albite granodiorite	4820–4840	Texas craton	core	165
	granodiorite gneiss	4839–4840		cuttings	165

COUNTY	OPERATOR and FARM	LOCATION Sec-Block Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev
Hartley—1	Birdwell #1 Houghton	Lge 202–St Cap Lds	51	3899	4464	4444?	–545?
Hartley—2	Birdwell #1-A Houghton	Lge 202–St Cap Lds	52	3931	4454	4395	–464
Hartley—3	Bridwell #2 A Houghton	Lab 14–Lge 210–JJ Subd	52	3873	4106	4095	–222
Hartley—4	Holmes & Heck #1 Coots	58– –XR	b'29	4181	2990	2965	+1216
Hartley—5	Humble #2 Shelton	63–Rio Bravo Subd	b'27	3869	3076	2977	+892
Hartley—6	Kerr-McGee #1 Berneta	29–21–St Cap Lds	52	3823	6051	6034	–2211
Hartley—7	Kerr-McGee #2 Berneta	30–21–St Cap Lds	52	3720	6626	6135	–2433
Hartley—8	Kerr-McGee #3 Berneta	19–21–St Cap Lds	52	3718	5881	5860	–2142
Hartley—9[F]	Kerr-McGee #1 Shelton	3– –Bravo Subd	54	nr	4195	nr	nr
Hartley—10	Phillips #1-GG Bivins	28–21–Cap Sch Lds	53	3828	6178	6117	–2289
Hartley—11	Pure #1 Lankford	148–48–H&TC	49	3934	7853	7845	–3911
Hartley—12	Shamrock #1 Dammier	7–LE–G&M	54	4023	6113	6070	–2047
Hartley—13	Sinclair Prairie #1 Bivins Est.	5–26–ELRR	53	3664	5926	5842	–2178
Hartley—14	Stanolind #1 Beck	164–15–CS	46	4256	5959	5915	–1659
Hartley—15	Texas Gulf #1 Matador	53–22–Cap Synd	52	3702	4801	4796	–1094
Hockley—1	Big Chief #1 DeLoache	Lab 72–Lge 7–Reeves CSL	50	3632	11452	11420	–7788
Hockley—2	Honolulu #1-A Lockett	2–1–PSL	53	3464	12214	12210	–8764
Hockley—3	Honolulu and Signal #1-24 Elwood Est.	Lab 24–Lge 5–Wilbarger CSL	48	3405	11632	11605	–8200
Hockley—4	Honolulu and Sunray #1 Moore	4–0–PSL	52	3345	11305	11295	–7950
Hockley—5	Humble #1 Campbell	16–A–R. M. Thompson	46	3440	11730	11600?	–8160?
Hockley—6	Humble #1 Hobgood	Lab 10–Lge 693–St Cap Lds	50	3470	10179	9060	–5590
Hudspeth—1	Amer Land #1 Roseborough	7–21–Tws 6–PSL	29	4799	1786	1600?	+3199?
Hudspeth—2	California #1 Theison	19–E–UL	30	5109	4850	4732	+377
Hudspeth—3	General Crude #1 Merrill-Voyles	8–69–T&P	52	3874	4792	4782	–908
Hutchinson—1	H. T McGee #1 Smith-Capers	10–Y–M&C	b'32	2908	3175	3135	–227
Jones—1	Hunter & Hunter #1 Steele	Robt Smith	46	1680	5095	5074	–3394
Kent—1	Chapman & McFarlin #26 Cogdell	716–97–H&TC	50	2262	7983	7970	–5708
Kent—2	General Crude #1 P Jones	169–G–W&NWRR	48	2036	7589	7400?	–5634?
Kent—3	General Crude #82 1 Jones	82–G–W&NWRR	54	2150	7685	7654	–5504
Kent—4	Humble #14 Spires	719–97–H&TC	50	2435	8292	8247	–5812
Kent—5	Superior #8 Wood "194"	194–G–W&NWRR	50	2165	7910	7805	–5640
Kimble—1	Humble #1 Bolt	134– –Mary Tolliver	48	2025	4171	3281	–1256
Kimble—2	Phillips #1 Spiller	10– –W A. Choice	45	2227	4264	4229	–2002
King—1	Continental #1 Martin	167–F–H&TC	50	1842	7201	6950?	–5108?
King—2	Continental #2 Martin	173– –H&TC	50	1982	7100	7060	–5078
King—3	Helmerich & Payne #1 Gillespie	113–F–H&TC	53	1796	6803	6770	–4974
King—4	Humble #4 Bateman	101–A–J. B Rector	44	1740	6388	6381	–4641
King—5	Humble #43 Bateman	114–A–J B Rector	48	1731	6631	6626	–4895
King—6	Humble #70 Bateman	118–A–J. B. Rector	51	1781	6315	6294	–4513
King—7	Humble #1 Ross	27– –S. L. Graves	48	1772	6601	6592	–4820

[F] Data received too late for inclusion on map, Plate I

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Permian	rhyolite porphyry-X	4450–4460	Panhandle volcanic terrane	cuttings	165
Permian	rhyolite porphyry-X	4430–4458	Panhandle volcanic terrane	cuttings	165
Permian	rhyolite porphyry	4080–4106	Panhandle volcanic terrane	cuttings	165
Permian	nsl				
ni	albite granodorite	2990	Wichita igneous province	cuttings	165
	albite granodiorite	3048		cuttings	166
Pennsylvanian	nsl				
Pennsylvanian	rhyolite porphyry-X?	?	Panhandle volcanic terrane	cuttings	166
Pennsylvanian	granite	5878–5881	Wichita igneous province?	core	166
ni	rhyolite porphyry	3892	Panhandle volcanic terrane	core	166
Pennsylvanian	microgranite porphyry	6130–6176	Wichita igneous province?	cuttings	166
Cambro Ord	granite	7848	Wichita igneous province?	core	166
Pennsylvanian	nsl				
Pennsylvanian	nsl				
Pennsylvanian	rhyolite porphyry	5955–5959	Panhandle volcanic terrane	core	166
Pennsylvanian	rhyolite porphyry	4800–4802	Panhandle volcanic terrane	core	166
Cambro-Ord	rhyolite porphyry	11445–11450	Panhandle volcanic terrane	cuttings	167
Cambro-Ord	micrographic granite	12214	Panhandle volcanic terrane	cuttings	167
Cambro-Ord	rhyolite porphyry-X	11630–11632	Panhandle volcanic terrane	cuttings	167
Cambrian	rhyolite porphyry X	11304–11305	Panhandle volcanic terrane	core	167
Cambrian	albite diabase	11621	Swisher gabbroic terrane?	cuttings	167
	albite diabase	11690–11700		cuttings	167
	albite diabase	11710–11720		cuttings	167
	albite diabase	11720		core	168
Cambrian	albite microdiorite	9060–9250	Panhandle volcanic terrane	cuttings	168
	gabbro	9250–9265		cuttings	168
	gabbro	9465–9490		cuttings	168
	gabbro	9595– ?		cuttings	168
	quartz-epidote rock	9917		core	168
	feldspar-quartz-epidote rock	9919		core	168
	albite andesite	9924		core	168
	rhyolite porphyry-X	10174		core	169
	rhyolite porphyry-X	10175		core	169
	rhyolite porphyry-X	10177		core	169
	rhyolite porphyry-X	10179		core	169
Permian	rhyolite porphyry	1600–1610	?	cuttings	169
	rhyolite porphyry	1625–1786	?	cuttings	169
Ordovician	micrographic granite	4844–4848	?	cuttings	169
Ordovician	nsl				
ni	nsl				
Cambro Ord	rhyolite? metarkosite?	5090–5093	Fisher metasedimentary terrane	cuttings	170
Cambro Ord	nsl				
Cambro Ord	rhyolite porphyry	7580–7590	Fisher metasedimentary terrane	cuttings	170
Cambro-Ord	granite	7669–7684	Texas craton	core	170
Cambro-Ord	granite	8260–8270	Texas craton	cuttings	170
Cambro Ord	granite	7890–7910	Texas craton	cuttings	170
Cambrian	biotite amphibolite	4167–4170	Texas craton	core	171
Cambrian	microgranite	4255–4260	Texas craton	cuttings	171
Cambro-Ord	granite	6980–7200	Texas craton	cuttings	171
Cambro-Ord	nsl				
Cambrian	nsl				
Cambrian	granite	6388	Texas craton	core	171
Cambrian	nsl				
Cambrian	nsl				
Cambrian	granite	6600–6601	Texas craton	core	172

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT DEPTH	ELEV
King—8	Ohio #1 Burnett	J. Gates	47	1850	6438	6435	-4585
King—9	Ohio #1 Pitchfork L&C	Lge 1–Somerville CSL	45	1940	6974	6970?	-5030?
King—10	Ohio #2-A Ross	24– –R B Masterson	45	1769	6474	6462	-4703
King—11	Superior #1 Pitchfork L&C	171–A96–J H. Gibson	46	2017	7145	7145	-5128
King—12	Superior #2 Pitchfork L&C	176–A96–J. H. Gibson	46	2024	7045	7040	-5016
King—13	Tidewater and Seaboard #1 Pitchfork L&C	143–A65–BS&F	50	2029	7035	7025	-4996
Knox—1	Seaboard #1 Big Four Ranch	DL&C	53	1650	7040	7026	-5376
Knox—2	Benedum & Trees #1 Big Four Ranch	32–4–D&WRR	53	1646	7188	7122	-5476
Lamb—1	Anderson-Prichard #1 Gettys	59–1–Halsell Subd	52	3719	9315	9280	-5561
Lamb—2	Honolulu #1 Halsell	Lab 19–Lge 219–Castro CSL	47	3795	9138	9070	-5275
Lamb—3	Humble #1 Jackson	19–T–R M. Thompson	44	3461	7191	7185	-3724
Lamb—4	San Juan #1 Jones	16–687–St Cap Lds	53	3465	9000	8960	-5495
Lamb—5	Seaboard #1 Jackson	Lab 15–Lge 680–St Cap Lds	47	3715	9327	9257	-5542
Lamb—6	Stanolind #1 Hopping	25–F–T. A. Thompson	42	3561	9624	9600	-6039
Lampasas—1	Texoleum Trust #1 White	P. T. Hill	b'32	1250	3000	3000	-1750
Lampasas—2	Western Lampasas Oil #1 Whittenburg	38–229–John Boyd	b'32	1450	4180	3580	-2130
Lubbock—1	Amerada #1 Stribling	9–D7–ELRR	48	3240	10679	10650	-7410
Lubbock—2	Bankline #1-A Elliott	33–JS–ELRR	51	3270	11406	11395	-8125
Lubbock—3	Honolulu #1 Rhoades	9–E–GC&SF	47	3216	10471	10450	-7234
Lubbock—4	Humble #1 Farris	29–P–ELRR	51	3350	11783	11776	-8426
Lubbock—5	Magnolia #1 Johnson	88–C–D&WRR	45	3166	10178	10169	-7053
Lubbock—6	Phillips #1 Kary	25–D7–ELRR	49	3317	11450	11430	-8113
Lynn—1	Honolulu #1 King	424–21–HE&WT	47	3216	10756	10746	-7530
Lynn—2	Phillips #1-A Bartley	1372–1–ELRR	45	2981	9909	9900	-6919
Mason—1	Cochran & Steward #1 Brandenburger	M. Patton	b'32	1700	1900	1065	+635
McCulloch—1	Burford & Brimm #1 Cawyer	D. Mechels	b'32	1422	2130	2100	-678
McCulloch—2	Haby & Allison, Haby well	138– –C. Volmar	b'32	1935	1920	1900	+35
McCulloch—3	Prairie #1 Zelle	H&TC	b'32	1498	3516	3309	-1811
McCulloch—4	Sterrett #1 Scoggin	911– –J. Henk	50	1705	3010	2650	-945
McCulloch—5	Thomas #1 Craig	1351– –C Usner	b'32	1755	3666	3473	-1718
McCulloch—6	Thomas #1 White	Fisher & Miller	b'32	1750	3406	2982	-1232
Menard—1	American Republics #1 Bradford	29– –J. V. Massey	47	2043	2745	2680	-637
Menard—2	Deep Rock #1 Bevans	31–A–GH&SA	52	2218	5147	5120	-2902
Menard—3	Phillips #1 Meta	501– –J. W. Bradford	45	2335	3939	3863	-1528
Menard—4	Sheffield and Dakota-Texas #1 Rudder	7– –TTRR	51	2103	2247	2210	-7
Mills—1	Miller #1 Savoy	E M. Pease	46	1518	4230	4225	-2707
Mills—2	Venture #1 Harrison & Slayden	T. Carroll	b'32	1271	3268	3268±	-1997±
Mitchell—1	Humble #1 Pratt	28–25–T&P	47	2292	8131	8115	-6423
Mitchell—2	Sun #2 Elwood	25–16–SPRR	48	2158	8659	8464	-6303
Montague—1	Boyd #3 Maddox	C. W. Thompson	b'32	864	2273	2262	-1398
Montague—2	Bridwell #1 Bouldin	E. Votaw	b'32	795	3024	2683	-1888

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambrian	microgranite	6430–6438	Texas craton	cuttings	172
Cambrian	microgranite	6970–6974	Texas craton	cuttings	172
Cambrian	granite	6473–6474	Texas craton	cuttings	172
Cambrian	granite	7145	Texas craton	cuttings	172
Cambrian	granite	7041	Texas craton	cuttings	172
Cambrian	nsl				
Cambrian	granite	7030–7040	Texas craton	cuttings	172
Cambrian	nsl				
Cambro-Ord?	albite syenodiorite	9300–9310	?	cuttings	172
Cambro-Ord	rhyolite	9120–9130	Panhandle volcanic terrane	cuttings	172
	rhyolite porphyry	9137		core	173
Permian	rhyolite porphyry	7186–7191	Panhandle volcanic terrane	core	173
Permian	rhyolite porphyry	8990–9000	Panhandle volcanic terrane	cuttings	173
Cambro-Ord	rhyodacite tuff	9300–9310	Panhandle volcanic terrane	cuttings	173
Cambro-Ord?	albite andesite tuff?	9600–9624	Panhandle volcanic terrane	core	174
	andesite porphyry	9606–9614		core	174
	magnetite-albite tuff	9622–9624		cuttings	174
Ordovician	arkose gneiss	3000	Texas craton	cuttings	174
Cambrian	granite	3558–3580	Texas craton	cuttings	174
Cambro-Ord	rhyolite porphyry-X?	10650–10679	Panhandle volcanic terrane	cuttings	174
Cambro-Ord	tuff	11400–11406	Panhandle volcanic terrane	cuttings	174
Cambro-Ord	albite microdiorite	11450–11460	Texas craton?	cuttings	175
	microsyenite	11450–11460		cuttings	175
	quartz microdiorite	core–"top"		core	175
	albite microdiorite	core–"middle"		core	175
	albite microdiorite porphyry	core–"bottom"		core	175
Cambro-Ord	rhyolite porphyry-X	11778–11783	Panhandle volcanic terrane	core	175
Cambrian	granite	10171–10178	Texas craton	core	176
Cambro-Ord	rhyolite porphyry-X	11440	Panhandle volcanic terrane	cuttings	176
Cambro-Ord	rhyolite porphyry-X	10746–10756	Panhandle volcanic terrane	core	176
Cambrian	albite granodiorite	9908–9910	Texas craton	cuttings	177
Cambrian	graphite-biotite schist	1900	Texas craton	cuttings	177
Cambrian	nsl				
Cambrian	nsl				
Cambrian	granite	3450	Texas craton	core	177
Cambrian	nsl				
Cambrian	nsl				
Cambrian	hornblende-andesine schist (amphibolite)	3035	Texas craton	cuttings	177
Cambrian	nsl				
Cambrian	nsl				
Cambrian	microgranite	3900–3905	Texas craton	cuttings	177
Cambrian	nsl				
Cambrian	nsl				
Ordovician	nsl				
Cambro-Ord	granite	8125–8130	Texas craton	cuttings	177
Cambrian	granite gneiss	8464–8474	Texas craton	core	177
	granite	8520–8524		core	178
Pennsylvanian?	nsl				
Cambrian?	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Montague—3	Continental #4 Hynds	J. J. Wall	40	877	2137	2132	-1255
Montague—4	Humphreys #1 Hinton	A. Coates	b'32	802	1844	1841	-1039
Montague—5	Lesh-McCall #7 Davenport	J. Fitch	43	846	2925	2730?	-1884?
Montague—6	Nu-Enamel #1 Agee	21– –Kaufman CSL	45	916	5371	5270	-4359
Montague—7	Phillips #1 Fields	J. L. Graham	40	165?	3813	3804	-3639?
Montague—8	Pure #1 Jones	W. Donoho	b'32	782	1966	1797	-1015
Montague—9	Pure #2 Jones	W. Donoho	b'32	861	2795	2084	-1223
Montague—10	Pure #3 Rowland	J. Chambliss	b'32	848	2700	2622	-1774
Montague—11	Red River #1 Jones	W. Donoho	b'32	858	2595	2500	-1642
Montague—12	Seitz #1 Guerin	R. H. Grimes	39	852	3730	3718	-2866
Montague—13	Sztykgold #1 Charles	Mary Burnsides	50	895	5482	4450	-3555
Montague—14	Texas #1 Cobb	C. A. Barnes	44	905	3394	3384	-2479
Montague—15	Texas #1 Lemons	S. Little	22	891	2915	2707	-1816
Montague—16	Texas #1 Martin	C. A. Barnes	40	931	3624	3610	-2679
Montague—17	Warner #1 Monroe	Fielding-Seacrest	b'32	946	3243	2950	-2004
Moore—1	Gulf #1 Kilgore	22–PMc–ELRR	b'32	3743	3632	3450	+293
Motley—1	Amerada #1 Birney	1–GP–C&MRR	51	2595	10010	10001	-7506
Motley—2[6]	General Crude #43-1 Swenson	43– –J. Stephens	54	2213	4802	4744	-2531
Motley—3	Humble #1-B Matador	44–M–Blanco CSL	40	2662	8604	8601	-5939
Motley—4	Humble #1-D Matador	127– –J. H. Gibson	41	2362	6269	6266	-3904
Motley—5	Humble #1-H Matador	128–M–Matador Land & Cattle Co.	49	2205	8616	8590	-5385
Motley—6	Humble #2-H Matador	131–M–Matador Land & Cattle Co.	50	1964	7882	7872	-5908
Nolan—1	American Trading #1 Little	25–20–T&P	53	2004	5696	5680	-3676
Nolan—2	Honolulu #2 Whittaker	35–20–T&P	54	2040	5703	5670	-3630
Nolan—3	Honolulu #3 Whittaker	35–20–T&P	54	2020	5659	5656	-3636
Nolan—4	Honolulu #4 Whittaker	35–20–T&P	54	2053	5844	5815	-3762
Nolan—5	Hunt #1 McElmurray	36–20–T&P	53	1991	5561	5453	-3462
Nolan—6	Seaboard #1 Earwood	211–64–H&TC	54	2410	6890	6869	-4459
Nolan—7	Seaboard #1-A Hanks	28–Z–T&P	51	2410	6140	6000	-3590
Nolan—8	Seaboard #1 Jordan	14–Z–T&P	54	2514	6445	6423	-3909
Nolan—9	Penrose #1 Kirk	W. E. McRory	54	2408	6890	6869	-4461
Oldham—1	Albough #1 Matador	Lge 291–St Cap Lds	52	3856	4915	4845	-989
Oldham—2	Albough #2 Matador	95–B7–ELRR	53	3532	4115	4090	-558
Oldham—3	Benedum & Trees #2 Matador	26–7–ELRR	b'32	3635	2390	2380	+1255
Oldham—4	Benedum & Trees #1 Shelton	137– –Bravo Subd	b'32	3850	2580	2462	+1388
Oldham—5	Humble #1 Shelton	43– –Bravo Subd	b'32	3699	2590	2560	+1139
Oldham—6	Humble #1-E Matador	Lge 329–St Cap Lds	43	3895	6282	6280	-2385
Oldham—7	Livermore #1 Moser	26–T7N–R1E–CM	51	3881	6922	6790	-2909
Oldham—8	Stanolind #1 Green	Lge 320–St Cap Lds	44	3730	6114	6082	-2352
Oldham—9	Superior #54-9 Gray Ranch	9–S–CS&SF	51	3720	7216	7150	-3430
Oldham—10	Superior #1 Howard	85–K6–GB&C	51	4143	8640	8610	-4467

[6] Completed too late for inclusion on the map, Plate I.

[7] Personal communication, Robert Roth, 1953. No thin section studied.

[8] Robert Roth (personal communication, 1953) reports this as a riebeckite granite.

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Pennsylvanian	nsl				
ni	granite	1839–1840	Red River mobile belt	core	178
Pennsylvanian?	granite gneiss	2733–2734	Red River mobile belt	core	178
Pennsylvanian	granite	5340–5350	Red River mobile belt	cuttings	178
Pennsylvanian	granite	3813	Red River mobile belt	cuttings	178
Pennsylvanian?	nsl				
Pennsylvanian?	nsl				
Pennsylvanian?	nsl				
Pennsylvanian?	nsl				
Pennsylvanian	nsl				
Pennsylvanian	granite	4330–4480	Red River mobile belt	cuttings	178
	diabase	4480–4520		cuttings	178
	granite	4520–4640		cuttings	178
	diabase	4640–4690		cuttings	178
	granite	4690–5140		cuttings	178
	diabase	5140–5230		cuttings	179
	granite	5230–5384		cuttings	179
Pennsylvanian	granite	3394	Red River mobile belt	cuttings	179
Pennsylvanian	leuco-diabase	2755–2903	Red River mobile belt	cuttings	179
	granite	2898		cuttings	179
Pennsylvanian	nsl				
Pennsylvanian	diorite	2953–2955	Red River mobile belt	cuttings	180
	diorite	2960–2965		cuttings	180
	diorite gneiss	2995–3000		cuttings	180
	diorite gneiss	3020–3025		cuttings	180
ni	rhyolite porphyry	3524–3532	Panhandle volcanic terrane	cuttings	180
	diorite or gabbro	3617–3621		cuttings	180
Mississippian	arkose or granite gneiss	10010	Red River mobile belt? Texas craton?	cuttings	181
Mississippian	arkose gneiss	4789–4792	Red River mobile belt	core	181
Mississippian	granite[7]	?	Texas craton	cuttings	
Pennsylvanian	rhyolite porphyry	6269	Red River mobile belt?	core	181
Cambrian	sericite phyllite	8610–8616	Red River mobile belt	core	181
Mississippian	microsyenite?	7875	Red River mobile belt	cuttings	181
	sericite phyllite	7878–7882		core	181
Cambrian	nsl				
Cambrian	chlorite schist	5687–5688	Fisher metasedimentary terrane	core	181
	arkose gneiss	5696–5697		core	182
Cambrian	granite gneiss	5656–5659	Fisher metasedimentary terrane	core	182
Cambrian	metaquartzite	5840	Fisher metasedimentary terrane	core	182
Cambrian	metarkosite	5443–5561	Fisher metasedimentary terrane	cuttings	182
Cambrian	arkose gneiss	6886–6890	Fisher metasedimentary terrane?	cuttings	182
Cambrian	microgranite	6100–6110	Texas craton	cuttings	182
	granite	6140		cuttings	182
Cambrian	syenite gneiss	6430–6434	Fisher metasedimentary terrane?	cuttings	182
Cambrian	nsl				
Pennsylvanian	micrographic granite	4850–4915	Wichita igneous province	cuttings	183
Permian	micrographic granite	4090–4115	Wichita igneous province	cuttings	183
ni	nsl				
ni	nsl				
ni	nsl				
Pennsylvanian	granite (riebeckite?)[8]	6280	Wichita igneous province	core	183
Pennsylvanian	rhyolite porphyry	6880	Panhandle volcanic terrane	cuttings	183
	trachyte porphyry	6880–6884		cuttings	183
Pennsylvanian	micrographic granite	6112–6114	Wichita igneous province	core	183
Pennsylvanian	rhyolite porphyry-X	7181–7187	Panhandle volcanic terrane	core	184
	rhyolite porphyry-X	7208–7214		core	184
Pennsylvanian	micrographic granite	8636	Wichita igneous province	core	184

COUNTY	OPERATOR and FARM	Sec-Block-Survey LOCATION	YEAR COMPLETED	ELEVATION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Oldham—11	Superior #1 Matador	Lge 328–St Cap Lds	51	4020	6897	6823	-2803
Oldham—12	Superior #2 Matador	Lge 312–St Cap Lds	51	3805	6177	6165	-2360
Oldham—13	Superior #3 Matador	Lge 331–St Cap Lds	51	3861	5499	5460	-1599
Oldham—14	Superior #4 Matador	Lge 330–St Cap Lds	51	3967	7074	7025	-4058
Oldham—15	Superior and Lazard #1-312 Matador	Lge 312–St Cap Lds	54	3795	6965	6963	-3168
Parker—1	Garland-Anthony #1 Hammons	J. Johnson	52	877	7798	7660	-6783
Parmer—1	Gulf #1-A Keliehor	5–Brown Subd–Gregg CSL	53	3996	9628	9562	-5566
Parmer—2	Stanolind #1 Jarrell	19–B–St Cap Lds	44	4177	8162	8160	-3983
Parmer—3	Sunray #1 Kimbrough	23– –Doud & Feefer	48	3985	9423	8855	-4870
Parmer—4	U.S. Smelt. & Rfg. #1-A Osborner	5–RIN–R3E–Cap Synd Subd	52	4165	9720	9700?	-5535?
Pecos—1	Aldrich #1 St. Nat'l Bank	25–140–T&STL	46	2491	4748	4730	-2239
Pecos—2	Anderson-Prichard #1 Boren	4–110–Pink-Phelps	41	2469	4880	4808	-2339
Pecos—3	Anderson-Prichard #2 Boren	4–110–Pink-Phelps	41	2471	4858	4780	-2309
Pecos—4	Anderson-Prichard #2 Masterson	104–10–H&GN	39	2430	4740	4519	-2089
Pecos—5	Anderson-Prichard #1-A Masterson	24–140–T&STL	43	2553	4565	4560	-2008
Pecos—6	Burk Royalty #2 Shearer	107–10–H&GN	43	2435	4740	4740	-2305
Pecos—7	Byrd-Frost #1 Giesecke	54–11–H&GN	45	2593	4677	4655	-2062
Pecos—8	Childress Royalty #1 Masterson	104–10–H&GN	39	2430	4605	4505	-2075
Pecos—9	Gulf #1 Garvin	60–11–H&GN	43	2516	4537	4518	-2002
Pecos—10	Gulf #1 Millar	39–11–H&GN	41	2576	4538	4532	-1956
Pecos—11	Gulf #2 Millar	43–11–H&GN	42	2534	4494	4464	-1930
Pecos—12	Gulf #3 Millar	43–11–H&GN	42	2543	4406	4392	-1849
Pecos—13	Gulf #1 O'Sullivan	38–11–H&GN	44	2485	4643	4630	-2145
Pecos—14	Helmerich & Payne #1 Barnes	130–10–H&GN	45	2400	4687	4680	-2280
Pecos—15	Humble #1 B. F. Smith	12–145–T&STL	44	2605	5175	5149	-2544
Pecos—16	Humble #2 St. Nat'l Bank El Paso	1–141–T&STL	45	2478	4838	4796	-2318
Pecos—17	Humble #1-L University	5–18–UL	48	2523	5640	5294	-2771
Pecos—18	Humble #1 Wilson	1–145–T&STL	44	2651	5238	5235	-2584
Pecos—19	Los Nietos #1-B University	20–26–UL	49	2677	5649	5220	-2543
Pecos—20	McCandless #1-10 Atlantic	10–141–T&STL	44	2520	4878	4877	-2357
Pecos—21	McCandless #101 Atlantic	101–11–H&GN	45	2397	4103	3099	-702
Pecos—22	McCandless #1 Turney	19–141–T&STL	43	2511	4986	4980	-2469
Pecos—23	McCandless #1 University	20–26–UL	43	2629	5514	5507	-2878
Pecos—24	Magnolia #3 Fromme	106–10–H&GN	43	2457	4697	4663	-2206
Pecos—25	Magnolia #2-96 Powell-State	96–10–H&GN	43	2408	4700	4685	-2277
Pecos—26	Midcontinent #1 Shearer	107–10–H&GN	43	2424	4726	4658	-2234
Pecos—27	Olson & McCandless #1 Crockett	5–110–TCRR	41	2461	4526	4524	-2063
Pecos—28	O'Neill #1 Tyrrell Trust	602– –P. H. Fall	51	2569	5394	5370	-2801
Pecos—29	Pan American #1-4 MacDer	26–144 T&STL	48	2756	5297	5255	-2499
Pecos—30	Phillips #1 Pascoe	114–11–H&GN	44	2448	4645	4580	-2132
Pecos—31	Phillips #1-A Puckett "B"	44–101–TCRR	53	3325	16535	16510	-13185
Pecos—32	Phillips #1-C Puckett	42–101–TCRR	53	3330	14930	14903	-11513
Pecos—33	Phillips #1-D Puckett	26–101–TCRR	53	3321	14320	14210	-10889
Pecos—34	Shell (Humphries) #1 University	23–26–UL	29	2620	5204	4809	-2189
Pecos—35	Standard of Texas #2 Fromme	106–10–H&GN	43	2453	4654	4550	-2097
Pecos—36	Standard of Texas #1-3 MacDer	64–11–H&GN	44	3002	5374	5350?	-2348?
Pecos—37	Standard of Texas #1-4 MacDer	36–144–H&GN	44	2643	5313	5280	-2637
Pecos—38	Stanolind #1 Conry-Davis	31–9–H&GN	41	2376	5745	5740	-3364
Pecos—39	Stanolind #1-A Hinyard	29–144–T&STL	47	2859	6731	6605	-3746
Pecos—40	Sunray #1 Masterson	105–10–H&GN	44	2450	5455	5081?	-2631?
Pecos—41	Superior #1 Cordova Union	3–110–Pink-Phelps	43	2517	4862	4860	-2343

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Pennsylvanian	micrographic granite	6892–6897	Wichita igneous province	core	184
Pennsylvanian	micrographic granite	6167–6173	Wichita igneous province	core	184
Pennsylvanian	granite	5992–5998	Wichita igneous province	core	185
Pennsylvanian	micrographic granite	7074	Wichita igneous province	core	185
Pennsylvanian	nsl				
Cambrian	biotite-hornblende schist	7660±	?	core	185
Mississippian	olivine gabbro	9578–9584	Swisher gabbroic terrane	core	185
	olivine gabbro	9627–9628		core	185
Pennsylvanian	rhyolite porphyry-X	8160–8161½	Panhandle volcanic terrane	core	185
Mississippian?	micrographic granite	8870–8880	Texas craton?	cuttings	186
Mississippian	rhyolite porphyry-X	9700–9710	Panhandle volcanic terrane	cuttings	186
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granodiorite gneiss	4858	Texas craton	core	186
Permian	diorite	4570	Texas craton	core	186
Cambrian	granite	4560–4564	Texas craton	cuttings	186
Cambro-Ord	nsl				
Permian	nsl				
Permian	gabbro	4600–4605	Texas craton	cuttings	186
Cambro-Ord	granodiorite	4525–4530	Texas craton	cuttings	187
Permian	granite	4536–4538	Texas craton	core	187
Cambrian	microgranite	4489–4493	Texas craton	cuttings	187
Cambrian	granite	4396–4404	Texas craton	cuttings	187
Cambrian	leuco-quartz microgabbro	4630–4635	Texas craton	cuttings	187
Permian?	nsl				
Permian	diorite	5167–5168	Texas craton	cuttings	187
Cambro-Ord	nsl				
Permian	granodiorite gneiss	5630–5640	Texas craton	core	187
Permian	granite gneiss	5235	Texas craton	core	188
Permian	microgranite	5550–5560	Texas craton	cuttings	188
	microgranite	5615–5620		cuttings	188
Permian	microgranite	?	Texas craton	cuttings	188
Cambro-Ord?	nsl				
Permian	granite gneiss	4980–4986	Texas craton	cuttings	188
Permian	microgranite	5513	Texas craton	core	188
Cambrian	syenite	4667–4682	Texas craton	core	188
	microsyenite	4682–4697		core	188
Cambro-Ord	nsl				
Permian	nsl				
Cambrian	nsl				
Permian	nsl				
Permian	granite gneiss	5290–5295	Texas craton	cuttings	189
Cambro-Ord	microdiorite	4630–4640	Texas craton	cuttings	189
Cambrian	granite	16510–16525	Texas craton	cuttings	189
Cambrian	granite	14923	Texas craton	core	189
Cambrian	granite	14309–14320	Texas craton	core	189
Permian	microgranite	5200–5204	Texas craton	cuttings	189
Cambro-Ord	nsl				
Permian	microgranite	5350–5360	Texas craton	cuttings	189
Permian	microgranite	5280–5313	Texas craton	cuttings	190
	rhyolite porphyry	5280–5313		cuttings	190
Cambro-Ord	quartz diorite	5745	Texas craton	cuttings	190
Permian	metarkosite	6473–6473½	Texas craton	core	190
	metarkosite	6487–6489		core	190
	biotite amphibolite	6721–6724		core	190
	metaquartzite	6721–6724		core	190
Permian	nsl				
Permian	albite granodiorite	4860–4864	Texas craton	cuttings	190

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COMPLETED	ELEVATION DF	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Pecos—42	Superior and McCandless #1 Crockett-State	-2B-Pink-Phelps	43	2466	4648	4620	-2154
Pecos—43	Union of California #1-C Heiner	589-105-GC&SF	45	2557	6162	6125	-3568
Potter—1	Amarillo Oil & Gas #3 Masterson	102-018-D&P	b'32	3434	3082	2698	+757
Potter—2	Amarillo Oil & Gas #5 Masterson	31-3-Gunter & Munson	b'32	3279	2230	2205	+1074
Potter—3	Canadian River #4-B Masterson	103-018-D&PRR	42	3331	1952	1940	+1391
Potter—4	Colo. Interstate #25-A Bivins	2-018-D&PRR	39	3669	3030	2460	+1209
Potter—5	Colo. Interstate #41-B Masterson	84-3-Gunter & Munson	53	3356	2496	2400?	+944?
Potter—6	Emerald #1 Masterson	82-3-Gunter & Munson	b'20	3433	2130	2045	+1465
Potter—7	Greater Amarillo Oil #1 Masterson	20-3-Gunter & Munson	b'32	3423	2595	2045	+1378
Potter—8	Prairie #1 Bivins	42-M-20-Gunter & Munson	b'32	3238	3485	2525	+713
Potter—9	Ranch Creek #1 Masterson	-018-D&PRR	b'32	3397	2480?	2480	+917
Potter—10	Ranch Creek #1 Masterson	2-B-11-ELRR	b'32	3434	2675	2200	+1234
Potter—11	Sinclair #2 Bivins	28-018-D&PRR	49	3519	2908	2863	+656
Potter—12	Sinclair-Prairie #1 Bush	23-6-BS&F	39	3424	6161	5100?	-1676?
Potter—13	Standard of Texas #1 Bush	12-20F-ELRR	52	3510	6847	6824	-3314
Presidio—1	Hunt #1 Presidio Trust	99-3-D&PRR	53	3858	8111	8005	-4147
Presidio—2	Welch #1 Espy	110-4-H&TC	52	4746	7837	7773	-3027
Randall—1	Placid #1 Greeley	53-1-TTRR	51	3759	8244	8200	-4441
Reagan—1	Big Lake #13-C University	25-9-UL	46	2675	9854	9853	-7175
Roberts—1	Phillips #1 Jenkie	38-2-GH&H	48	3167	11737	11719	-8552
Runnels—1	Superior #1 McDowell	80-T&NORR	48	1856	6307	6200	-4344
San Saba—1	Cayce #1 Moore	C. Hernandez	b'32	1250	1659	1655	-405
San Saba—2	Newman #1 Weldon	5- -H&TC	49	1563	3022	3020	-1457
Schleicher—1	Atlantic #1 Roberts	175-A-HE&WT	53	2405	7751	7745	-5340
Schleicher—2	Humble #1 Spencer	176-A-HE&WT	53	2374	6978	6897	-4526
Schleicher—3	Humble #1 Stanford	196-A-HE&WT	53	2447	9032	9017	-6570
Schleicher—4	Phillips #1 Callan	311- -J. F. Wilhelm	44	2306	6065	5955	-3649
Scurry—1	Humble #1 Nachlinger	146-3-H&TC	53	2419	8271	8060	-5641
Scurry—2	Magnolia #1-F McDonnell Est.	341-97-H&TC	50	2512	8546	8544	-6032
Scurry—3	Stanolind #1 Jordan	579-97-H&TC	49	2779	8922	8905	-6126
Scurry—4	Sun and Ohio #1 Helms	633-97-H&TC	49	2122	7524	7520	-5398
Shackleford—1	Honolulu #1 Pool	35- -UL	49	1339	5276	5273	-3934
Sherman—1	Humble #1 Morris	79-1T-T&NO	54	3740	6100	6085	-2345
Sherman—2	I.T.I.O. #1 Bryan	369-1T-T&NO	47	3640	7051	5114	-1476

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	nsl				
Cambro-Ord	microdiorite	6145–6150	Texas craton	cuttings	190
	granite	6145–6150		cuttings	190
	microdiorite	6155–6160		cuttings	190
	microgabbro	6155–6160		cuttings	191
ni	trachyte porphyry-X	2750	Panhandle volcanic terrane	core	191
	leuco-diabase	2765		core	191
ni	granite	2200	Wichita igneous province	cuttings	191
Pennsylvanian	rhyolite porphyry	1954–1952	Panhandle volcanic terrane	core	191
	rhyolite tuff	1952		core	191
Pennsylvanian	rhyolite porphyry	2460–2467	Panhandle volcanic terrane	cuttings	191
	leuco-olivine gabbro	2546–2552		cuttings	192
	leuco-olivine diabase	2610–2660		cuttings	192
	diabase and iron ore	2767–2776		cuttings	192
	diabase and iron ore	2875–2883		cuttings	192
	olivine diabase	2956–2962		cuttings	192
	basalt porphyry	3002–3010		cuttings	192
	rhyolite porphyry	3013–3030		cuttings	193
Pennsylvanian	microgranite	2419–2424	Wichita igneous province	cuttings	193
ni	rhyolite tuff	2065±	Panhandle volcanic terrane	cuttings	193
	rhyolite porphyry	2125–2130		cuttings	193
ni	trachyte tuff	2777	Panhandle volcanic terrane	cuttings	193
	trachyte porphyry	2777		cuttings	193
ni	olivine diabase	2585–2595	Wichita igneous province	core	193
ni	trachyte tuff	2480	Panhandle volcanic terrane	cuttings	193
	trachyte porphyry	2480		cuttings	193
ni	nsl				
Pennsylvanian	nsl				
Pennsylvanian	rhyolite porphyry	5300–5700	Panhandle volcanic terrane	cuttings	193
	rhyolite porphyry-X?	5900–6161		cuttings	194
	rhyolite porphyry-X	6158–6161		core	194
Pennsylvanian	rhyolite porphyry-X	6843–6848	Panhandle volcanic terrane	core	194
Permian	granitized metarkosite	8110	Van Horn mobile belt	core	194
Cambrian?	granite	7830	Van Horn mobile belt	core	195
Pennsylvanian	rhyolite porphyry-X	8240–8244	Panhandle volcanic terrane	cuttings	195
Cambrian	nsl				
Cambro-Ord	granodiorite	11737	Wichita igneous province	cuttings	195
Cambrian	albite hornfels?	6283	Texas craton	cuttings	195
Cambrian	granite	1656–1669	Texas craton	cuttings	195
Cambrian	nsl				
Cambrian	granite	7751	Texas craton	core	195
Pennsylvanian	granite	6909–6910	Texas craton	core	196
Cambrian	granite	9020	Texas craton	core	196
Cambrian	olivine gabbro	6058–6065	Texas craton	core	196
Cambrian	metadolomite	8266	Fisher metasedimentary terrane	core	196
Cambro-Ord	nsl				
Cambrian	granodiorite	8920–8921	Texas craton	cuttings	196
	granite	8920–8925		cuttings	196
Cambro-Ord	quartz diorite	?	Texas craton	core	197
Cambrian	syenite	5273–5276	Texas craton	core	197
Cambrian	micrographic granite	6085–6100	Wichita igneous province	core	197
Cambro-Ord	leuco-albite-quartz diorite	5123–5128	Wichita igneous province	cuttings	197

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev.
Sherman—3	Phillips #1 Kathryn	8–3B–GH&H	49	3404	7739	7734	-4330
Sherman—4	Phillips #1 Virginia	234–1T–T&NO	47	3640	7051	7044	-3404
Stonewall—1	Honolulu #1 Baugh	375–2–H&TC	47	1893	6914	6880	-4987
Stonewall—2	Wiggins & Norsworthy #1 Green	99–F–H&TC	50	1725	6705	6703	-4978
Sutton—1	Phillips #1 Libb Wallis	52–14–TWNGRR	52	2223	5489	5470	-3247
Sutton—2	Shell #3 Miers (Core Test #3)	53–14–TWNGRR	51	2240	5009	4840	-2600
Swisher—1	Humble #1 Nanny	9–OD–S. B. Dinwiddie	29	3602	9658	9590?	-5988?
Swisher—2	Standard of Texas #1 Johnson	116–M10–AB&M	52	3396	9218	9193	-5799
Taylor—1	Jamison #1 Webb	46–Lunatic Asylum	31	1905	6395	5800	-3895
Terry—1	Anderson-Prichard #1 Rich	15–DD–J. H. Gibson	54	3322	13134	13125	-9808
Terry—2	J. L. Hamon (Coroco) #1 Atlas Life	93–D11–C&M	52	3457	13260	13215	-9758
Tom Green—1	Honolulu #1 Nasworthy	A. E. White	54	1930	7689	7684	-5754
Tom Green—2	Plymouth #1-B Green	193– –SPRR	49	2153	5657	5650	-3497
Tom Green—3	Richardson #1 Schwartz	155½– –John Cherry	53	1849	7168	7141	-5292
Upton—1	Slick-Urschel #1 Standefer	50½–F. B. Scott	48	2681	12505	12490	-9809
Wheeler—1	Alma #1 Welch	7–A8–H&GN	41	2330	2340	2280	+50
Wheeler—2	Best #1 Tindal	19–A8–H&GN	b'25	2332	2249	2248	+84
Wheeler—3	Murchison & Fain #5 Close	76–23–H&GN	b'32	2530	1290	1290	+1240
Wheeler—4	Murchison & Fain #11 Close	77–23–H&GN	b'32	2498	1510	1490	+1008
Wheeler—5	Murchison & Fain #12 Close	77–23–H&GN	b'32	2501	1415	1385	+1116
Wheeler—6	Palaskie #1 Tyrell	128–23–H&GN	b'32	2584	2132	1435	+1149
Wheeler—7	Schenck et al. #1 George	85–17–H&GN	b'32	2270	2270	2693	-222
Wheeler—8	Sheldon #1 Emler	70–13–H&GN	b'32	2287	2385	2167	+120
Wheeler—9	Smith #2 Farren	34–24–H&GN	42	2610	4488	ni	ni
Wheeler—10	Thomas & McFarland #1 Kachelhoffer	70–23–H&GN	b'32	2773	2393	2155	+618
Wichita—1	Continental & Magnolia #1 Beach	C. T. Ry.	b'32	1005	3450	3000	-1995
Wichita—2	Frabar-Hodges #1 George	J. Waldschmidt	ni	ni	3394	ni	ni
Wichita—3	Gulf #1 Miller	2– –SPRR	ni	1172	4331	ni	ni
Wichita—4	Rollstone #1 Schnokenberg	Lot 1, Tidwell Subd, F. W. Huseman Surv	b'32	1080	3595	3575	-2495
Wichita—5	Texas #44 Skinner	J. F. Torrey & Co.	46	1180	2865	2800	-1620
Wilbarger—1	Barkley-Meadows #14-A Stevens	83–14–H&TC	b'32	1252	3007	2970	-1718
Wilbarger—2	Gulf #6-E Blackman	W. A. McKinney	46	ni	3548	3505	ni
Wilbarger—3	Humble #6 Stevens	83–14–H&TC	37	1244	2815	2728	-1484
Wilbarger—4	Texas #1 Main	16–8–H&TC	43	1338	4725	ni	ni
Wilbarger—5	Texas #1 Zipperle	80–14–H&TC	b'32	1253	2970	2881	-1628
Williamson—1	Shell and Sinclair #1 Purcell	Wm. H. Magill	54	1060est	9465	9474	-8414
Winkler—1	A. G. Carter #2-C Walton	1–B3–PSL	43	2955	10015	10002	-7047
Winkler—2	A. G. Carter #1-E Walton	2–B3–PSL	45	2972	9985	9958	-6989

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	rhyolite porphyry	7739	Panhandle volcanic terrane	core	197
Cambro-Ord	metarkosite?	7040–7050	?	cuttings	197
Cambrian	metarkosite	?	Fisher metasedimentary terrane	core	197
Cambro-Ord	nsl				
Cambrian	granite	5470–5480	Texas craton	cuttings	198
Pennsylvanian	albite diorite	4940–4950	Texas craton	cuttings	198
	granite	4950–5003		cuttings	198
Mississippian	albite microdiorite	9590–9600	Swisher gabbroic terrane	cuttings	198
	albite microdiorite	9630–9640		cuttings	198
	diorite	9630–9640		cuttings	198
	diorite	9640–9650		cuttings	198
Mississippian	olivine diabase	9193–9200	Swisher gabbroic terrane	core	198
Cambrian	feldspathic biotite schist	5845–5850	Fisher metasedimentary terrane	cuttings	198
	feldspathic biotite schist	6081		core	199
	feldspathic biotite schist	6125–6126		core	199
	feldspathic biotite schist	6234–6244		cuttings	199
Ordovician	microgranite porphyry?	13130–13134	Texas craton	cuttings	199
Ordovician	granite	13250–13260	Texas craton	cuttings	199
Cambrian	granite	7688–7689	Texas craton	core	199
Cambrian	nsl				
Cambrian	granite	7160–7168	Texas craton	cuttings	199
Cambro-Ord	microdiorite?, amphibolite?	12490–12500	Texas craton	cuttings	199
Pennsylvanian	nsl				
ni	microgranite	2252	Wichita igneous province	cuttings	200
	microgranite	2267		cuttings	200
ni	nsl				
ni	nsl				
ni	nsl				
ni	nsl				
ni	diabase	2492–2504	Wichita igneous province	cuttings	200
	quartz diorite	2542–2547		cuttings	200
ni	nsl				
ni	granite (brecciated)	2490–2500	Wichita igneous province	cuttings	200
	albite syenodiorite	2961–2969		cuttings	200
	granite (brecciated)	3065–3070		cuttings	201
	granite	3125		cuttings	201
	granite	3275		cuttings	201
	microgranite	4286		cuttings	201
ni	granite	2280	Wichita igneous province	cuttings	201
	granite	2325		cuttings	201
Cambrian	epidote-sericite phyllite?	3180	Red River mobile belt	cuttings	201
ni	chlorite-epidote rock	3318	Red River mobile belt	core	201
ni	meta-arkose	4231–4235	Red River mobile belt	core	201
ni	nsl				
ni	metagraywacke	2860	Red River mobile belt	core	202
	meta-arkose	2860–2865		core	202
ni	leuco-microgabbro	3007	Red River mobile belt	core	202
ni	metarkosite	3515–3533	Red River mobile belt	core	202
Pennsylvanian	diorite	2810–2815	Red River mobile belt	cuttings	202
ni	biotite schist	4725	Red River mobile belt	core	202
ni	nsl				
Cambro-Ord	granite gneiss	9474–9479	Texas craton	core	202
Cambrian	nsl				
Cambro-Ord	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Winkler—3	A. G. Carter #6-E Walton	1–B3–PSL	44	2965	9780	9770	-6805
Winkler—4	A. G. Carter #7-E Walton	1–B3–PSL	44	2962	9914	9695	-6731
Winkler—5	A. G. Carter and Pure #8-E Walton	2–B3–PSL	45	2964	9724	9913	-6951
Winkler—6	Gulf #46-E Keystone	6–B2–PSL	44	2971	10005	9990	-7019
Winkler—7	Gulf #50-E Keystone	6–B2–PSL	45	2966	10090	10085	-7119
Winkler—8	Gulf #51-E Keystone	10–B3–PSL	45	2951	9700	9676	-6725
Winkler—9	Gulf #59-E Keystone	6–B2–PSL	45	2970	9920	9910	-6940
Winkler—10	Gulf #62-E Keystone	10–B3–PSL	45	2963	9660	9640	-6677
Winkler—11	Gulf #65-E Keystone	6–B2–PSL	45	2962	9909	9900	-6938
Winkler—12	Gulf #68-E Keystone	6–B2–PSL	45	2970	9969	9950	-6980
Winkler—13	Gulf #69-E Keystone	10–B3–PSL	46	2955	9871	9650	-6695
Winkler—14	Gulf #70-E Keystone	6–B2–PSL	46	2961	9749	9744	-6783
Winkler—15	Gulf #73-E Keystone	6–B2–PSL	47	2975	9842	9830	-6855
Winkler—16	Gulf #75-E Keystone	6–B2–PSL	46	2964	9810	9700	-6736
Winkler—17	Gulf #93-E Keystone	10–B3–PSL	46	2951	9663	9661	-6710
Winkler—18	Gulf #133-E Keystone	10–B3–PSL	48	2946	9711	9666	-6720
Winkler—19	Phillips #2 Bashara	21–77–PSL	45	2963	9951	9890	-6927
Winkler—20	Phillips #5 Bashara	21–77–PSL	44?	2976	10122	10114	-7138
Winkler—21	Phillips #4 Walton	2–B3–PSL	45	2964	9714	9685	-6721
Winkler—22	Phillips #5 Walton	2–B3–PSL	46	2960	9740	9627	-6667
Winkler—23	Richardson & Bass #1-E McCutcheon	15–B2–PSL	45	2962	9761	9760	-6798
Winkler—24	Richardson & Bass #1 KC Stock Co.	25–B2–PSL	45	2940	10673	10620	-7680
Winkler—25	Richardson & Bass #10-E Walton	1–B3–PSL	44	2957	9858	9838	-6881
Winkler—26	Richardson & Bass #15-E Walton	1–B3–PSL	45	2967	9695	9690	-6723
Winkler—27	Richardson & Bass #23-E Walton	1–B3–PSL	45	2962	9771	9760	-6798
Winkler—28	Richardson & Bass #31-E Walton	2–B3–PSL	46	2958	9791	9650	-6692
Winkler—29	Richardson & Bass #32-E Walton	1–B3–PSL	47	2957	9622	9610	-6653
Winkler—30	Richardson & Bass #42-E Walton	2–B3–PSL	46?	2962	9745	9685	-6723
Winkler—31	Sinclair #6-A Walton	20–77–PSL	45	2964	9958	9940	-6976
Yoakum—1	Continental #1 Rodgers	106–D–J. H. Gibson	51	3865	13016	12985	-9120
Yoakum—2	Fikes & Murchison #17-C Elliott	832–D–J. H. Gibson	49	3623	11210	11189	-7566
Yoakum—3	Stanolind #1 Argo	98–D–J. H. Gibson	52	3809	13131	13125	-9316

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granite	9995–10000	Texas craton	cuttings	203
	granite	10000–10005		cuttings	203
Cambrian	granite	10080–10090	Texas craton	cuttings	203
Cambrian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granite	9650–9660	Texas craton	cuttings	203
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granite	9865–9871	Texas craton	cuttings	203
Cambro-Ord	granite	9744–9748	Texas craton	cuttings	203
Cambro-Ord	granodiorite	9830–9840	Texas craton	cuttings	203
Cambro-Ord	granite	9800–9810	Texas craton	cuttings	203
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granodiorite gneiss	9915	Texas craton	core	204
Cambro-Ord	nsl				
Cambrian	granite	9705–9710	Texas craton	cuttings	204
Cambro-Ord	biotite schist	9685–9690	Texas craton	cuttings	204
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granodiorite	9857–9858	Texas craton	core	204
Ordovician	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	microgranodiorite	9955–9965	Texas craton	cuttings	204
Ordovician	trachyandesite tuff	13015	Panhandle volcanic terrane	core	204
	rhyolite porphyry	13015		core	204
	rhyolite tuff	13016		core	205
Ordovician	micrographic granite	11200–11205	Texas craton	cuttings	205
Ordovician	nsl				

PART 2—DATA ON NEW MEXICO BASEMENT WELLS

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Chaves—1	Amerada #1-RA State	22–8S–32E	50	4373	11621	11580	-7207
Chaves—2	Arkansas #1 Manning	14–15S–17E	26	5455	3400	3245	+2210
Chaves—3	Barnsdall #1-A State	23–8S–32E	49	4459	12040	11994	-7535
Chaves—4	Black #1 Shildneck	24–16S–20E	48	4365	6996	6655	-2290
Chaves—5	Buffalo #3 Comanche Unit	26–11S–26E	49	3669	6175	6173	-2504
Chaves—6	Continental #1 Lankford	2–14S–26E	47	3409	8099	7980	-4571
Chaves—7	DeKalb #1 Lewis	13–10S–25E	46	3721	5650	5526	-1805
Chaves—8	DeKalb and Magnolia #1 White	13–9S–28E	51	3888	7463	7448	-3560
Chaves—9	Franklin, Ashton & Fair #1 Orchard Park	22–12S–28E	51	3563	5828	5320	-2242
Chaves—10	Gulf #1 Jennings	5–8S–30E	50	4055	8326	8293	-4238
Chaves—11	Gulf #1 State-Chaves U	10–18S–16E	52	6490	3147	2960	+3530
Chaves—12	Honolulu #1 Hinkle-Federal	24–11S–27E	50	3745	7315	7305	-3560
Chaves—13	Honolulu #1 Levick-State	16–10S–27E	50	3861	7215	7198	-3337
Chaves—14	Honolulu #1 McConkey Est.	10–9S–26E	51	3843	6371	5950?	-2107?
Chaves—15	Honolulu #1 Texas-State	13–11S–27E	50	3763	6933	6928	-3165
Chaves—16	Humble #1 Gorman-Federal	30–15S–22E	48	4168	5849	5750	-1583
Chaves—17	Humble #1-N State (see Table 10)	35–14S–17E	44	3615	4014	3350	+265
Chaves—18	Humble #1-U State	10–12S–27E	48	3672	7851	7835	-4163
Chaves—19	Humble #1-Y State	33–11S–27E	50	3708	7430	7411	-3703
Chaves—20	Magnolia #1 Black Hills Unit	31–17S–20E	46	4902	6085	5900?	-998
Chaves—21	Magnolia #1-B O'Brien	1–9S–28E	50	3949	7666	7656	-3707
Chaves—22	Magnolia #1 Shaw-Federal	6–13S–31E	53	4031	12072	12067	-8036
Chaves—23	Magnolia #1-Z State	36–7S–29E	50	4186	8731	8723	-4537
Chaves—24	Magnolia #1 Turney-Federal	23–14S–22E	48	4075	5342	5305	-1230
Chaves—25	Olson #1 Noble Trust	18–4S–27E	50	3874	8034	6556	-2682
Chaves—26	Richfield #1 Comanche Unit	13–11S–26E	47	369	6129	6120	-2511
Chaves—27	Richfield #1 Coll	18–11S–27E	45	3673	6630	617	-2944
Chaves—28	Richfield #1 Mullis	21–15S–29E	47	3809	12153	12148	-8339
Chaves—29	Richfield #1-A Trigg	35–14S–27E	48	3528	9993	9970	-6442
Chaves—30	Richfield #1-3 White	6–12S–29E	47	3710	9058	9040	-5330
Chaves—31	Sanders #1 Sanders (Saunders?)	25–5S–24E	50	3872	5355	4900?	-1028?
Chaves—32	Spartan #1-25 State	25–5S–29E	50	4339	8911	8903	-4564
Chaves—33	Sun #1 Pinion	19–19S–17E	51	6544	1911	1800?	+4744?
Chaves—34	Sun #2 Pinion	20–19S–17E	52	6314	1659	1645	+4669
Chaves—35	Union of California and DeKalb #1 State	27–11S–27E	49	3791	7582	7566	-3775
Curry—1	Union Prod. #1 Jones	18–5N–37E	53	4239	8180	8124	-3885

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	rhyolite and rhyolite porphyry	11580–11621	Panhandle volcanic terrane	cuttings	206
Permian	nsl				
Mississippian	basalt	12034–12040	Panhandle volcanic terrane?	core	206
	diabase	?		cuttings	206
Ordovician	granite	6850–6860	Texas craton	cuttings	206
	albite granodiorite	6860–6870		cuttings	206
	diabase	6860–6870		cuttings	206
Ordovician	nsl				
Cambro-Ord	metaquartzite	8040–8050	?	cuttings	207
	metaquartzite	8075–8095		cuttings	207
Permian	granodiorite	5635–5638	Texas craton	core	207
Cambro-Ord	granite	7458–7463	Texas craton	core	207
Permian	albite granodiorite	5350–5810	Texas craton	cuttings	207
	granite	5814–5827		core	208
Cambro-Ord	granite	8300	Texas craton	core	208
	granite	8319		core	208
Cambrian	tuff?	3100±	?	core	208
Devonian	granite	7310–7315	Texas craton	core	209
	albite-quartz microdiorite	7310–7315		core	209
Silurian-Dev	albite granodiorite	7210–7250	Texas craton	cuttings	209
Devonian	rhyolite porphyry	5970–5980	Panhandle volcanic terrane	cuttings	209
	microgranodiorite	6340–6350		cuttings	209
	granite	6350–6360		cuttings	209
	rhyolite porphyry	6364–6371		core	209
Cambro-Ord	nsl				
Cambro-Ord	granite	5848–5849	Texas craton	core	209
Permian?	diabase	3476, 3500–03, 3804–09	(Tertiary?)	core	210
	metaquartzite	3835		core	210
	diabase	3939		core	210
Cambro-Ord	granite	7847–7851	Texas craton	cuttings	210
Cambro-Ord	granite	7425–7430	Texas craton	cuttings	211
Silurian	argillite?	5930–5940	?	cuttings	211
Cambro-Ord	granodiorite	7665–7666	Texas craton	core	211
Ordovician	microgranite porphyry	12070	Texas craton	core	211
Cambro-Ord	granodiorite	8728	Texas craton	cuttings	211
Permian?	granodiorite gneiss	5321–5324	Texas craton?	core	211
	epidote-chlorite-oligoclase gneiss	5321–5324		core	211
Mississippian	sericite phyllite	7630–7660	?	core	212
	sericite phyllite	8030		core	212
Cambro-Ord	rhyolite porphyry-X?	6128	Panhandle volcanic terrane	core	212
Ordovician-Dev	nsl				
Cambro-Ord	granodiorite	12143–12153	Texas craton	core	212
Cambro-Ord	albite diorite	9980–9990	Texas craton	cuttings	212
	syenodiorite	9980–9990		cuttings	212
	granodiorite	9980–9993		cuttings	212
Cambro-Ord	quartz microdiorite	9046–9047	Texas craton	core	213
Mississippian	sheared rhyolite porphyry	4940–5290	Panhandle volcanic terrane	cuttings	213
Cambro-Ord	nsl				
Permian	albite andesite porphyry-X	1850	Panhandle volcanic terrane	core	213
Permian	nsl				
Cambro-Ord	granite	7575–7580	Texas craton		
Pennsylvanian	nsl			cuttings	213

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Debaca—1	Abercrombie & Hawkins #1-X Napier	22–5N–26E	49	4518	7149	7148	–2630
Debaca—2	Cities Production #1 Hobson	12–1S–27E	53	4279	6742	6720	–2441
Debaca—3	Pure #1 Fee-Federal	31–3N–28E	46	4121	6469	6452	–2331
Debaca—4	South Basin #1 Good	5–4N–20E	42	5002	4779	4750	+252
Debaca—5	Transcon. and California #1 McWhorter	6–3S–22E	29	4500	4770	4667	–167
Debaca—6	Woolworth & Hawkins #1 Myrick	17–2N–25E	49	4369	6174	6070	–1674
Eddy—1	Continental #1 Thurman-Federal	11–16S–27E	51	3668	10770	10748	–7080
Eddy—2	Humble #1 Pearson	12–16S–25E	50	3449	8248	8195	–4746
Eddy—3	Magnolia #1 State W	16–21S–22E	48	4464	11312	11235	–6771
Eddy—4	Richardson & Bass #1 Cobb-Federal	23–20S 31E	53	3515	16460	16396	–12881
Eddy—5	Southern Union and Magnolia #1 Elliott	24–18S–23E	48	3886	9885	9883	–5997
Lea—1	Amerada #5 Corrigan	4–22S–37E	46	3466	7813	7803	–4337
Lea—2	Amerada #6 Corrigan	4–22S–37E	47	3466	7698	7687	–4221
Lea—3	Amerada #7 Corrigan	4–22S–27E	47	3459	7646	7634	–4175
Lea—4	Amerada #11 Corrigan	4–22S–37E	47	3459	7600	7400?	–3941?
Lea—5	Amerada #8 Andrews	12–20S–36E	48	3576	10827	10822	–7246
Lea—6	Amerada #4 Hare	33–21S–37E	47	3459	7938	7925	–4466
Lea—7	Amerada #5 Hare	33–21S–37E	47	3456	7856	7844	–4388
Lea—8	Amerada #5 Phillips	1–20S–36E	48	3587	9953	9943	–6356
Lea—9	Amerada #7 Phillips	1–20S–36E	49	3578	10214	10211	–6633
Lea—10	Amerada #3-A Phillips	31–19S–37E	48	3588	11019	11006	–7418
Lea—11	Amerada #1 State BTA	2–12S–33E	49	4246	11766	11709	–7464
Lea—12	Amerada #1 State BTB	26–12S–33E	49	4259	11199	11173	–6914
Lea—13	Amerada #5-F State-Graham	36–19S–36E	48	3590	10255	10250	–6660
Lea—14	Amerada #1 Turner-State	17–20S–38E	52	3566	9429	9418	–5852
Lea—15	Amerada #1 Walden	15–22S–37E	47	3402	7870	7855	–4453
Lea—16	Amerada #3 Walden	15–22S–37E	47	3393	7875	7868	–4475
Lea—17	Amerada #4 Walden	15–22S–37E	47	3410	7913	7906	–4496
Lea—18	Amerada #5 Wood	22–22S–37E	47	3374	8116	8100	–4726
Lea—19	Amerada #6 Wood	22–22S–37E	47	3360	7524	7519	–4159
Lea—20	Amerada #9 Wood	22–22S–37E	48	3370	8025	8016	–4646
Lea—21	Amerada #10 Wood	22–22S–37E	48	3360	7670	7661	–4301
Lea—22	Aztec #1 Dauron	10–21S–37E	50	3452	7875	7845	–4393
Lea—23	Aztec #2 State	2–21S–37E	51	3505	8620	8600	–5095
Lea—24	Carter #3 Elliott	22–22S–37E	48	3377	8110	8000	–4623
Lea—25	Cities Service and Repollo #1-B Brunson	4–22S–37E	46	3447	7625	7614	–4167
Lea—26	Cities Service #3-S State	15–21S–37E	51	3447	8034	7997	–4550
Lea—27	Cities Service #1 Burger B-28	28–20S–37E	52	3560	9379	9373	–5813
Lea—28	Continental #5 Burger A-19	19–20S–38E	50	3546	9731	9720	–6174
Lea—29	Continental #3 Elliott A-15	15–22S–37E	47	3382	7813	7812	–4430
Lea—30	Continental #1 Elliott B-15	15–22S–37E	47	3384	7353	7351	–3967
Lea—31	Continental #2 Elliott B-15	15–22S–37E	49	3372	7513	7510	–4138
Lea—32	Continental #5-A Elliott	15–22S–37E	48	3370	7700	7680	–4310
Lea—33	Continental #1-E Hawk B-3	3–21S–37E	51	3465	7975	7958	–4493
Lea—34	Continental #2-E Hawk B-3	3–21S–37E	51	3474	8021	8005	–4531
Lea—35	Continental #3-E Hawk B-3	3–21S–37E	51	3480	8191	8170	–4690
Lea—36	Continental #4-E Hawk B-3	3–21S–37E	51	3432	8070	8060	–4628

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Pennsylvanian?	arkose (not basement)	7140–7149	?	cuttings	.....
	Note: Arkose contains numerous fragments of rhyolite suggesting underlying volcanic terrane				
Pennsylvanian	granite	6720–6730	Texas craton?	cuttings	214
Pennsylvanian	granite	6467	Texas craton	core	214
Pennsylvanian	biotite-hornblende schist	4774–4779	?	core	214
Pennsylvanian	nsl				
Pennsylvanian	leuco-diorite	6080–6090	Texas craton	cuttings	214
	quartz-diorite	6080–6090		cuttings	214
	quartz-diorite	6168–6174		cuttings	215
Cambro-Ord	diorite	10760–10765	Texas craton?	cuttings	215
Cambro-Ord	metaquartzite	8243–8248	?	core	215
	metarkosite	8243–8248		core	215
Ordovician	chlorite-epidote phyllite	11290–11310	?	cuttings	215
	chlorite phyllite	11300–11310		cuttings	216
	metabasalt?	11310–11312½		core	216
Cambro-Ord	granite	16459	Texas craton	core	216
Silurian-Dev	microgranite	9886–9887½	Texas craton?	core	216
Cambro-Ord	granodiorite	7803	Texas craton	cuttings	216
Cambro-Ord	granite	7687	Texas craton	cuttings	216
Cambro-Ord	granite	7634	Texas craton	cuttings	216
Cambro-Ord	granite	7410	Texas craton	cuttings	216
Ordovician	nsl				
Cambro-Ord	microgranodiorite porphyry	7928	Texas craton	cuttings	217
Cambro-Ord	microgranodiorite	7844	Texas craton	cuttings	217
Cambro-Ord	nsl				
Cambro-Ord	microgranite	10211	Texas craton	cuttings	217
	microgranite	10214		cuttings	217
Cambro-Ord	albite microgranodiorite	11006	Texas craton	cuttings	217
Cambro-Ord	silicified rhyolite	11716	Panhandle volcanic terrane	core	217
	silicified rhyolite	11754–11755		core	217
Cambro-Ord	microgranite porphyry	?	Texas craton	core	218
Cambro-Ord	microgranite	10250	Texas craton	cuttings	218
Cambro-Ord	nsl				
Cambro-Ord	albite microgranodiorite	7858	Texas craton	cuttings	218
Cambro-Ord	microgranodiorite	7868	Texas craton	cuttings	218
Cambro-Ord	microgranodiorite	7906	Texas craton	cuttings	218
Cambro-Ord	microgranite	8113	Texas craton	cuttings	218
Cambro-Ord	microgranite	7519	Texas craton	cuttings	218
Cambro-Ord	microgranite	8016	Texas craton	cuttings	218
Cambro-Ord	microgranite	7661	Texas craton	cuttings	218
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	microgranodiorite	8030–8034	Texas craton	cuttings	219
Cambro-Ord	microdiorite	9373–9376	Texas craton	core	219
	granite (stringer)	9373–9379		core	219
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	TOP OF BASEMENT Elev.
Lea—37	Continental #1-E Hawk B-10	10-21S-37E	51	3434	7950	7945	-4511
Lea—38	Continental #2-E Hawk B-10	10-21S-37E	51	3450	7981	7970	-4520
Lea—39	Continental #3-E Hawk B-10	10-21S-37E	51	3427	7728	7728	-4301
Lea—40	Continental #5-E Hawk B-10	10-21S-37E	52	3462	8079	8075	-4613
Lea—41	Continental #1-E Lockhart A-27	27-21S-37E	49	3431	7782?	7780?	-4349?
Lea—42	Continental #2-E Lockhart A-27	27-21S-37E	50	3432	7770	7767	-4335
Lea—43	Continental #3-E Lockhart A-27	27-21S-37E	50	3418	7652	7585	-4167
Lea—44	Continental #4-E Lockhart A-27	27-21S-37E	51	3417	7541	7530	-4113
Lea—45	Continental #1-S Lockhart A-27	27-21S-37E	50	3432	7866	7857	-4425
Lea—46	Continental #5 Lockhart B-11	11-21S-37E	52	3469	7831	7825	-4356
Lea—47	Continental #3-E Lockhart B-11	11-21S-37E	51	3426	7658	7640	-4214
Lea—48	Continental #4-E Lockhart B-11	11-21S-37E	52	3462	7811	7783	-4321
Lea—49	Continental #6-E Lockhart B-11	11-21S-37E	52	3473	8065	8196	-4723
Lea—50	Continental #1 Lockhart B-12	12-21S-37E	52	3480	8268	8254	-4774
Lea—51	Continental #4 Lockhart B-12	12-21S-37E	53	3467	8206	8196	-4729
Lea—52	Continental #1-A Lockhart B-13	13-21S-37E	53	3427	7600	7520	-3793
Lea—53	Continental #1 Nolan	11-21S-37E	50	3423	7523	7480	-4057
Lea—54	Continental #2 Skaggs B-23	23-20S-37E	44	3540	10465	10463	-6890
Lea—55	Continental #5 Skaggs B-23	23-20S-37E	47	3539	10231	10155	-6616
Lea—56	Continental #1-E Wantz	21-21S-37E	49	3440	8304	8304	-4864
Lea—57	Continental #1 Warren A-29	29-20S-38E	49	3538	9391	9360	-5822
Lea—58	Continental #1 Warren B-27	27-20S-38E	51	3552	9392	9330	-5778
Lea—59	Continental #2 Warren B-28	28-20S-38E	50	3549	9072	8970	-5421
Lea—60	Continental #2 Warren B-29	29-20S 38E	49	3548	9852	9830	-6282
Lea—61	Gulf #1 Amanda	25-22S-37E	47	3317	7335	7330	-4013
Lea—62	Gulf #8 J. N. Carson	28-21S-37E	48	3451	8005	8000	-4549
Lea—63	Gulf #5-A J. N. Carson	28-21S-37E	48	3444	7910	7881	-4437
Lea—64	Gulf #7-A J. N. Carson	33-21S-37E	48	3459	7644	7643	-4184
Lea—65	Gulf #9-A J. N. Carson	28-21S-37E	49	3455	8073	8072	-4617
Lea—66	Gulf #6-C J. N. Carson	28-21S-37E	49	3446	7500	7493	-4047
Lea—67	Gulf #8-C J. N. Carson	28-21S-37E	49	3435	7743	7726	-4291
Lea—68	Gulf #4-A Cole-State	16-22S-37E	47	3411	7651	7644	-4233
Lea—69	Gulf #5 Eubank	22-21S-37E	50	3424	7756	7755	-4331
Lea—70	Gulf #6 Eubank	22-21S-37E	50	3425	7686	7686	-4261
Lea—71	Gulf #5-F Graham-State	36-19S-36E	48	3586	9822	9819	-6233
Lea—72	Gulf #7 King	28-21S-37E	48	3447	8063	8050	-4603
Lea—73	Gulf #10 King	28-21S-37E	48	3456	8040	8030	-4574
Lea—74	Gulf #12 King	28-21S-37E	49	3441	7975	7970	-4529
Lea—75	Gulf #15 King	28-21S-37E	49	3461	8146	8135	-4674
Lea—76	Gulf #21 King	28-21S-37E	50	3440	7935	7925	-4485
Lea—77	Gulf #6 LaMunyon	28-23S-37E	48	3294	10218	10205	-6911
Lea—78	Gulf #16-E LaMunyon	27-23S-37E	52	3283	10165	10120	-6837
Lea—79	Gulf #8-E Leonard	2-21S-37E	52	3487	7926	7920	-4433
Lea—80	Gulf #10-E Leonard	2-21S-37E	52	3483	8168	8165	-4682
Lea—81	Gulf #2 Stitcher	4-22S-37E	46	3440	7980	7979	-4539
Lea—81a	Humble #10 Greenwood	9-22S-37E	47	3428	7711	7700	-4272
Lea—82	Humble #11 Greenwood	9-22S-37E	47	3427	7501	7495	-4068
Lea—83	Humble #12 Greenwood	9-22S-37E	47	3424	8090	8080	-4656
Lea—84	Humble #1 Keinath-Federal	8-21S-38E	45	3582	9954	9890	-6308
Lea—85	Humble #3-V State	10-21S-37E	51	3463	7673	7665	-4202
Lea—86	Humble #5-V State	10-21S-37E	51	3470	8396	8240	-4470
Lea—87	Humble #6-V State	10-21S-37E	51	3464	7717	7700	-4246
Lea—88	Humble #8-V State	10-21S-37E	52	3452	7573	7510	-4058
Lea—89	Humble #9-V State	10-21S-37E	52	3462	8240	8200	-4738
Lea—90	Lion #1 Wylie	5-23S-37E	46	3385	8519	8518	-5133
Lea—91	Magnolia #9 Brunson-Argo	9-22S-37E	46	3436	7881	7830	-4384
Lea—92	Magnolia #10 Brunson-Argo	9-22S-37E	46	3433	7901	7895	-4462
Lea—93	Magnolia #11 Brunson-Argo	9-22S-37E	46	3426	7644	7643	-4217
Lea—94	Magnolia #12 Brunson-Argo	9-22S-37E	46	3432	7471	7476	-4044
Lea—95	Magnolia #16 Brunson-Argo	10-22S-37E	48	3425	7454	7438	-4013

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	albite microgranodiorite	7791	Texas craton	core	219
Cambrian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	micrognanite	8058–8065	Texas craton	cuttings	219
Cambro-Ord	nsl				
Cambro-Ord	granite	8202	Texas craton	cuttings	219
	microdiorite	8202		cuttings	219
Permian	syenite	7514–7539	Texas craton	cuttings	220
	syenite	7585–7590		cuttings	220
Ordovician	nsl				
Ordovician	nsl				
Ordovician	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granodiorite	9361–9391	Texas craton	core	220
	olivine gabbro	9371–9372		core	220
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granodiorite	9850–9852	Texas craton	core	220
Permian	biotite schist	7332	Texas craton	cuttings	220
	microgranite	7332		cuttings	220
Cambro-Ord	nsl				
Cambro-Ord	granite	7881	Texas craton	core	221
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	microgranite	7649	Texas craton	cuttings	221
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	albite microgranodiorite	9820	Texas craton	core	221
Cambro-Ord	granite	8051–8060	Texas craton	core	221
	microgranite	8060–8063		core	221
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	micrognanite	7980	Texas craton	core	221
Cambro-Ord	micrognanite	7710	Texas craton	cuttings	222
Cambro-Ord	micrognanite	7495–7500	Texas craton	cuttings	222
Cambro-Ord	nsl				
Cambro-Ord	granodiorite	9951–9954	Texas craton	core	221
	micrognanite	9951–9954		cuttings	222
Cambro-Ord	granite	7665–7670	Texas craton	cuttings	222
Cambro-Ord	granite	8395–8399	Texas craton	cuttings	222
Cambro-Ord	granite	7705	Texas craton	core	222
Cambro-Ord	granite	7560–7565	Texas craton	cuttings	222
Cambro-Ord	granite	8235–8240	Texas craton	cuttings	222
Cambro-Ord	nsl				
Cambrian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Ordovician	nsl				
Cambro-Ord	nsl				

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Lea—96	Magnolia #9 E. O. Carson	33–21S–37E	47	3469	8172	8171	–4702
Lea—97	Magnolia #10 E. O. Carson	33–21S–37E	48	3464	8216	8214	–4750
Lea—98	Magnolia #13 E. O. Carson	33–21S–37E	47	3461	7591	7590	–4129
Lea—99	Magnolia #14 E. O. Carson	33–21S–37E	47	3471	8220	8215	–4744
Lea—100	Magnolia #17 E. O. Carson	28–21S–37E	48	3461	8156	8152	–4691
Lea—101	Magnolia #2 J. N. Carson	33–21S–37E	47	3462	7270	7460	–3998
Lea—102	Magnolia #4 Corrigan	33–21S–37E	47	3541	7662	7644	–4193
Lea—103	Magnolia #7 Corrigan	33–21S–37E	47	3449	7446	7443	–3994
Lea—104	Magnolia #1 Laura May	35–22S–37E	49	3313	8834	8834	–5521
Lea—105	Magnolia #6 Marshall	34–21S–37E	48	3457	7477	7473	–4016
Lea—106	McAlester Fuel #1-C McClure	14–15S–37E	51	3803	13983	13716	–9913
Lea—107	Mid-Continent #1 Lynch	1–22S–37E	47	3364	7236	7080	–3716
Lea—108	Moran #2 Owen	14–21S–37E	50	3442	7614	7534	–4092
Lea—109	Ohio #1 Muncy	24–22S–37E	46	3331	7298	7292	–3961
Lea—110	Ohio #3 Muncy	24–22S–37E	49	3328	7447	7447	–4119
Lea—111	Ohio #7-B Marshall	27–21S–37E	50	3430	7774	7771	–4341
Lea—112	Ohio #9–B Marshall	27–21S–37E	51	3425	7591	7580	–4155
Lea—113	Ohio #9 Warlick	15–21S–37E	51	3424	7503	7490	–4066
Lea—114	Ohio #5-C Warlick	15–21S–37E	50	3427	7827	7775	–4348
Lea—115	Ohio #6-C Warlick	15–21S–37E	50	3430	7847	7846	–4116
Lea—116	Ohio #8-C Warlick	15–21S–37E	51	3426	7627	7615	–4189
Lea—117	Olson and Atlantic #1 Langlie	11–25S–37E	43	3133	9592	9555	–6422
Lea—118	O'Neill #1-A State	36–28S–38E	52	3576	9724	9710	–6134
Lea—119	Penrose #4 Elliott B-9	9–22S–37E	46	3435	7971	7691	–4526
Lea—120	Penrose #3 Hinton	12–22S–37E	45	3344	7387	7381	–4037
Lea—121	Penrose #1 Penrose-Federal	9–22S–37E	45	3429	8370	8351	–4922
Lea—122	Penrose #1 Rogers	7–22S–38E	46	3347	7742	7678	–4331
Lea—123	Penrose #4 Walden	15–22S–37E	48	3412	7819	7805	–4393
Lea—124	Penrose #5 Walden	15–22S–37E	48	3414	7669	7669	–4255
Lea—125	Penrose #3-A Walden	15–22S–37E	47	3409	7568	7528	–4119
Lea—126	Phillips #1 Shipp	20–18S–37E	49	3747	12626	12590	–8843
Lea—127	Phillips #1 Sims	24–22S–37E	45	3333	7377	7333	–4000
Lea—128	Phillips #2 Sims	24–22S–37E	47	3334	7305	7295	–3961
Lea—129	Rowan & Penrose #5 Cary	22–22S–37E	48	3374	8086	8070	–4696
Lea—130	Rowan & Penrose #1 Elliott A-15	15–22S–37E	48	3392	7690	7689	–4297
Lea—131	Rowan & Penrose #1 Elliott B-15	15–22S–37E	46	3416	7365	7325	–3909
Lea—132	Rowan & Penrose #3 Walden	15–22S–37E	46	3415	7581	7570	–4155
Lea—133	Rowan & Penrose #6 Walden	15–22S–37E	47	3407	7788	7787	–4380
Lea—134	Samedan #2 Parks	14–22S–37E	47	3345	7324	7322	–3977
Lea—135	Shell #5 Argo-Herring	15–21S–37E	50	3429	8091	7975	–4546
Lea—136	Shell #6 Argo-Herring	15–21S–37E	50	3428	7908	7897	–4469
Lea—137	Shell #7 Argo-Herring	15–21S–37E	51	3457	8193	8185	–4728
Lea—138	Shell #8 Argo-Herring	22–21S–37E	51	3435	8188	8185	–4750
Lea—139	Shell #9 Argo-Herring	15–21S–37E	51	3445	8189	8186	–4741
Lea—140	Shell #4-A Argo-Herring	22–21S–37E	50	3426	7810	7760	–4334
Lea—141	Shell #6-A Argo-Herring	22–21S–37E	50	3428	7907	7897	–4469
Lea—142	Shell #8-A Argo-Herring	22–21S–37E	51	3435	8188	8185	–4750
Lea—143	Shell #10-A Argo-Herring	22–21S–37E	51	3437	8130	8120	–4683
Lea—144	Shell #1 Carter	32–17S–39E	50	3646	14044	14015	–10369
Lea—145	Shell #1 Chesher	12–21S–37E	52	3465	7695	7630	–4155
Lea—146	Shell #4 Livingston	3–21S–37E	52	3429	8167	8160	–4731
Lea—147	Shell #3 Rinewalt	4–22S–37E	47	3469	7986	7985	–4516
Lea—148	Shell #4 Rinewalt	4–22S–37E	47	3462	7957	7944	–4482
Lea—149	Shell #3 State	2–21S–37E	50	3467	7906	7900	–4433
Lea—150	Shell #4 State	15–21S–37E	51	3431	7567	7550	–4119
Lea—151	Shell #5 State	2–21S–37E	51	3483	7956	7951	–4468
Lea—152	Shell #6 State	2–21S–37E	51	3488	8207	8197	–4709
Lea—153	Shell #7 State	2–21S–37E	51	3473	7854	7847	–4374
Lea—154	Shell #8 State	2–21S–37E	51	3498	8156	8130	–4632
Lea—155	Shell #9 Turner	22–21S–37E	50	3423	7951	7939	–4516
Lea—156	Shell #15 State	2–21S–37E	52	3502	8147	8145	–4643
Lea—157	Shell #1 Taylor Glenn	3–21S–37E	48	3484	8590	8550	–5056
Lea—158	Shell #3 Taylor Glenn	3–21S–37E	52	3493	8224	8222	–4729
Lea—159	Shell #4 Turner	22–21S–37E	49	3436	7890	7883	–4447
Lea—160	Shell #11 Turner	22–21S–37E	50	3420	7782	7770	–4350
Lea—161	Shell #14 Turner	22–21S–37E	51	3423	7758	7725	–4302

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	albite granodiorite	?	Texas craton	core	222
Cambro-Ord	nsl				
Cambro-Ord	nsl				
ni	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Ordovician	nsl				
Permian	nsl				
Permian	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian?	nsl				
Cambro-Ord	micrograpite	9584–9592	Texas craton	core	223
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian	micrograpite	7387	Texas craton	cuttings	223
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granite	12620–12625	Texas craton	cuttings	223
Permian	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	granite	7980–8089	Texas craton	cuttings	223
Cambro-Ord	nsl				
Cambro-Ord	granite	8185–8190	Texas craton	cuttings	223
Cambro-Ord	nsl				
Cambro-Ord	granite	8185–8189	Texas craton	cuttings	223
Cambro-Ord	granite	7760–7800	Texas craton	cuttings	223
Cambro-Ord	granite	7885–7907	Texas craton	cuttings	223
Cambro-Ord	nsl				
Cambro-Ord	granite	8125–8132	Texas craton	cuttings	224
Cambro-Ord	granite	14020–14040	Texas craton	cuttings	224
Cambro-Ord	granodiorite	7630–7665	Texas craton	cuttings	224
Cambro-Ord	granite	8150–8167	Texas craton	cuttings	224
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	microgranodiorite	7900–7905	Texas craton	cuttings	224
Cambro-Ord	granite	7550–7567	Texas craton	cuttings	224
Cambro-Ord	microgranodiorite	7955–7956	Texas craton	core	224
Cambro-Ord	microgranite	8205–8209	Texas craton	cuttings	224
Cambro-Ord	nsl				
Cambro-Ord	granodiorite	8132–8150	Texas craton	cuttings	224
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	granite	8575–8590	Texas craton	cuttings	225
Cambro-Ord	microgranite	8225–8228	Texas craton	cuttings	225
Cambro-Ord	microgranite	7890–7896	Texas craton	cuttings	225
Cambro-Ord	granite	7770–7783	Texas craton	cuttings	225
Cambro-Ord	granite	7725–7755	Texas craton	cuttings	225

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Lea—162	Shell #15 Turner	22–21S–37E	51	3416	7472	7430	–4014
Lea—163	Shell #16 Turner	22–21S–37E	52	3427	7864	7850	–4423
Lea—164	Sinclair #1 Barton	23–21S–37E	52	3407	7787	7786	–4379
Lea—165	Sinclair #4 Brunson	4–22S–37E	46	3436	7883	7880	–4444
Lea—166	Sinclair #5 Brunson	4–22S–37E	46	3450	7846	7840	–4390
Lea—167	Sinclair #8 Brunson	3–22S–37E	48	3436	7445	7440	–4004
Lea—168	Sinclair #1 Hill	26–21S–37E	48	3386	7642	7610	–4224
Lea—169	Sinclair #2 State 367	36–21S–37E	47	3376	7685	7640	–4264
Lea—170	Skelly #3-A Baker	26–22S–37E	45	3324	8154	8151	–4827
Lea—171	Skelly #5-B Baker	10–22S–37E	46	3417	7322	7312	–3895
Lea—172	Skelly #6-B Baker	10–22S–37E	47	3421	7582	7579	–4158
Lea—173	Skelly #14-B Baker	10–22S–37E	50	3418	7590	7589	–4171
Lea—174	Skelly #1 Sticher	4–22S–37E	47	3449	8053	8047	–4598
Lea—175	Stanolind #2 Corrigan	33–21S–37E	47	3449	7452	7445	–3996
Lea—176	Stanolind #1-A Eva Owen	3–22S–37E	47	3432	7356	7330	–3898
Lea—177	Stanolind #1 W. H. Jones	19–19S–39E	45	3581	10596	10570	–6989
Lea—178	Stanolind #4 South Mattix	15–24S–37E	51	3266	10270	10260	–6944
Lea—179	Stanolind #5 South Mattix	22–24S–37E	51	3247	11150	11148	–7901
Lea—180	Stanolind #6 South Mattix	15–24S–37E	52	3279	10544	10525	–7246
Lea—181	Stanolind #1-T State-Andrews	32–22S–38E	47	3398	8063	7470	–4072
Lea—182	Stanolind #1-U State	2–20S–38E	49	3580	10015	10005	–6425
Lea—183	Stanolind #11-X State	4–19S–38E	52	3639	8160	8050	–4411
Lea—184	Texas #1 Blinebry	19–22S–38E	45	3369	7517	7435	–4066
Lea—185	Texas #4 Blinebry	20–22S–38E	46	3397	8377	8320	–4923
Lea—186	Texas #2 Lockhart	18–22S–37E	45	3354	7597	7560	–4206
Lea—187	Tidewater #1-E Brunson	4–22S–37E	46	3441	7600	7592	–4151
Lea—188	Tidewater #3-S State	15–21S–37E	50	3458	7629	7614	–4156
Lea—189	Tidewater #4-S State	15–21S–37E	51	3459	7896	7858	–4399
Lea—190	Tidewater #5-S State	15–21S–37E	51	3458	8148	8128	–4670
Lea—191	Tidewater #7-S State	15–21S–37E	52	3459	8145	8141	–4682
Lincoln—1	National Exploration #1 Picacho	21–11S–18E	24	5031	2199	1670	+4361
Lincoln—2	Standard of Texas #1 Heard-Federal	33–6S–9E	51	5892	8050	7750	–1858
Lincoln—3	Stanolind #1 Picacho Unit	10–12S–18E	45	5958	2843	2425	+3533
Otero—1	Hunt & Turner #1 McMillan	5–26S–16E	43	4260	2176	2170	+2090
Otero—2	Standard of Texas #1 Scarp Unit	18–21S–18E	48	5340	2664	2580	+2760
Quay—1	Penrose #1 Pippins	35–12N–34E	52	4063	6128	5290	–1225
Quay—2	Stanolind #1 Fuller	25–8N–20E	43	4459	6747	6730	–2271
Roosevelt—1	Austral #1 Saddler	29–4S–32E	52	4424	8154	8126	–3702
Roosevelt—2	Goldston #1-A Lambirth-State	36–5S–32E	51	4436	8297	8038	–3602
Roosevelt—3	Magnolia #1 Brown	6–7S–34E	51	4347	9067	7100	–2753
Roosevelt—4	Magnolia #1 A. K. Smith	11–7S–33E	48	4382	10015	9965	–5583
Roosevelt—5	Mid-Continent #1 Strickland	9–4S–35E	51	4280	7608	7480	–3600
Roosevelt—6	Shell #1 Harwood	27–7S–35E	39	4199	7957	7945	–3746
Roosevelt—7	Shell #1 Saunders	5–8S–37E	48	4072	8679	8640	–4568
Roosevelt—8	Signal #1 Bell-Federal	33–3S–33E	53	4310	7996	7990	–3680
Roosevelt—9	Southern Union #1 Lucas	5–2N–30E	46	4249	7155	7140	–2891

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Cambro-Ord	granite	7430–7470	Texas craton	cuttings	225
Cambro-Ord	nsl				
Permian	olivine-augite syenite	7786	Texas craton	core	225
Cambro-Ord	microgranodiorite	7880–7883	Texas craton	cuttings	225
Cambro-Ord	microgranodiorite	7840–7845	Texas craton	cuttings	225
Cambro-Ord	nsl				
Permian	nsl				
Permian	granite gneiss	7642–7646	Texas craton	core	226
	granite	7680		cuttings	226
Ordovician	nsl				
Permian	microgranodiorite	7315–7322	Texas craton	cuttings	226
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	microgranodiorite	8052–8053	Texas craton	cuttings	226
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	micrgranite	10570–10580	Texas craton	cuttings	226
Cambro-Ord	nsl				
Cambrian	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Cambro-Ord	nsl				
Permian	granite	8150	Texas craton	core	226
Permian	micrgranite	7510–7515	Texas craton	cuttings	226
Permian	granite	8370–8375	Texas craton	cuttings	226
Permian	granite	7590–7595	Texas craton	cuttings	227
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Cambro-Ord	nsl				
Permian	nsl				
Pennsylvanian	olivine gabbro	7800–7870	?	cuttings	227
	olivine gabbro	8050		core	227
Permian	metarkosite	2685–2690	?	cuttings	227
	metarkosite	2740–2750		cuttings	227
Permian	rhyolite porphyry	2175	?	core	227
	micrographic granite	2175		core	228
Cambro-Ord	gabbro	2592–2610	?	cuttings	228
	gabbro	2630–2660		cuttings	228
	syenogabbro	2655–2660		core	228
Pennsylvanian?	nsl				
Pennsylvanian	rhyolite metatuff	6746–6747	Panhandle volcanic terrane	core	229
Silurian	amphibolite	8130–8156	?	core	229
Silurian-Dev	amphibolite	8287	?	core	229
Cambro-Ord	hornblende-quartz-albite gneiss	7110	Texas craton?	core	229
	hornblende-quartz-albite gneiss	7200		core	229
	granodiorite gneiss	7215		core	229
	leuco-albite syenodiorite	9067		core	230
Cambro-Ord	rhyolite porphyry-X	10000–10016	Panhandle volcanic terrane	cuttings	230
Permo-Penn	diabase	7508–7513	Swisher gabbroic terrane	core	230
	albite diabase	"bottom hole"		cuttings	230
Permian	rhyolite	7935–7955	Panhandle volcanic terrane	cuttings	230
	rhyolite	7950–7955		cuttings	230
Pennsylvanian	rhyolite	8640–8679	Panhandle volcanic terrane	cuttings	231
	rhyolite porphyry	8650		core	231
Devonian	leuco-olivine gabbro	7990–7996	Swisher gabbroic terrane	core	231
Pennsylvanian	diabase	7140–7155	?	cuttings	231

COUNTY	OPERATOR and FARM	LOCATION Sec-Block-Survey	YEAR COM-PLETED	DF ELEVA-TION	TOTAL DEPTH	TOP OF BASEMENT Depth	Elev.
Roosevelt—10	Spartan #1-36 State	36–4S–31E	51	4516	7263	7120	-2604
Roosevelt—11	Tidewater #1 Grady Best	27–2S–29E	51	4384	7277	7090	-2706
Roosevelt—12	Tidewater #1 Boone	7–5S–30E	51	4412	8475	8410	-3998
Union—1	Quaker State #1 Zurick	2–21N–34E	36	4625	2925	2925±	+1300

AGE OF FORMATION ON BASEMENT	LITHOLOGY OF BASEMENT	INTERVAL	PRECAMBRIAN PROVINCE	MATERIAL STUDIED	PAGE
Permo-Penn	granite	7140	Texas craton?	core	231
	quartz-hornblende-plagioclase gneiss	7204		core	231
	quartz diorite gneiss	7210		core	232
	quartz diorite gneiss	7240–7242		core	232
Miss? Ord?	mylonitized granite	7265–7277	Texas craton	core	232
Silurian-Dev	mylonitized syenite	8450–8465	Texas craton	cuttings	232
	leuco-diorite	8460–8465		cuttings	232
Permian?	*nsl*				

APPENDIX I

GLOSSARY OF PETROGRAPHIC NOMENCLATURE

This glossary is included as an aid to those not familiar with petrographic nomenclature and to clarify the usage of ambiguous petrographic terms. The writer has leaned heavily on the excellent glossary of Johannsen (1939, pp. 163–288), but there are differences between some definitions given by Johannsen and usage in this paper.

As used by the writer, the term *texture* includes the elements of grain size, degree of crystallinity, and relationships of minerals and/or rock fragments to each other. For this third category, the term *fabric* is preferred, but many writers, including Johannsen, use texture as a synonym for fabric. Arguments for the simplified philosophy of rock nomenclature favored by the writer are presented on pages 16–19.

Textural and Fabric Terms

1. *Anti-perthitic.*—A term applied to plagioclase that shows more or less regularly distributed inclusions of potash feldspar all of which have the same optical orientation. Cf. *poikilitic.*
2. *Cataclastic.*—A fabric resulting from crushing and shearing of constituent minerals which commonly are strained, deformed, and granulated. The ultimate result of cataclasis is mylonite.
3. *Clastic.*—A fabric of sedimentary rocks formed by the accumulation of solid mineral and rock particles. The mineral and/or rock fragments, which have been more or less modified by weathering and transporting agencies, are commonly held in a cement or matrix.
4. *Cryptocrystalline.*—A texture so fine that individual grains cannot be resolved under high magnification[11] but whose crystalline nature is demonstrated by polarization effects.
5. *Crystalloblastic.*—A fabric of metamorphic rocks caused by simultaneous recrystallization of old mineral constituents and/or growth of new materials as a result of metamorphism. Shapes of mineral grains are determined by the relative powers of the minerals to assert their own crystal boundaries during growth in the solid state. A general term including diablastic, lepidoblastic, granoblastic, and porphyroblastic fabrics.
6. *Diablastic.*—A variety of crystalloblastic fabric produced by the intergrowth in the solid state of two or more mineral constituents which include and penetrate each other. It is synonymous with sieve fabric and hornfels fabric but distinguished from poikiloblastic fabric in which included minerals were inactive in an active host mineral.
7. *Fibrolamellar.*—A fabric characterizing fibrous and scaly aggregates of serpentine minerals.
8. *Foliated.*—A general term for a metamorphic fabric that shows oriented planar elements. Foliation as used in this paper includes specific planar structures such as schistosity, slaty cleavage, and gneissic structure.
9. *Gneissic.*—A metamorphic fabric, characterized by parallel orientation of platy or linear minerals but without schistosity, a gneiss is a less perfect foliate rock than a schist because it commonly contains less dimensionally oriented micaceous and/or prismatic minerals—the bulk of the rock is commonly a recrystallized quartz-feldspar aggregate. Some gneisses show a layering expressed in grain size and/or mineral composition.
10. *Granoblastic.*—A variety of crystalloblastic fabric in which equant minerals form a granular aggregate or a mosaic.

10a. *Granophyric.*—A fabric of granitic igneous rocks in which quartz and alkali feldspar are intergrown more or less irregularly. Cf. *micrographic; granophyre.*

11. *Hypidiomorphic granular.*—A fabric in which some mineral constituents are idiomorphic, some are partly idiomorphic, and others are xenomorphic. This fabric is thought to characterize deep-seated plutonic rocks that crystallized from a magma, in which the early forming minerals developed their own crystal shapes. Recent investigations of large volumes of granitic rocks allegedly formed by metasomatic processes weakens the inference of molten magmatic origin that formerly was drawn from this particular fabric. Synonymous with *hypautomorphic granular* and *subhedral granular.*
12. *Idiomorphic.*—A term referring to minerals that show their own characteristic crystal outlines.
13. *Lepidoblastic.*—A variety of crystalloblastic fabric in which oriented platy minerals impart a pronounced foliation.
14. *Metasomatic fabric.*—A secondary fabric caused by alteration of the original mineral

[11] It is difficult to assign a number to this magnification because special objectives and devices can increase resolution. For practical purposes "high magnification" as used in the definition is less than the greatest magnification that can be obtained with the standard equipment of the petrographic microscope (45x objective + 10x ocular = 450x) and greater than the common intermediate working magnification (10x objective + 10x ocular = 100x). Of course, the magnification at which a mineral grain can first be resolved is considerably less than that required for working on it.

constituents of the rocks, most commonly by deuteric or hydrothermal agencies. The original minerals may exist as relics showing corrosion, embayment, and replacement by new minerals. This fabric is difficult to recognize if alteration is complete.

15. *Microcrystalline.*—Crystalline rocks whose crystallinity can be determined only by microscopic examination. In this paper used mainly in the description of the groundmass of volcanic rocks.
16. *Microgranular.*—A fine crystalline aggregate whose granularity is visible only under the microscope.
17. *Micrographic.*—A term applied in this paper to a more or less regular intergrowth of two minerals that can be discerned only by microscopic examination (*graphic* is the megascopic equivalent of this term). Most commonly the term is applied to a quartz and potassium feldspar intergrowth. It is essentially synonymous with *granophyric* and *micropegmatitic* but some petrographers prefer to reserve *granophyric* for less regular intergrowths between *micrographic* and *myrmekitic*.
18. *Microlitic.*—A fabric of rock composed mainly of fine mineral laths or rods of microscopic size called *microlites*. This has been used as a general term to include *trachytic* where the microlites are in a parallel orientation, *felty* for a non-oriented aggregate of microlites, and terms given to describe various proportions of microlites and glass. In this paper it is used as a synonym for *felty*.
19. *Microspherulitic.*—A fabric of volcanic rocks wherein the original glass crystallized (devitrified) wholly or in part to radial crystal aggregates or spherulites of a size that can be recognized only under the microscope.
20. *Myrmekitic.*—A term applied to vermicular intergrowths of quartz and plagioclase feldspar. Cf. *micrographic*.
21. *Ophitic.*—A hypidiomorphic granular fabric characteristic of diabase in which plagioclase laths in radial or triangular pattern are included in large pyroxene individuals. Nearly synonymous with *diabasic*.
22. *Perthitic.*—A term applied to potassium feldspar that contains included sodic plagioclase as parallel veinlets, oriented blebs, or irregular patches.
23. *Poikilitic.*—A fabric characterized by spongy host minerals that contain inclusions of other minerals, generally not in a common lattice orientation.
24. *Porphyritic.*—A fabric which shows larger crystals or phenocrysts of one or more minerals in a finer crystalline and/or glassy groundmass.
25. *Porphyroblastic.*—A variety of crystalloblastic fabric where some constituents have grown larger than the minerals forming the mass of the rock.
26. *Protoclastic.*—A fabric caused by cataclasis of an igneous rock not wholly consolidated and resulting in granulation and shearing of early crystallizing constituents; late crystallizing minerals are affected only in that they must crystallize in a deformed sponge of older minerals.
27. *Pyroclastic.*—The fabric of fragmental volcanic rocks where the fragmentation of the constituents is due to volcanic processes. The term is applied both to directly deposited volcanic fragmental material and to volcanic material that has been handled by normal sedimentary processes if the pyroclastic nature of the fragments is still recognizable.
28. *Sieve fabric.*—A variety of crystalloblastic fabric in which mineral constituents without preferred orientation interpenetrate and are included within each other as a result of thermal metamorphism in an essentially static or isotropic stress environment. It is synonymous with *hornfels* fabric and *diablastic* fabric.
29. *Subophitic.*—A hypidiomorphic granular fabric characteristic of diabase in which augite fills the interstices between plagioclase laths in a radial or triangular pattern. Nearly synonymous with *diabasic*.
30. *Sutured.*—A fabric in which grain boundaries are highly irregular with many reentrants.
31. *Trachytic.*—A fabric of rocks showing a parallel or subparallel orientation of feldspar laths.
32. *Trachytoid.*—Similar to trachytic; a fabric with parallel or subparallel mineral laths (not specifying feldspar laths).
33. *Vitroclasic.*—A fabric of pyroclastic volcanic rocks whose original fragmental material was in large part composed of broken glass shards.
34. *Xenomorphic granular.*—A fabric in which the constituent minerals mutually interfere and consequently have not developed regular crystal boundaries. Synonymous with *panallotriomorphic granular*.

Rock Nomenclature

The rock names used in this paper are briefly defined in the following glossary. For quantitative data the reader is referred to Tables 2 and 3 (pp. 17, 19).

1. *Andesite.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to diorite (No. 5).
2. *Argillite.*—Structureless, weakly metamorphosed, less than 50 percent reconstituted argillaceous rock up to 0.05 mm in grain size.
3. *Basalt.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to gabbro (No. 6).
4. *Dacite.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to quartz diorite (No. 22).

5. *Diorite.*—A megascopically granular igneous rock composed about equally of an intermediate to calcic plagioclase and ferromagnesian minerals, most commonly hornblende, with various accessory minerals (Table 2).
6. *Gabbro.*—A megascopically granular igneous rock composed about equally of calcic plagioclase and ferromagnesian minerals, commonly olivine and pyroxene, with various accessory minerals (Table 2).
7. *Gneiss.*—A megascopically crystalline metamorphic rock characterized by an imperfect foliation (due to poor orientation or a paucity of tabular or platy minerals) and layers or bands defined by mineral segregation and/or grain size. *Orthogneiss* is applied to gneisses formed by metamorphism of igneous rocks; *paragneiss* is applied to gneisses formed by metamorphism of sedimentary rocks; however, the nature of the original rocks cannot always be recognized. *Primary gneiss* is applied to gneiss formed by flowage of consolidating magma; this is an igneous rock and metamorphic processes are not involved in its formation.
8. *Granite.*—A megascopically granular plutonic igneous rock[12] composed dominantly of potassium feldspar with subordinate sodic plagioclase, quartz, ferromagnesian minerals, and various accessory minerals (Table 2).
9. *Granodiorite.*—A megascopically granular plutonic igneous rock composed dominantly of sodic plagioclase with subordinate potassium feldspar, quartz, ferromagnesian minerals, and various accessory minerals (Table 2).

9a. *Granophyre.*—A granitic igneous rock characterized by intergrown quartz and alkali feldspar. The term suffers from a history of varied usage, but the modern tendency is to apply it to rocks in which the quartz and alkali feldspar show a cuneiform (micrographic), irregular, or myrmekitic intergrowth. Granophyre as a rock name is more inclusive than granophyric as a textural term.

10. *Leuco.*—A prefix for the common igneous rock types to denote a variety with an abnormally low ferromagnesian mineral content.
11. *Mela.*—A prefix for the common igneous rock types to denote a variety with an abnormally high ferromagnesian mineral content.
12. *Meta.*—A prefix to a rock name indicating that the mineral and/or chemical composition of the rock has been modified by alteration by metamorphic processes excluding weathering but its original character is still discernible.
13. *Meta-argillite.*—Structureless, weakly metamorphosed, more than 50 percent reconstituted argillaceous rock up to 0.05 mm in grain size.
14. *Meta-arkose.*—A weakly metamorphosed arkose in which the quartz and feldspar have not recrystallized but the intergranular material has been reconstituted.
15. *Metarkosite.*—A metamorphic rock resulting from the recrystallization of arkose by metamorphic processes. Equivalent to metaquartzite in metamorphic grade. Equals the *arkosite* of Grout which is unsatisfactory as a metamorphic rock term because of its use in sedimentary petrography for unmetamorphosed rocks.
16. *Metaquartzite.*—A metamorphic rock resulting from recrystallization of quartz sandstone by metamorphic processes; the rock is composed predominantly of quartz and contains less than 25 percent feldspar.
17. *Metasandstone.*—A weakly metamorphosed sandstone in which the quartz has not recrystallized but the intergranular material has been reconstituted. *Orthoquartzite* is a quartzose sedimentary rock with siliceous cement. Although sedimentary in origin this rock breaks across quartz grains and therefore fulfills the fundamental definition of a quartzite; unfortunately this fundamental definition has been ignored by some sedimentary petrographers who apply the term to pure quartz sandstones.
18. *Micro.*—A prefix for the common igneous rock types to denote a fine-grained variety with a grain size between 0.05 and 1.0 mm.
19. *Monzonite.*—A megascopically granular igneous rock composed about equally of potassium feldspar and sodic or intermediate plagioclase with subordinate ferromagnesian minerals and various accessory minerals. Not used in this paper; cf. *syenite* and *syenodiorite.*
20. *Phyllite.*—Completely reconstituted (crystalline) foliated low-grade metamorphic rock up to 0.5 mm in grain size.
21. *Porphyry.*—An igneous rock characterized by larger crystals, phenocrysts, in a finer grained groundmass; commonly the same minerals occur in two generations—as phenocrysts and in the groundmass.
22. *Quartz diorite.*—Similar to diorite but with an appreciable quartz content (> 5 percent) and, commonly, appreciable but subordinate potassium feldspar (Table 2). Synonymous with *tonalite.*
23. *Quartz monzonite.*—A megascopically granular igneous rock composed about equally of potassium feldspar and sodic or intermediate plagioclase with subordinate quartz and ferromagnesian minerals and various accessory minerals. This term is not used in this paper, although it is popular in the western part of the United States. The writer has attempted to use as few rock names as possible, and because the field of quartz monzonite is overlapped by the fields of granite and granodiorite, it can be omitted.
24. *Rhyodacite.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to granodiorite.
25. *Rhyolite.*—The extrusive equivalent of a granite. This is the most common definition,

[12] Under favorable temperature-pressure conditions granite can also occur as stocks, sills, dikes, etc., but the great volume of granite is in batholithic masses. Results of recent studies of some large granite masses indicate that the term must be expanded to include rock of metasomatic origin.

but the same rock also occurs as shallow intrusives and the term should not by definition be limited to extrusive rocks. Perhaps a better definition is: Rhyolite is a glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to granite.

26. *Schist.*—Schistose metamorphic rock ranging from low to high metamorphic grade. Schist is commonly megascopically crystalline, but in this paper 0.1 mm is established as the lower grain size limit for schist with medium to high-grade metamorphic minerals; schistose rocks with low-grade metamorphic minerals and a grain size less than 0.5 mm are classed as phyllite (p. 18).
27. *Syenite.*—A megascopically granular igneous rock composed dominantly of potassium feldspar with subordinate sodic plagioclase, ferromagnesian minerals, and various accessory minerals (Table 2).
28. *Syenodiorite.*—A megascopically granular igneous rock composed dominantly of an intermediate plagioclase with subordinate potassium feldspar, ferromagnesian minerals, and various accessory minerals (Table 2).
29. *Syenogabbro.*—A megascopically granular igneous rock composed about equally of calcic plagioclase and ferromagnesian minerals, commonly pyroxene, but with appreciable potassium feldspar content. Various accessory minerals are present (Table 2).
30. *Trachyandesite.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to syenodiorite.
31. *Trachyte.*—A glassy and/or finely crystalline igneous rock, commonly porphyritic, that is chemically and, except for the possible presence of glass, mineralogically equivalent to syenite.

APPENDIX II

PETROGRAPHIC DESCRIPTIONS

Evaluation of petrographic descriptions.—The following pages contain petrographic descriptions of thin sections of basement rocks, either cuttings or core chips, from wells listed in Table 1. They are arranged alphabetically by county and again alphabetically by operator under the county heading. Each individual report is headed by the name of the well, the nature of the sample (whether core chip or cuttings), the depth of the sample, and the ownership of the thin section studied. The list includes thin sections from the Gulf Oil Corporation, Honolulu Oil Corporation, Humble Oil & Refining Company, Shell Oil Company, Stanolind Oil & Gas Company, and Bureau of Economic Geology.

The primary purpose of preparing and studying these thin sections was to classify the basement rock in the various wells so as to be able to map major rock types. The following abbreviated petrographic descriptions are presented to that end: minerals were identified, a mode was estimated, grain size was measured, and the texture or fabric was determined. All these elements are essential in classification of the rock. It was not considered feasible to make a very detailed petrographic study of each slide for the purpose of this project. Rosiwal modal analysis and precise determination of mineral species by immersion and other methods are of value in investigation of an exposed rock mass that can be freely sampled, but such refinements are of little actual value when trying to interpret major geologic features with small random samples separated by many miles.

The percentages of minerals given are estimated figures derived by examination of the entire slide under low magnification and of randomly selected portions of the slide under higher magnification. Thin sections of core chips of fine-grained rocks are the most satisfactory subjects for modal estimation under the well-known sampling theory which calls for size of sample to increase with grain or fragment size of the sampled material. Thus a mode estimated from a standard thin section of a fine-grained rock would be more likely representative of the rock than a mode estimated from a standard thin section of a coarse-grained rock. The least satisfactory thin sections for model estimation are those of fine cuttings of coarse-grained rocks; these yield a thin section of mineral fragments rather than rock fragments. It is impossible, for example, to distinguish between granite and granodiorite in such a thin section, because both rocks have substantial amounts of potassium and plagioclase feldspar, but because we are primarily interested in whether the rock is a volcanic rock, a plutonic rock, or a metamorphic rock, these sections of cuttings are very useful.

PART 1—TEXAS

ANDREWS COUNTY

Gulf #9-E University "Z" cuttings 11100-05 Bureau of Economic Geology
Microcline microperthite (67%), quartz (15%), albite (15%), biotite (1%), pyrite (1%), calcite (1%), chlorite (tr), apatite (tr). Plagioclase is partly sericitized and partly replaced by calcite; biotite is a green-brown variety. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular (poorly shown in a few fragments). Rock: *granite.*

Humble #3 Lineberry cuttings 10665-68 Bureau of Economic Geology

Microcline microperthite (47%), oligoclase (40%), quartz (12%), magnetite or ilmenite (1%), chlorite (tr), zircon (tr), apatite (tr). Quartz and plagioclase locally show myrmekitic intergrowths. Grain size: 0.2 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Humble #3 Lineberry cuttings 10665-68 Bureau of Economic Geology

Calcic plagioclase (66%), augite (25%), magnetite or ilmenite (8%), biotite (1%), apatite (tr). Biotite is red-brown; very poor slide shows only a few fragments. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microgabbro.*

Humble #1 Pinson cuttings 10855-60 Bureau of Economic Geology

Microcline (65%), quartz (15%), albite (10%), biotite (8%), sphene (2%), myrmekite (tr), apatite (tr), zircon (tr). Biotite pleochroism is olive to very dark brown. Grain size: 0.2 to 0.4 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Humble #1 Scarborough cuttings 10910-26 Shell Oil Co.

Microcline (70%), quartz (20%), albite (5%), biotite (4%), chlorite (1%), leucoxene (tr), apatite (tr), zircon (tr). Albite is partly kaolinized; biotite pleochroism is olive-brown to very dark brown—the biotite is partly altered to chlorite; quartz and feldspar show mutual embayment. Grain size: 0.1 to 3 mm. Fabric: xenomorphic granular. Rock: *granite.*

Humble #1 Scarborough core 10926-29 Stanolind Oil & Gas Co.

Andesine (58%), hornblende (30%), biotite (5%), magnetite or ilmenite (4%), calcite (2%), pyrite (1%), leucoxene (tr), chlorite (tr), apatite (tr). Hornblende grains show patchy uneven pleochroism and centers of grains commonly are altered to a fibrous, highly birefringent mineral. Grain size: 1 mm. Fabric: hypidomorphic granular. Rock: *microdiorite.*

Humble #1 Scarborough core 10926-29 Bureau of Economic Geology

Albite (69%), chlorite (20%), biotite (5%), ilmenite (3%), pyrite (1%), leucoxene (1%), calcite (1%), apatite (tr), quartz (tr). Chlorite occurs in large fine-granular masses; biotite is partly altered to chlorite and occurs in "nests" and scattered plates; calcite partly replaces plagioclase. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: altered *albite diorite.*

Phillips #38 University cuttings 8000-05 Bureau of Economic Geology

Microcline microperthite, quartz, calcite, chlorite, zircon. Cuttings consist of only a few small grains so that estimates of mineral percentages are not practical. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Phillips #50 University core 7854-57 Humble Oil & Rfg. Co.

Microcline microperthite (57%), quartz (20%), albite (15%), calcite (5%), biotite (1%), leucoxene (1%), fluorite (1%), muscovite (tr), zircon (tr). Quartz shows severe strain; calcite occurs in dirty masses, apparently replacing a primary ferromagnesian mineral; biotite is present as bleached and altered remnants; general distribution of minerals is irregular—there are quartz-rich areas and microcline-rich areas. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Phillips #50 University core 7854-57 Stanolind Oil & Gas Co.

Microcline microperthite (50%), quartz (20%), oligoclase (16%), hornblende (8%), fluorite (3%), biotite? (2%), calcite (1%), chlorite (tr), zircon (tr). Pale green hornblende is smeared out into lenses and layers; quartz shows severe strain and dimensional orientation; chlorite occurs in veinlets and within hornblende grains as result of alteration of hornblende; biotite? is very pale with only a faint pleochroism and may be a highly birefringent chlorite. Grain size: 0.2 to 2 mm. Fabric: gneissic to xenomorphic granular. Rock: *granite gneiss.*

Phillips #57 University cuttings 8030-35 Bureau of Economic Geology

Microline (56%), oligoclase (20%), quartz (20%), biotite (4%), fluorite (tr), calcite (tr), apatite (tr), zircon (tr). Microcline is locally microperthitic; biotite pleochroism is yellow-brown to very dark brown; quartz shows strain. Grain size: 0.3 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Phillips #58 University core 7922-26 Bureau of Economic Geology

Microcline microperthite (40%), albite-oligoclase (20%), quartz (20%), hornblende (8%), biotite (5%), chlorite (4%), calcite (2%), leucoxene (1%), sphene (tr), sericite (tr), zircon (tr). Microcline microperthite ranges from almost pure microcline to microperthite that is almost all plagioclase (anti-perthite); hornblende is yellow-green and occurs in part in large poikilitic grains; it is partly replaced by calcite; biotite pleochroism is pale red-brown to very dark brown—it is partly altered to chlorite; sericite occurs in veinlets. Grain size: 0.5 mm to 1 cm. Fabric: hypidiomorphic granular. Rock: *granite.* (Photomicrograph, Pl. IV, A.)

Phillips #5-M University cuttings 10820-25 Bureau of Economic Geology

Andesine (56%), quartz (15%), hornblende (15%), biotite (10%), pyroxene? (2%), magnetite or ilmenite (2%), pyrite (tr), epidote (tr), calcite (tr), orthopyroxene (tr), sphene (tr). Plagioclase is partly sericitized and locally bent; hornblende, yellow-green to green pleochroism, is locally poikilitic; biotite peochroism is pale to red-brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Shell #1 Cox cuttings 11030-40 Shell Oil Co.

Quartz (60%), microcline (29%), albite (8%), biotite (2%), muscovite (1%), apatite (tr). Albite shows incipient alteration to sericite; biotite pleochroism is green-olive-brown to very dark brown. Slide consists of only a few small fragments, commonly of only a few grains each, and estimated percentages (above) are probably not representative of the rock; the high quartz content is not significant. Grain size: 0.1 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Shell #1 Cox core 11057-61 Stanolind Oil & Gas Co.

Microcline microperthite (62%), albite-oligoclase (20%), quartz (15%), biotite (3%), sphene (tr), magnetite or ilmenite (tr), leucoxene (tr), sericite (tr), fluorite (tr), apatite (tr), zircon (tr). Plagioclase is zoned; biotite is a green-brown variety; sphene is partly altered to leucoxene. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #1 Nelson cuttings 10600-06 Shell Oil Co.

Labradorite? (60%), augite (20%), magnetite or ilmenite (8%), biotite (5%), calcite (5%), sericite (2%). Labradorite is partly altered to sericite; augite is pale brown and probably titaniferous; biotite is partly bleached. Grain size: 0.1 to 0.4 mm. Fabric: subophitic. Rock: *leuco-diabase.*

Shell #1 Nelson cuttings 10606 Shell Oil Co.

Labradorite? (73%), magnetite or ilmenite (10%), augite (8%), sericite (3%), biotite (2%), chlorite (2%), calcite (2%). Augite is violet-brown and probably titaniferous; biotite is a red-brown variety, partly altered. Grain size: 0.1 to 0.3 mm. Fabric: subophitic?—not many fragments in slide. Rock: altered *leuco-diabase.*

Shell #1-A Nelson cuttings 10330-35 Bureau of Economic Geology

Microcline microperthite (43%), oligoclase (40%), magnetite or ilmenite (5%), altered ferromagnesian—pyroxene? (5%), calcite (5%), biotite (2%), amphibole (tr), apatite (tr). Biotite is partly altered and very deeply colored; plagioclase is partly replaced by calcite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *syenite.*

Shell #1-E Scarborough core 7911-14 middle Shell Oil Co.

Albite (79%), quartz (10%), biotite (6%), ilmenite (3%), alkali feldspar (1%), leucoxene (1%), sphene (tr), apatite (tr), zircon (tr). Quartz is interstitial to feldspar subhedrons; biotite pleochroism is pale to very dark brown; ilmenite is surrounded by leucoxene; apatite occurs in prisms and round grains and zircon forms halos in biotite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-albite-quartz diorite.*

Shell #1-E Scarborough core 7911-14 bottom Shell Oil Co.

Albite (78%), biotite (10%), hornblende (8%), epidote (2%), magnetite or ilmenite (1%), calcite (1%), apatite (tr), zircon (tr). Biotite pleochroism is pale to very dark brown—commonly it is rimmed with magnetite or ilmenite; hornblende, pleochroism yellow-green to green, is mostly altered to a colorless highly birefringent mass; epidote is probably from alteration of hornblende; apatite is in round grains and elongated prisms. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-albite diorite.*

Shell and Texas #1 Collins cuttings 10370-80 Bureau of Economic Geology

Microcline microperthite (54%), oligoclase (40%), altered ferromagnesian mineral (3%), calcite (2%), magnetite or ilmenite (1%), apatite (tr), zircon (tr). Oligoclase is in part in a sub-micrographic intergrowth with microcline and superficially resembles quartz; oligoclase is partly replaced by calcite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *syenite.*

Sinclair-Prairie #1 Grisham-Hunter cuttings 11315-22 Bureau of Economic Geology

Microcline microperthite (64%), quartz (25%), albite (5%), hornblende (2%), calcite (2%), ilmenite (1%), leucoxene (1%), sphene (tr), muscovite (tr), zircon (tr). Quartz is strained, sutured, and granulated; hornblende pleochroism is yellow-green to dark green; sphene rims ilmenite. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular—locally cataclastic. Rock: *granite.*

Sinclair-Prairie #1 Grisham-Hunter core 11321-22 Stanolind Oil & Gas Co.

Microcline microperthite (71%), quartz (15%), biotite (5%), oligoclase (5%), chlorite (1%), muscovite (1%), calcite (1%), fluorite (1%), magnetite or ilmenite (tr), zircon (tr). Grain size: 2 to 5 mm. Fabric: xenomorphic granular. Rock: *granite.*

Stanolind #1 McCrea core 10475-79 Stanolind Oil & Gas Co.

Microcline microperthite (62%), oligoclase (30%), calcite (3%), chlorite (4%), leucoxene (1%), biotite (tr), muscovite (tr), pyrite (tr), apatite (tr). Only a few grains of microcline show microperthitic structure; oligoclase commonly occurs as twinned patches in microcline; biotite, light brown to very dark brown pleochroism, is partly altered to chlorite; leucoxene, calcite, and some chlorite are associated together in fine masses. Grain size: 1 to 2 mm. Fabric: xenomorphic granular. Rock: *syenite.*

Stanolind #1 Sims core 10871-83 Stanolind Oil & Gas Co.

Microcline microperthite (80%), albite (15%), leucoxene (2%), chlorite (2%), ilmenite (1%), calcite (tr), apatite (tr). Microcline is only sparsely microperthitic; chlorite is finely fibrous; leucoxene surrounds ilmenite. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular (feldspars are mutually interpenetrating). Rock: *syenite.*

Stanolind #1 Sims core 10871-83 Stanolind Oil & Gas Co.

Microcline microperthite (73%), chlorite (20%), sericite (5%), magnetite or ilmenite (2%), leucoxene (tr), apatite (tr). Chlorite is replacing a mineral that was graphically intergrown with feldspar (amphibole?); apatite shows a core and an overgrowth. Grain size: 0.1 to 0.5 mm. Fabric: subgraphic. Rock: *microsyenite.*

Stanolind #1 Sims core 10871-83 Stanolind Oil & Gas Co.

Microcline (69%), chlorite (30%), sericite (1%), ilmenite (tr), leucoxene (tr). Microcline is in a subgraphic intergrowth with chlorite; chlorite is in fine granular masses as result of alteration or replacement of an unknown primary mineral—an amphibole? Grain size: 0.5 mm. Fabric: micrographic. Rock: *microsyenite.*

Stanolind #1 Sims cuttings 10880-90 Shell Oil Co.

Microcline microperthite (80%), albite (20%), chlorite (tr), zircon (tr). An exceptional development of perthitic structure with veins and patches of albite extremely varied in size occurring throughout the potassium feldspar. Grain size: 0.1 to 1 mm. Fabric: xenomorphic granular. Rock: *leuco-microsyenite.*

Stanolind #1 Sims cuttings 10890-10900 Shell Oil Co.

Slide is composed of a few grains of microcline microperthite and albite.

Stanolind #1 Sims core 10902-13 Stanolind Oil & Gas Co.

Chlorite (90%), leucoxene (10%), magnetite or ilmenite (tr), calcite (tr). Nearly all rock is finely fibrous microcrystalline chlorite.

Stanolind #1 Sims core 10913-24 Stanolind Oil & Gas Co.

Serpentinized? feldspathic mass (95%), red iron oxide (4%), leucoxene (1%), chlorite (tr), ilmenite (tr). Altered feldspathic groundmass shows vague, subgraphic, and myrmekitic structures; only identifiable mineral grains are relict albite grains; alteration mineral in groundmass is apparently serpentine. Grain size: less than 0.02 mm. Fabric: metasomatic—relict microgranular. Rock: altered *feldspathic igneous rock.*

Stanolind #1 Sims core 10924-42 Stanolind Oil & Gas Co.

Microcline microperthite (67%), chlorite (30%), leucoxene (1%), magnetite or ilmenite (1%), red iron oxide (1%), calcite (tr), sericite (tr), biotite (tr), apatite (tr). Chlorite replaces amphibole; apatite is zoned. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *syenite.*

Stanolind #1 Sims core 10942-60 Stanolind Oil & Gas Co.

Microcline (69%), chlorite (30%), sericite (1%), magnetite or ilmenite (tr), hematite (tr), red iron oxide (tr). Grain size: 0.5 to 3 mm. Fabric: subgraphic. Rock: altered *syenite.*

Stanolind #1 Stiles cuttings 11500 Stanolind Oil & Gas Co.

Andesine (76%), magnetite or ilmenite (15%), augite? (5%), amphibole (2%), biotite (1%), apatite (1%). Plagioclase occurs in laths, some of which are zoned; biotite pleochroism is pale brown to red-brown; amphibole occurs in long colorless needles; augite? is present as altered relicts; apatite occurs in long needles. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microdiorite.*

Stanolind #3-AE University cuttings 10590-95 Bureau of Economic Geology

Oligoclase or andesine (60%), myrmekite (20%), biotite (10%), quartz (10%), apatite (tr), calcite (tr), zircon (tr). There is only one very small fragment of basement rock in slide. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *leuco-quartz microdiorite.*

Stanolind #4-AE University cuttings 10490-500 Bureau of Economic Geology

Microcline microperthite (45%), albite (25%), quartz (15%), biotite (15%), apatite (tr) Plagioclase is partly kaolinized; biotite is a very dark-colored green-brown variety. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Stanolind #6-PP University cuttings 10885-93 Bureau of Economic Geology

Oligoclase-andesine (34%), quartz (30%), hornblende (20%), biotite (15%), sphene (1%), ilmenite (tr), epidote (tr), apatite (tr), calcite (tr). Hornblende pleochroism is yellow-green to green, biotite pleochroism is pale brown to dark red-brown; quartz shows very severe strain; sphene envelops ilmenite. Grain size: 0.5 mm. Fabric: ranges from hypidiomorphic granular—cataclastic in some fragments to gneissic in others. Some fragments are nearly all quartz and feldspar (hypidiomorphic feldspar and crushed quartz) with little hornblende; other fragments are gneissic with oriented biotite, hornblende, quartz, and feldspar grains and greater content of ferromagnesian minerals. Rock: *quartz diorite gneiss.*

ARCHER COUNTY

Phillips #1 Bullington core 7913-15 Bureau of Economic Geology

Albite and microcline microperthite (56%), quartz (25%), chlorite (5%), biotite (5%), epidote (4%), sericite (3%), muscovite (1%), sphene (1%), ilmenite (tr), calcite (tr,), apatite (tr), rhyolite fragment (tr). Plagioclase occurs in little-modified subhedral grains, partly sericitized; microcline microperthite is partly kaolinized; there are about equal amounts of each feldspar in the rock; quartz occurs in poorly sized angular grains and angular fragments of quartz mosaic; epidote, chlorite, sericite, and green biotite occur as mixed masses between the grains of quartz and feldspar and result from reconstitution of original argillaceous matrix; sericite also occurs as result of alteration of plagioclase; muscovite occurs in fairly fresh plates, some of which are bent, and is a second-cycle mineral; ilmenite is surrounded by sphene. Grain size: 0.2 to 0.5 mm. Fabric: relict clastic—incipient crystalloblastic (quartz and feldspar not recrystallized—low-grade metasedimentary rock). Rock: *metagraywacke.*

ARMSTRONG COUNTY

Hassie Hunt Trust #1 J. L. Cattle Co. cuttings 6930-70 Humble Oil & Rfg. Co.

Quartz and alkali feldspar (67%), calcite (15%), chlorite (8%), sericite (5%), magnetite or ilmenite and leucoxene (5%). Quartz and alkali feldspar, forming the mass of the rock, are replaced by irregular grains and patches of calcite; sericite and chlorite occur as shreds and fibers, chlorite locally also occurs in masses; magnetite or ilmenite occurs as scattered grains; leucoxene is present along grain boundaries and as cavity linings. Grain size: 0.02 to 0.2 mm. Fabric: relict pyroclastic? Rock: altered and possibly reworked *rhyolite tuff.*

Hassie Hunt Trust #1 J. L. Cattle Co. cuttings 6970-7000 Humble Oil & Rfg. Co.

Groundmass (75%), albite (10%), rock fragments (4%), chlorite (3%), microperthite (3%), leucoxene, magnetite or ilmenite, and red-brown iron oxide (3%), calcite (2%), apatite (tr). Mostly cryptocrystalline groundmass shows flowage structure outlined by sericite fibers, locally it is microspherulitic with patches of spherulites separated by cracks filled with later quartz and feldspar; albite and microperthite occur as phenocrysts in rounded and corroded subhedrons; chlorite occurs as cavity fillings and fibers in the groundmass; calcite replaces part of the groundmass and the albite phenocrysts; microspherulitic and micrographic grains appear to be fragments of earlier formed rock. Grain size: groundmass cryptocrystalline; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Hassie Hunt Trust #1 Helms cuttings 6070-6180 Humble Oil & Rfg. Co.

(1) Alkali feldspar (50%), quartz (44%), magnetite or ilmenite and leucoxene (3%), amphibole? (2%), epidote (1%), zircon (tr), apatite (tr). Feldspar is partly kaolinized; amphibole?, apparently secondary, occurs in minute fibers, and identification is not certain. Grain size: 0.05 to 0.1 mm. Fabric: microgranular. Rock: *rhyolite.*

(2) Groundmass (89%), albite (10%), magnetite or ilmenite (1%), apatite (tr). Quartz-alkali feldspar groundmass shows flowage structure; albite occurs as phenocrysts. Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

(3) Groundmass (77%), quartz and feldspar (15%), rock fragments (5%), calcite (1%), leucoxene (1%), red-brown iron oxide (1%), zircon (tr), chlorite (tr). Groundmass is microcrystalline to cryptocrystalline and composed mostly of alkali feldspar and minute fibers of amphibole? in a fine mat; the amphibole? appears to be secondary; partly kaolinized feldspar and quartz occur as broken and embayed grains; rock fragments are rhyolite. Grain size: groundmass less than 0.01 mm; feldspar and quartz fragments 0.1 to 0.2 mm. Fabric: pyroclastic? Rock: *rhyolite tuff?*

(4) Plagioclase, quartz, calcite, sphene, zircon, magnetite or ilmenite, chlorite, rock fragments. Grain size: 0.1 to 0.2 mm. Fabric: clastic. Rock: *arkose* (debris from volcanic rocks).

(5) *Summary:* Slide is composed of a variety of rocks (rhyolite, rhyolite tuff, rhyolite porphyry, and arkose) that have in common a volcanic origin either directly or indirectly.

Hassie Hunt Trust #1 Helms cuttings 6080-6180 Bureau of Economic Geology

(1) Talc (77%), amphibole—tremolite? (20%), carbonate (3%). Talc and amphibole are associated in fibrous masses; carbonate occurs in scattered grains. Grain size: 0.02 to 0.2 mm. Fabric: crystalloblastic. Rock: *tremolite-talc hornfels.*

(2) Groundmass (72%), quartz (7%), feldspar (15%), magnetite or ilmenite (5%), chlorite (1%), apatite (tr), zircon (tr). Quartz-alkali feldspar groundmass is microgranular to micrographic; feldspar phenocrysts are heavily kaolinized; quartz is in round and embayed phenocrysts; chlorite is after biotite. Grain size: groundmass 0.01 to 0.1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Hassie Hunt Trust #1 Helms cuttings 6180-6280 Bureau of Economic Geology

(1) Dolomite (90%), serpentine (10%), leucoxene (tr), chlorite? (tr). Dolomite is partly altered to serpentine; chlorite? is a brownish variety. Grain size: 0.1 mm. Fabric: metasomatic. Rock: *serpentinized dolomite.*

(2) Fragments of siltstone showing no signs of metamorphism but similar in other respects to the metasiltstone associated with altered dolomite in other wells in the Swisher gabbroic terrane.

Hassie Hunt Trust #1 Helms cuttings 6180-6280 Bureau of Economic Geology

(1) Dolomite, serpentine, tourmaline, nontronite?, chlorite?. Dolomite is partly altered to serpentine; masses and veinlets of pale to reddish brown tourmaline are present in one fragment; percentages of minerals are extremely variable in different fragments. Grain size: 0.01 to 0.2 mm. Fabric: metasomatic. Rock: *serpentinized dolomite.*

(2) Fragments of *siltstone* showing no signs of metamorphism but similar in other respects to metasiltstones associated with altered dolomites in other wells in the Swisher gabbroic terrane.

Hassie Hunt Trust #1 Helms cuttings 6180-6280 Humble Oil & Rfg. Co.

Dolomite, serpentine, calcite, amphibole?. Fragments contain dolomite that shows a varying degree of sepentinization; some fragments are composed almost entirely of fibrolamellar masses of serpentine which locally contain small fibers of amphibole?; serpentine is cut by veinlets of calcite. Grain size: dolomite 0.01 mm. Fabric: metasomatic. Rock: *serpentinized dolomite.*

Hassie Hunt Trust #1 Helms cuttings 6300-6570 Humble Oil & Rfg. Co.

(1) Groundmass (66%), albite (20%), epidote (5%), calcite (5%), red iron oxide (3%), leucoxene (1%), magnetite (tr). Groundmass is obscured by red iron oxide stain but appears to be mostly composed of partly kaolinized alkali feldspar, locally it is microspherulitic; albite occurs as phenocrysts; calcite replaces part of groundmass; epidote occurs in veinlets; magnetite is in scattered grains partly altered to red iron oxide. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *trachyte porphyry.*

(2) Groundmass (43%), albite (30%), rock fragments (15%), microperthite (5%), red iron oxide (4%), leucoxene (1%), magnetite or ilmenite (1%), calcite (1%), apatite (tr). Groundmass shows a relict vitroclastic fabric preserved in a fine granular mass of alkali feldspar and quartz; feldspar occurs in angular grains; rock fragments are rhyolite, in part microgranular but also showing flowage structures, micrographic structures, and microspherulitic structures. Grain size: groundmass less than 0.02 mm; feldspar and rock fragments up to 2 mm. Fabric: relict vitroclastic. Rock: *rhyolite tuff.*

Hunt #4 Ritchie cuttings 6810-7070 Humble Oil & Rfg. Co.

(1) Andesine-labradorite (62%), augite (25%), chlorite (4%), hornblende (3%), alkali feldspar (3%), magnetite or ilmenite (3%), pyrite (tr), apatite (tr). Amphibole, green-brown, is apparently derived from pyroxene; chlorite is an olive variety with variable birefringence and may be after olivine; alkali feldspar, finely micrographic, occurs between plagioclase laths; apatite occurs in long needles. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microgabbro.*

(2) Plagioclase (52%), augite (40%), magnetite or ilmenite (8%). Plagioclase is in oriented elongate laths. Grain size: 0.1 to 0.2 mm. Fabric: hypidiomorphic granular. Rock: *microgabbro.*

Placid #1 Matheson cuttings 4650 Humble Oil & Rfg. Co.

Groundmass (84%), albite (8%), microperthite (4%), chlorite (3%), magnetite or ilmenite (1%), apatite (tr), leucoxene (tr). Microgranular quartz-alkali feldspar groundmass shows flowage and local coarse areas; microperthite and partly sericitized albite are phenocrysts; chlorite is after biotite and contains flecks of leucoxene. Grain size: groundmass 0.01 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Standard of Texas #1-A Palm core 6140-41 Bureau of Economic Geology

Groundmass (89%), microperthite (5%), quartz (5%), leucoxene (1%), sphene (tr), magnetite or ilmenite (tr), apatite (tr), albite (tr), zircon (tr). Microcrystalline-cryptocrystalline-microspherulitic groundmass shows well-developed flowage structure and local coarsenings of quartz and sericitized feldspar; microperthite and albite occur as phenocrysts but albite is mostly limited to areas of coarsened groundmass; quartz phenocrysts are embayed, corroded, and fractured; magnetite or ilmenite is present as cavity fillings and in fine lines of grains parallel to and emphasizing the flowage structure; sphene is almost completely altered to leucoxene. Grain size: groundmass cryptocrystalline to 0.2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.* (Photomicrograph, Pl. VIII, B.)

Stanolind #1 Corbin core 6118-19½ Bureau of Economic Geology

Groundmass (82%), albite-oligoclase (11%), microperthite (4%), magnetite or ilmenite (1%), biotite (1%), chlorite (1%), zircon (tr), red iron oxide (tr). Microcrystalline microgranular quartz-alkali feldspar groundmass contains coarser "eyes" and shows vague flowage structure defined by the more coarsely crystalline material; plagioclase and microperthite are present as phenocrysts; red-brown biotite is partly altered to chlorite. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Corbin core 6118-19½ Stanolind Oil & Gas Co.

Groundmass (79%), microperthite (10%), albite (10%), magnetite or ilmenite (1%), red iron oxide (tr). Microcrystalline microgranular groundmass is composed of quartz and alkali feldspar; microperthite and albite occur as phenocrysts. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

BAILEY COUNTY

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 8710-20 Bureau of Economic Geology

Plagioclase (43%), chlorite (25%), dolomite (25%), magnetite or ilmenite (5%), biotite (2%), apatite (tr). Plagioclase is almost completely sericitized; chlorite occurs as result of alteration of ferromagnesian minerals and in cross-cutting veinlets; dolomite occurs in veinlets cutting igneous rock and as porphyroblasts in the igneous rock along the vein walls—mostly it is associated with magnetite or ilmenite, iron oxide, and chlorite; magnetite or ilmenite occurs as scattered grains and in veinlets; biotite shows pale to very dark brown pleochroism and is partly altered to chlorite. Grain size: igneous rock 0.5 to 2 mm; vein material 0.2 to 0.5 mm. Fabric: metasomatic. Rock: altered igneous rock—probably a *gabbro.*

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 8720-90 Bureau of Economic Geology

Labradorite (60%), chlorite (15%), augite (10%), carbonate (7%), magnetite or ilmenite (4%), biotite (3%), iddingsite? (1%), amphibole (tr), apatite (tr). Plagioclase is partly sericitized; chlorite is derived from alteration of augite and is associated with carbonate; augite shows alteration to chlorite and carbonate in some fragments; biotite is red-brown; amphibole relicts occur in masses of chlorite. Grain size: 0.5 to 1 mm. Fabric: subophitic. Rock: *diabase.*

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 8790-8800 Bureau of Economic Geology

(1) Fragment composed of serpentine containing tiny corroded dolomite remnants.
(2) Fragment composed of serpentine containing irregular separated masses of talc.
(3) Fragment composed of dolomite with indistinct grain boundaries.
(4) Fragment of dolomite partly altered to serpentine; the serpentine contains minute amphibole needles and pyrite cubes.

Grain size: less than 0.05 mm. Fabric: metasomatic—most of slide is composed of fragments of (1) above. Rock: *serpentinized dolomite.*

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 8800-8950 Bureau of Economic Geology

Plagioclase (54%), augite (25%), chlorite (10%), magnetite or ilmenite (6%), biotite (3%), amphibole (2%), calcite (tr), epidote (tr), apatite (tr). The plagioclase, probably originally calcic, is altered to sericite or sericite and chlorite; augite is predominantly a violet-brown-tinted variety but locally there are patches of colorless augite in optical continuity with the colored grains; chlorite occurs as both an olive-drab and a green variety; biotite is red-brown; amphibole includes a green secondary amphibole and relicts of green-brown primary mineral; apatite is in grains and needles. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 8960-9050 Bureau of Economic Geology

Labradorite (65%), augite (12%), magnetite or ilmenite (6%), olivine (5%), biotite (5%), iddingsite?-chlorite-mica (3%), chlorite (2%), amphibole (1%), apatite (1%). Zoned labradorite is in an advanced stage of sericitization; olivine is partly altered to a mass of what seems to be iddingsite-mica-chlorite; both green-brown and red-brown biotite are present; amphibole is a secondary green variety. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

El Paso Natural Gas #1 West Texas Mortgage and Loan cuttings 9050-90 Bureau of Economic Geology

Quartz-feldspar-sericite-chlorite mass (71%), carbonate (15%), quartz (10%), feldspar (3%), leucoxene (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Fine matrix of quartz-feldspar-sericite-chlorite contains some fine crystalloblastic needles that may be amphibole;

carbonate occurs in patches with indistinct grain boundaries and as veinlets; feldspar and quartz are present as angular grains in the matrix; mineral percentages are highly variable in different fragments. Grain size: quartz and feldspar 0.1 mm; quartz-feldspar-sericite-chlorite matrix less than 0.02 and mostly less than 0.01 mm. Fabric: clastic—vague indications of beginning metamorphism. Rock: *calcareous sandy metasiltstone.*

El Paso Natural Gas #1 West Texas Mortgage and Loan — cuttings 9090–9100 — Bureau of Economic Geology

Labradorite (61%), augite (25%), olivine (5%), chlorite (5%), magnetite (3%), pyrite (1%). Zoned plagioclase is in advanced stage of sericitization; augite is lavender-brown and probably titaniferous; chlorite is an olive highly birefringent variety probably derived from alteration of olivine; pyrite is in places intergrown with magnetite. Grain size: 1 mm. Fabrc: hypidiomorphic granular. Rock: *olivine gabbro.*

El Paso Natural Gas #1 West Texas Mortgage and Loan — core ? — Bureau of Economic Geology

Labradorite? (64%), augite (15%), chlorite (15%), magnetite or ilmenite (6%), apatite (tr). Plagioclase is in advanced stage of sericitization; augite is in large skeletal crystals; magnetite or ilmenite contains hematite lamellae; two types of chlorite are present: (a) low-birefringent green chlorite and (b) a moderately birefringent olive-brown chlorite. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-gabbro.*

Lion #1 Bridwell — cuttings 8750-8810 — Bureau of Economic Geology

(1) Fragments of calcareous arkose, limestone, and dolomite that show no evidence of metamorphism.
(2) One fragment of dolomite that shows evidence of weak metamorphism—rhombic fabric is blurred and rhombs lose their integrity; the rock is spotted with tiny points of brown iron oxide.

Lion #1 Bridwell — cuttings 8810-8950 — Bureau of Economic Geology

Similar to other slides in this interval—rock is an altered *leuco-gabbro.*

Lion #1 Bridwell — cuttings 8815-8948 — Bureau of Economic Geology

Oligoclase (69%), chlorite (10%), augite (8%), amphibole? (7%), magnetite or ilmenite (3%), calcite (3%), sphene (tr), apatite (tr). Zoned plagioclase is partly sericitized, partly chloritized, and, locally, altered to fine-grained masses of epidote—sodic character results from saussuritization of a more calcic variety; chlorite occurs in granular masses from alteration of plagioclase and in sheaf-like masses from alteration of a ferromagnesian mineral—probably augite; amphibole? is colorless and probably secondary. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—metasomatic. Rock: altered (saussuritized) *leuco-gabbro.*

Lion #1 Bridwell — core 8951-53 — Humble Oil & Rfg. Co.

Labradorite (68%), augite (8%), chlorite (8%), olivine (6%), serpentine (5%), magnetite or ilmenite (4%), biotite (1%), apatite (tr). Zoned plagioclase is partly sericitized; olivine occurs in large masses and is mostly altered to serpentine and an olive-colored chlorite; augite and olivine accommodate themselves to plagioclase; a green low-birefringent chlorite and an olive-colored moderately birefringent chlorite are commonly mixed; probably the latter is an intermediate stage between a primary ferromagnesian mineral and the common chlorites; biotite is a pale orange-brown variety that fringes augite and the opaque mineral; the opaque mineral, magnetite or ilmenite, occurs locally in skeletal or dendritic masses; apatite is in long needles. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Phillips #1-A Stevens — cuttings 8190-8200 — Bureau of Economic Geology

Groundmass (83%), chlorite (8%), altered feldspar (3%), leucoxene (3%), sericite (2%), Cryptocrystalline to microcystalline quartz-alkali feldspar groundmass is locally microspherulitic and locally shows coarsenings; quartz, microperthite, and plagioclase? form phenocrysts. Grain size: groundmass mostly less than 0.01 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Shell #1 Nichols | cuttings 9030-40 | Shell Oil Co.

Groundmass (83%), chlorite (8%), altered feldspar (3%), leucoxene (3%), sericite (2%), brown iron oxide (1%), quartz (tr), apatite (tr). Cryptocrystalline groundmass contains sporadic feldspar microlites showing polysynthetic twinning—albite?; brown iron oxide stains most of slide. Grain size: groundmass cryptocrystalline; microlites up to 0.2 mm. Fabric: porphyritic. Rock: altered *rhyolite.*

Shell #1 Nichols | cuttings 9030-40 | Shell Oil Co.

Groundmass (64%), plagioclase (15%), sericite (10%), chlorite (5%), calcite (5%), leucoxene (1%), zircon (tr), apatite (tr). Microcrystalline microgranular groundmass of quartz and feldspar is partly sericitized; plagioclase phenocrysts are in advanced stage of sericitization. Grain size: groundmass 0.02 mm; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: altered *rhyolite porphry.*

BREWSTER COUNTY

Dodson (Hinton) #1 Texas American Syndicate | cuttings 4513-23; 4602-07; 4621-24; 4643-50; 4658-71 | Stanolind Oil & Gas Co.

A series of slides containing small fragments. Microcline microperthite and albite (97%), analcite (3%), amphibole (tr), magnetite or ilmenite (tr), apatite (tr), calcite (tr). Feldspar is partly kaolinized; microcline microperthite is the dominant feldspar in most slides; apatite occurs in needles. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *analcite microsyenite.* [Tertiary?—not basement.]

Dodson (Hinton) #1 Texas American Syndicate | cuttings 6100-6400 | Bureau of Economic Geology

Albite and alkali feldspar (84%), quartz (10%), alkali amphibole–arfvedsonite? (3%), calcite (2%), aegirine (1%), zircon (tr), fluorite (tr), magnetite or ilmenite (tr). Feldspar is probably mostly alkali feldspar, zoned, and partly kaolinized; quartz is interstitial to feldspar laths; laths of feldspar commonly show a parallel structure. Grain size: feldspar laths 0.2 x 1 mm maximum. Fabric: ranges from hypidiomorphic granular to trachytoid. Rock: *aegirine-arfvendsonite? microgranite.* [Tertiary?—not basement.]

BRISCOE COUNTY

Amerada #1 Hamilton | cuttings 8775 | Bureau of Economic Geology

Oligoclase-andesine (42%), hornblende (35%), quartz (12%), biotite (10%), chlorite (1%), sphene (tr), apatite (tr). Plagioclase is almost completely sericitized; blue-green hornblende is partly altered to chlorite; biotite pleochroism is pale brown to brown; in some fragments feldspar is crushed and granulated and hornblende is frayed. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular with cataclastic elements. Rock: *quartz diorite.*

Hunt #1 Ritchie | cuttings 7475-7590 | Bureau of Economic Geology

Labradorite (57%), augite (25%), magnetite or ilmenite (5%), chlorite (5%), mica? (5%), biotite (2%), amphibole (1%), pyrite (tr), apatite (tr). Zoned plagioclase is partly sericitized; augite is lavender-brown; magnetite or ilmenite is in large grains and skeletal masses; bleached biotite is surrounded by masses of colorless highly birefringent fibrous mineral that is probably a mica; pale green amphibole occurs as small prisms in masses of chlorite and is probably secondary. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-gabbro.*

Hunt #1 Ritchie | cuttings 7510-90 | Humble Oil & Rfg. Co.

Andesine-labradorite (61%), chlorite (12%), alkali feldspar (8%), augite (8%), magnetite or ilmenite (4%), amphibole (3%), iddingsite? (3%), biotite (1%), apatite (tr). Plagioclase is zoned and partly sericitized; locally it has alkali feldspar rims; colorless secondary amphibole occurs in sheaves or felts of small prisms; biotite, red-brown, rims magnetite or ilmenite; iddingsite? apparently indicates the former presence of olivine; apatite is in needles or prisms. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-gabbro.*

Hunt #1 Ritchie cuttings 7590-7635 Bureau of Economic Geology

(1) Talc (78%), dolomite (20%), serpentine (2%). Patches of dolomite occur in a mass of talc with minor serpentine. Grain size: dolomite 0.1 mm. Fabric: metasomatic. Rock: *dolomite-talc rock.*

(2) Quartz, calcite, feldspar, bleached biotite, chlorite, magnetite or ilmenite, leucoxene, apatite, zircon, amphibole?. Percentages of minerals vary widely in different fragments. Chlorite occurs in tufts; amphibole? occurs as tiny needles sprouting through the rock and occurring within calcite, quartz, and feldspar. Grain size: 0.05 to 0.2 mm. Fabric: relict clastic–incipient crystalloblastic. Rock: *meta-arkose.*

Hunt #1 Ritchie cuttings 7590-7610 Humble Oil & Rfg. Co.

Dolomite, talc, chert, diopside?. Slide shows fragments of dolomite, dolomite partly altered to talc, and dolomite almost completely altered to talc. Locally dolomite shows (1) linear zones that have more or less optical continuity and may be solution paths, (2) large equi-extinguishing masses with inclusions of more or less rhombic dolomite without optical continuity, (3) recrystallization into elongate grains. Sporadic grains of diopside? occur within the dolomite. One fragment of recrystallized chert is present. Grain size: less than 0.1 mm. Fabric: crystalloblastic (granoblastic to sieve). Rock: *metadolomite.*

Hunt #1 Ritchie cuttings 7610-50 Humble Oil & Rfg. Co.

(1) Dolomite (100%), diopside (tr), pyrite (tr). Grain size: 0.02 to 0.1 mm. Fabric: granoblastic. Rock: *metadolomite.*

(2) Groundmass, quartz, carbonate, pyroxene?. Brown groundmass partly replaced by carbonate is composed in part of small high relief laths; quartz grains appear to be phenocrysts; pyroxene? also appears to be a phenocryst (only one tiny fragment of this rock in the slide). Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.2 mm. Fabric: porphyritic?. Rock: *volcanic rock.*

(3) Quartz, feldspar, carbonate, magnetite-ilmenite, red iron oxide. Quartz occurs as large round pebbles in a finer matrix of quartz and feldspar stained with iron oxide. In some fragments there are masses of recrystallized spherulitic chert and masses of carbonate. Grain size: matrix less than 0.1 mm; pebbles up to 2 mm. Fabric: essentially clastic—matrix does not appear to have recrystallized; some signs of weak metamorphism. Rock: *feldspathic metasandstone.*

Hunt #1 Ritchie cuttings 7650-7710 Humble Oil & Rfg. Co.

Groundmass (70%), quartz and feldspar (15%), carbonate (5%), magnetite or ilmenite, leucoxene, and red iron oxide (7%), amphibole? (3%), bleached biotite (tr), tourmaline (tr), apatite (tr), zircon (tr). Fine brown groundmass is composed mostly of fine quartz and clay minerals with some incipient sericite; angular fragments of quartz, plagioclase, and microcline occur throughout the groundmass; patches of carbonate are common; amphibole? occurs as bundles of fine needles or hairs of crystalloblastic habit in quartz, carbonate, and feldspar. Mineral percentages vary considerably in different fragments. Grain size: groundmass less than 0.02 mm; fragmental quartz-feldspar ranges up to 0.2 mm. Fabric: clastic with incipient crystalloblastic elements (sieve). Rock: fragments range from *argillite* to *weakly metamorphosed siltstone* and *sandstone.*

Hunt #1 Ritchie cuttings 7710-20 Humble Oil & Rfg. Co.

(1) Dolomite, diopside, tremolite, serpentine. Diopside, tremolite, and relict dolomite occur in a mosaic and all are partly replaced by serpentine. Grain size: 0.2 to 1 mm. Fabric: crystalloblastic (granoblastic to sieve). Rock: *diopside-tremolite-dolomite hornfels.*

(2) Relict altered dolomite grains that locally contain concentrations of tremolite occur in a mass of serpentine. Serpentine shows outline of old dolomite mosaic.

Hunt #1 Ritchie cuttings 7720-40 Humble Oil & Rfg. Co.

Same as 7650-7710 but with more sericite in groundmass and no amphibole? needles.

Hunt #1 Ritchie cuttings 7635-7730 Bureau of Economic Geology

Similar to 7590-7635 (2).

Hunt #1 Ritchie cuttings 7730-45 Bureau of Economic Geology

Dolomite, serpentine, tremolite. Older stained and discolored dolomite occurs with clear recrystallized carbonate; fibrous tremolite has formed at the expense of dolomite in some fragments. In one fragment tiny fibrous amphibole? occurs in serpentine; granular patches of a semi-opaque mineral form small rings filled with serpentine and give the slide a pocked appearance. Grain size: 0.05 to 0.2 mm. Fabric: crystalloblastic (sieve)—metasomatic. Rock: *serpentinized tremolite-dolomite hornfels.*

Hunt #1 Ritchie cuttings 7740-60 Humble Oil & Rfg. Co.

Same as 7650-7710.

Hunt #1 Ritchie cuttings 7760-70 Humble Oil & Rfg. Co.

Dolomite, serpentine, talc, tremolite. Dolomite is locally sheared, recrystallized, and altered to tremolite, talc, and serpentine; some late carbonate in veinlets cuts metamorphic minerals. Grain size: 0.05 to 0.2 mm. Fabric: crystalloblastic (sieve)—metasomatic. Rock: *serpentinized talc-dolomite rock.*

Hunt #1 Ritchie cuttings 7770-90 Humble Oil & Rfg. Co.

Same as 7650-7710.

Hunt #1 Ritchie cuttings 7790-7890 Bureau of Economic Geology

Plagioclase (57%), hornblende (25%), alkali feldspar (5%), magnetite or ilmenite (5%), chlorite (4%), biotite (3%), apatite (1%), epidote (tr), sphene (tr), augite (tr). Zoned plagioclase is in an advanced stage of sericitization; yellow-green hornblende occurs as large grains and as felts of small prisms; some colorless amphibole surrounds pyroxene relicts; partly kaolinized alkali feldspar occurs as anhedral grains and locally rims plagioclase; biotite is red-brown; apatite occurs partly in long needles and partly in more or less equant grains; a few grains of epidote are present as result of alteration of feldspar. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *diorite.*

Hunt #1 Ritchie cuttings 7790-7890 Humble Oil & Rfg. Co.

Sodic plagioclase (60%), augite (15%), magnetite or ilmenite (8%), chlorite (7%), amphibole (7%), biotite (3%), sphene (tr), apatite (tr). Plagioclase is almost completely sericitized, but there is some unsericitized sodic plagioclase—albite?; sodic nature of the plagioclase is probably due to alteration of a more calcic variety; augite is partly altered to amphibole, with pale green-brown to green pleochroism, which in turn is partly altered to biotite; chlorite is in granular masses; magnetite or ilmenite is locally fringed with red-brown biotite. Grain size: up to 1 cm. Fabric: hypidiomorphic granular. Rock: altered *leuco-albite? gabbro.*

Hunt #2 Ritchie cuttings 7130-7560 Bureau of Economic Geology

Plagioclase (62%), biotite (10%), augite (8%), chlorite (7%), magnetite or ilmenite (5%), olivine (5%), amphibole (2%), apatite (1%), calcite (tr), unidentified secondary mineral (tr). Plagioclase is variably sericitized in different fragments and shows zonation from labradorite cores to sodic rims; red-brown biotite occurs as a fringe around opaque mineral and as large plates; augite is locally a very deep brown color; greenish-yellow chlorite replaces feldspar; olivine is locally partly altered to an olive-brown highly birefringent mineral which in turn is altered in part to a pale brown highly birefringent mineral; amphibole is secondary; apatite is in large grains. A moderately birefringent mineral with moderate relief and positive optic sign occurring within altered plagioclase was not identified. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Hunt #2 Ritchie cuttings 7590-7710 Bureau of Economic Geology

Dolomite (86%), serpentine (10%), anhydrite (3%), talc (1%). Dolomite is variably altered to serpentine in different fragments; large porphyroblastic anhydrite crystals are present in one fragment; locally dolomite is altered to talc. Grain size: 0.02 to 0.1 mm; anhydrite up to 4 mm. Fabric: metasomatic. Rock: *serpentinized dolomite.* (Photomicrograph, Pl. IX, C.)

Hunt #2 Ritchie cuttings 7630-40 Humble Oil & Rfg. Co.

Andesine-labradorite (66%), chlorite (8%), biotite (7%), augite (5%), olivine (5%), magnetite or ilmenite (4%), apatite (2%), amphibole (2%), carbonate (1%), pyrite (tr), epidote (tr). Partly sericitized zoned plagioclase ranges from albite through oligoclase, most is albite; there are three varieties of chlorite—green low-birefringent, olive low-birefringent, and olive moderate- to high-birefringent—these seem to be stages in the alteration of the ferromagnesian minerals; very red-brown biotite in part envelops opaque mineral and in part is fringed with amphibole; apatite is in very large grains. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Hunt #2 Ritchie cuttings 7640-60 Humble Oil & Rfg. Co.

Groundmass (90%), magnetite or ilmenite, quartz, and feldspar (10%). Brown fine-grained groundmass is an aggregate of quartz, feldspar, and clay minerals showing variable degree of reconstitution to sericite—sericite occurs in tiny fibers locally showing parallelism; magnetite or ilmenite is in fine scattered grains; quartz and feldspar occur in angular sand and silt-sized grains. Grain size: groundmass less than 0.02 mm; fragmental quartz and feldspar up to 0.1 mm. Fabric: clastic with incipient crystalloblastic elements. Rock: ranges from *argillite* to *meta-argillite.*

Hunt #2 Ritchie cuttings 7660-7700 Humble Oil & Rfg. Co.

Dolomite, diopside, tremolite, serpentine. Minerals are present to varying degree in different fragments; tremolite occurs as corroded grains in an almost completely serpentinized fragment; diopside is locally altered to serpentine. Grain size: dolomite about 0.1 mm; diopside up to 1 mm. Fabric: crystalloblastic (sieve). Rock: *serpentinized diopside-dolomite hornfels.*

Hunt #2 Ritchie cuttings 7700-20 Humble Oil & Rfg. Co.

Groundmass (82%), alkali feldspar (10%), clinozoisite (3%), magnetite or ilmenite, leucoxene, red iron oxide (3%), calcite (1%), biotite (1%), apatite (tr). Microcrystalline to cryptocrystalline groundmass is composed mostly of microgranular alkali feldspar and tiny prisms of clinozoisite; phenocrysts are partly kaolinized alkali feldspar and partly oxidized biotite. Grain size: groundmass cryptocrystalline to 0.05 mm; phenocrysts 0.5 to 1 mm. Fabric: porphyritic. Rock: altered *trachyte porphyry.*

Hunt #2 Ritchie cuttings 7710-20 Bureau of Economic Geology

Groundmass (86%), alkali feldspar (8%), magnetite or ilmenite (3%), leucoxene (1%), quartz (1%), calcite (1%), scheelite? (tr), red iron oxide (tr), apatite (tr). Brown-stained groundmass consists of a cryptocrystalline mass, probably alkali feldspar (on basis of relief), containing needles and short prisms of amphibole (10%) and clusters and masses of fine epidote grains that outline flowage structure (4%); alkali feldspar phenocrysts are in an advanced stage of kaolinization; quartz and calcite occur in a cross-cutting veinlet; magnetite or ilmenite occurs in tiny scattered grains; red iron oxide forms a pervading stain; scheelite? replaces plagioclase adjoining quartz-calcite veinlet and also occurs in the veinlet. Grain size: groundmass mostly cryptocrystalline; amphibole needles up to 0.2 mm long; epidote grains mostly less than 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: altered *trachyte porphyry.*

Hunt #2 Ritchie cuttings 7720-50 Humble Oil & Rfg. Co.

Groundmass (75%), alkali feldspar and albite (15%), magnetite or ilmenite, leucoxene, red iron oxide (5%), clinozoisite and epidote (4%), quartz (1%), axinite? (tr), apatite (tr). Cryptocrystalline to microgranular groundmass shows relict vitroclastic structure with the outline of the devitrified shards plainly visible; red iron oxide stain, grains of magnetite or ilmenite, and blobs of leucoxene occur throughout; albite and alkali feldspar occur as partly sericitized "phenocrysts"; clinozoisite (3%) and epidote (1%) occur as masses and tiny prisms throughout groundmass; the rock is cut by a quartz-calcite veinlet. Presence of clinozoisite and axinite? may indicate beginnings of metamorphism. Grain size: groundmass up to 0.02 mm; feldspar up to 1 mm. Fabric: relict vitroclastic. Rock: *trachyte? tuff.*

Hunt #2 Ritchie cuttings 7720-60 Bureau of Economic Geology

Groundmass (84%), microperthite (12%), magnetite or ilmenite (2%), leucoxene (1%), red iron oxide (1%), quartz (tr), calcite (tr). Most of the groundmass is obscured by red iron oxide, kaolinite, or masses of fine sericite, locally it is cryptocrystalline, in some fragments it appears to be vitroclastic, in some fragments it appears to be microlitic; microperthite occurs as partly kaolinized phenocrysts; one small quartz phenocryst is present. Grain size: groundmass cryptocrystalline to 0.02 mm; phenocrysts up to 1 mm. Fabric: porphyritic?, vitroclastic?. Rock: apparently fragments of both *tuff and flow rocks* are present.

Hunt #10 Ritchie cuttings 7920-8165 Humble Oil & Rfg. Co.

(1) Labradorite (75%), augite (8%), olivine (5%), magnetite or ilmenite (4%), talc (4%), chlorite (2%), biotite (1%), pyrite (1%), apatite (tr). Plagioclase is zoned and partly sericitized, outer zones may be andesine or more sodic varieties; talc? or possibly mica? occurs in fibrous masses with chlorite and appears to be partly altered to chlorite; red-brown biotite, locally altered to a green variety, occurs around magnetite or ilmenite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

(2) Plagioclase (75%), biotite (8%), magnetite or ilmenite (7%), augite (4%), chlorite (4%), epidote (2%). Zoned and partly sericitized plagioclase ranges from andesine through albite, although most of it is sodic; red-brown biotite and scattered equant grains of magnetite or ilmenite occur throughout the slide; chlorite, possibly including some serpentine, is probably derived from olivine; epidote occurs in small discrete grains and strings of grains and is easily confused with augite. Grain size: 0.2 to 0.5 mm. Fabric: subophitic. Rock: *leuco-albite diabase.*

Midstates #1 Hickok & Reynolds cuttings 8120-50 Shell Oil Co.

Labradorite? (79%), augite (15%), alkali feldspar (5%), chlorite (1%), pyrite (tr), apatite (tr). Alkali feldspar locally rims plagioclase; augite accommodates itself to plagioclase tablets. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-gabbro.*

Midstates #1 Hickok & Reynolds cuttings 8120-50 Shell Oil Co.

Labradorite? (74%), amphibole (10%), augite (5%), alkali feldspar (5%), chlorite (5%), biotite (1%), apatite (tr), leucoxene (tr), pyrite (tr), magnetite or ilmenite (tr). Plagioclase is partly sericitized; amphibole is a blue-green variety and was apparently derived from alteration of pyroxene. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-gabbro.*

Standard of Texas #1 Owen cuttings 8380-90 Bureau of Economic Geology

Plagioclase (65%), augite (10%), magnetite or ilmenite (10%), hornblende (4%), epidote (4%), biotite (3%), iddingsite? (3%), chlorite (1%), sphene (tr), apatite (tr). Plagioclase is almost completely sericitized; commonly it shows sericitized cores and kaolinized rims that appear to be albite; augite is brownish and probably titaniferous; hornblende shows yellow-green to green pleochroism and occurs in masses of short stubby prisms; biotite pleochroism is pale reddish brown to very dark brown; iddingsite? occurs in masses and indicates that olivine was present as a primary ferromagnesian mineral. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-gabbro.*

CARSON COUNTY

Cities Service #1 Whittemore cuttings 3267-3326 Humble Oil & Rfg. Co.

Albite-oligoclase (67%), quartz (10%), alkali feldspar (10%), calcite (3%), epidote (3%), chlorite (3%), biotite (2%), hornblende (1%), magnetite or ilmenite (1%), red iron oxide and magnetite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized and occurs in brecciated fragments; alkali feldspar is probably microperthite; fine granular epidote replaces large volumes of the rock; calcite occurs in brecciated fragments; biotite is green-brown and partly altered to chlorite; hornblende pleochroism is yellow-green to green; red iron oxide and magnetite occur in veinlets in the shattered fragments. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular with local cataclasis. Rock: *granodiorite.*

Dunnigan #1 Ellis cuttings 5320-65 Stanolind Oil & Gas Co.

Groundmass (90%), alkali feldspar? (5%), quartz (5%), magnetite or ilmenite (tr), red iron oxide (tr). Groundmass is stained and altered (kaolinized) and in one fragment shows a micrographic fabric; secondary quartz fills vesicles; sericitized feldspar phenocrysts are so altered as to be unidentifiable. Grain size: groundmass 0.02 to 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Shamrock #1 Thompson cuttings 3110-15 Bureau of Economic Geology

Andesine-labradorite (58%), augite (25%), magnetite or ilmenite (10%), chlorite (5%), alkali feldspar (2%), biotite (tr), hornblende (tr), sphene (tr), apatite (tr). Partly sericitized plagioclase shows an indistinct zoning; augite is obscured by unidentified alteration products; olive-drab chlorite is finely fibrous; alkali feldspar is interstitial to plagioclase and locally shows very fine micrographic structure which indicates the presence of minor quartz; biotite is red-brown; hornblende is green-brown and mantles augite; apatite is in myriad needles. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

Shamrock #1 Thompson cuttings 3130-35 Bureau of Economic Geology

Labradorite (56%), augite, hornblende, biotite, chlorite, and mica? (35%), magnetite or ilmenite (6%), alkali feldspar and quartz (2%), unidentified needles (1%). Twinned plagioclase laths show a more or less radial pattern; corroded augite relicts are mostly altered to a green-brown finely fibrous mineral with moderate birefringence that may be a mica; green-brown hornblende is associated with the altered pyroxene; interstitial alkali feldspar and quartz are late-crystallizing minor constituents. Grain size: 0.2 to 1 mm. Fabric: subophitic. Rock: altered *diabase.*

Shamrock #1 Thompson cuttings 3156-59 Bureau of Economic Geology

Albite and alkali feldspar (87%), quartz (8%), magnetite or ilmenite (3%), hornblende (2%), bleached biotite (tr), calcite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized and partly kaolinized; alkali feldspar is kaolinized; hornblende is green-brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

Stanolind #1 Griffin core 5602-04 Stanolind Oil & Gas Co.

Groundmass (85%), quartz (8%), microperthite (7%), calcite (tr), sphene (tr), leucoxene (tr). Microcrystalline groundmass shows flowage, micrographic, and microspherulitic structures; microperthite and quartz occur as phenocrysts, and the quartz, in particular, is rounded and embayed. Grain size: groundmass less than 0.02 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Griffin core 5613-14 Humble Oil & Rfg. Co.

Groundmass (85%), microperthite (9%), quartz (6%), red iron oxide (tr), magnetite or ilmenite (tr), sphene (tr), leucoxene (tr), zircon (tr). Stained groundmass shows pronounced flowage and contains (1) large and small spherulites and spherulitic areas, (2) cryptocrystalline areas, (3) lenses and layers of coarser quartz-alkali feldspar, (4) micrographic areas; quartz and microperthite occur as phenocrysts with the quartz in general rounded and embayed. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.4 to 1 mm; spherulites up to 2 mm in diameter. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Griffin core 5613-14 Stanolind Oil & Gas Co.

Groundmass (85%), microperthite (10%), quartz (5%). Similar to 5602-04. Microcrystalline groundmass shows flowage, microspherulitic, and micrographic structures; feldspar phenocrysts are subhedral, quartz phenocrysts are round and embayed. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Griffin core 5646-47 Humble Oil & Rfg. Co.

Groundmass (84%), quartz (9%), microperthite (6%), leucoxene (1%), sphene (tr), magnetite or ilmenite (tr), apatite (tr). Cryptocrystalline to microcrystalline groundmass is locally micrographic and microspherulitic and contains lenses of coarser quartz and alkali feldspar; flowage is prominent and the whole is stained with ocherous iron oxide; quartz occurs as round and embayed phenocrysts; microperthite phenocrysts show incipient kaolinization; sphene is mostly altered to leucoxene. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.3 to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Griffin cuttings 5646-48 Bureau of Economic Geology

Groundmass (85%), quartz (10%), microperthite (5%), magnetite or ilmenite (tr), red iron oxide (tr). Brown partly kaolinized groundmass is cryptocrystalline to microcrystalline and, locally, microspherulitic; flowage is well developed. Quartz is in embayed and corroded phenocrysts; microperthite phenocrysts are kaolinized. Grain size: groundmass less than 0.02 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Tipton & Waggoner #1 McConnell cuttings 3060 Bureau of Economic Geology

Labradorite (66%), augite (10%), amphibole (10%), magnetite or ilmenite (8%), alkali feldspar (5%), quartz (1%), biotite (tr), apatite (tr). Plagioclase is variably sericitized in different fragments and shows a vague zoning; augite is a brown-tinted variety partly altered to secondary green amphibole; there are two kinds of amphibole in the slide—a secondary green amphibole is predominant but a green-brown primary amphibole is also present; alkali feldspar micrographically intergrown with quartz occurs between plagioclase grains; biotite, yellow-brown to brown pleochroism, is associated with the green amphibole. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-microgabbro.*

Tipton & Waggoner #1 McConnell cuttings 3068 Bureau of Economic Geology

Similar to 3060.

CASTRO COUNTY

Anderson-Prichard #1 Fowler-McDaniel cuttings 9650 Humble Oil & Rfg. Co.

Plagioclase (61%), chlorite (10%), olivine (8%), augite (5%), iddingsite (5%), biotite (4%), amphibole (3%), magnetite or ilmenite (3%), talc? (1%), apatite (tr). Zoned and partly sericitized plagioclase has calcic cores (labradorite) and sodic rims (albite); chlorite is composed of two varieties—a green low-birefringent chlorite (2%) in granular masses and an olive low-birefringent chlorite (8%) in fibro-lamellar masses locally showing a mesh structure after olivine; red-brown biotite fringes opaque minerals and olivine; talc? or mica is a fibrous mineral apparently representing an intermediate alteration stage between primary ferromagnesian mineral and chlorite; three kinds of amphibole are present—pleochroism pale green to green (probably a secondary variety), a variety with brown to green pleochroism, and a red-brown variety associated with red-brown biotite. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Sun #1 Haberer cuttings 8890-8900 Shell Oil Co.

Labradorite (66%), magnetite or ilmenite (15%), chlorite (10%), epidote (8%), apatite (1%), biotite (tr). Partly kaolinized plagioclase is in twinned laths; original ferromagnesian minerals are altered to chlorite and epidote; biotite is almost completely altered to chlorite. Grain size: 0.2 to 0.5 mm with some plagioclase laths up to 2 mm long. Fabric: subophitic. Rock: altered *diabase.*

Sun #1 Haberer cuttings 8890-8900 Shell Oil Co.

Plagioclase (60%), chlorite (39%), leucoxene (1%), magnetite or ilmenite (tr). Rock is thoroughly altered but plagioclase is preserved as twinned laths. Grain size: 0.2 mm. Fabric: probably ophitic or subophitic. Rock: altered *diabase?.*

Sun #1 Haberer cuttings 8900-10 Shell Oil Co.

Labradorite (75%), albite (14%), chlorite (5%), augite (2%), calcite (2%), biotite (1%), apatite (1%). Partly sericitized calcic plagioclase (labradorite) is mantled with more sodic plagioclase (albite) which shows more advanced kaolinization; biotite is a reddish-brown variety partly altered to chlorite. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microgabbro.*

Sun #1 Haberer core 9124-25 Bureau of Economic Geology

Groundmass (91%), alkali feldspar and plagioclase (4%), leucoxene (3%), red iron oxide (2%), zircon (tr), calcite (tr), rock fragments (tr), sphene (tr). Groundmass is composed of irresolvable greenish material showing flowage structure and containing elongate lenses and blebs of colorless cryptocrystalline material with low index of refraction. Grain size: cryptocrystalline to 0.01 mm. Fabric: microgranular. Rock: altered *volcanic rock* (probably extrusive).

Sun #1 Herring cuttings 9730-90 Bureau of Economic Geology

(1) Fragments of crinoidal limestone.

(2) Fragment of altered gabbro.

(3) Quartz, feldspar, fine sericite-chlorite-quartz-feldspar mass, magnetic or ilmenite, leucoxene, carbonate, rock fragment. Quartz occurs mostly in angular fragments but some are sub-round; feldspar is present as altered fragments; magnetite or ilmenite is finely disseminated; fine sericite-chlorite-quartz-feldspar mass shows a rude foliation in one fragment; rock fragments are micrographic rhyolite; mineral percentages vary widely in different fragments. Grain size: fine sericite-chlorite-quartz-feldspar mass is less than 0.02 mm; quartz and feldspar fragments 0.2 to 0.4 mm. Fabric: clastic with incipient crystalloblastic elements in some fragments. Rock: mostly *arkose* and *sandstone* showing vague indications of metamorphism with one fragment of *clay slate.*

Sun #1 Herring cuttings 9790-10065 Bureau of Economic Geology

Labradorite (48%), augite (33%), magnetite or ilmenite (8%), chlorite (4%), biotite (2%), amphibole (2%), serpentine (2%), leucoxene (1%), rutile (tr), pyrite (tr), apatite (tr). Zoned plagioclase shows advanced sericitization and, locally, indications of development of more sodic phases, probably through alteration; augite includes irregular or skeletal masses of magnetite or ilmenite; amphibole is a secondary green variety; biotite is red-brown and fringes grains of the magnetite or ilmenite. Grain size: 2 to 4 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

Sun #1 Herring cuttings 10065-10135 Bureau of Economic Geology

(1) Albite and alkali feldspar (84%), quartz (5%), muscovite (5%), carbonate (3%), magnetite or ilmenite (3%), epidote (tr), biotite (tr), amphibole? (tr). Feldspar is mostly albite; quartz is in angular grains; poikiloblastic muscovite is locally porphyroblastic; biotite is green; fibrous radiating mineral is probably amphibole; mineral percentages are extremely variable in different fragments. Fabric: granoblastic—poikiloblastic. Rock: *hornfels.* (Photomicrograph, Pl. IX, D.)

(2) Quartz, feldspar, quartz-feldspar matrix, magnetite or ilmenite. Angular quartz and feldspar grains are set in a very fine quartz-feldspar matrix—individual grains are resolved only with difficulty; magnetite or ilmenite is finely disseminated. Grain size: quartz and feldspar fragments 0.05 to 0.2 mm; matrix less than 0.02 mm—no evidence of metamorphism. Fabric: clastic. Rock: *siltstone.*

Sun #1 Herring core 10114-28 Bureau of Economic Geology

Antigorite and chlorite? (72%), calcite (25%), magnetite or ilmenite (3%). Pale brownish fibrolamellar antigorite is inseparably mixed with a fibrous low-birefringent mineral, probably a chlorite, with a higher index of refraction than antigorite. Calcite is in veinlets and masses of grains. Magnetite or ilmenite is dendritic. Grain size: serpentine less than 0.02 mm; calcite 0.2 mm. Fabric: fibrolamellar. Rock: *serpentinite.*

Sun #1 Herring core 10128-33 Bureau of Economic Geology

Thoroughly altered aphanitic green rock. Semi-opaque brown material (48%), green mica (15%), nontronite (8%), talc (10%), calcite (7%), epidote (5%), chlorite (5%), pyrite (2%). Rock has a parallel banded structure marked by veinlets of calcite. The semi-opaque material is probably a clay derived from alteration of one of the other secondary minerals —apparently epidote. The talc and the green mica appear to be the same mineral and the color varies from predominantly pinkish or colorless to pale greenish to, locally, grass-green. It occurs in "pockets" with or without chlorite. The nontronite, with a distinct "crepe paper" appearance is intimately associated with calcite in veinlets. Grain size: 0.05 to 0.2 mm. Fabric: metasomatic-banded. Rock: altered *ferromagnesian-rich rock.*

Sun #1 Herring cuttings 10130-40 Stanolind Oil & Gas Co.

Original nature of rock obscured by a pale yellow-green fibrous mineral with moderate birefringence which is apparently derived from alteration of feldspar. Grain size: 0.01 to 0.02 mm.

Sun #1 Herring cuttings 10135-10500 Bureau of Economic Geology

(1) Plagioclase (50%), olivine (15%), chlorite (10%), augite (10%), magnetite or ilmenite (6%), talc (5%), biotite (2%), carbonate (1%), amphibole (1%), apatite (tr). Plagioclase is sericitized; biotite is red-brown; amphibole is a secondary green variety; carbonate is the product of alteration of original ferromagnesian constituents. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

(2) Plagioclase (53%), amphibole (30%), biotite (8%), magnetite or ilmenite (7%), chlorite (2%), apatite (tr). Plagioclase is in an advanced stage of sericitization; green-brown amphibole occurs as discrete grains and as fibrous masses; biotite is red-brown. Grain size: 0.2 mm. Fabric: subophitic. Rock: *diabase.*

Sun #1 Herring core 10447-59 Honolulu Oil Corp.

Labradorite (75%), augite (10%), magnetite or ilmenite (5%), olivine (4%), chlorite (3%), biotite (2%), leucoxene (1%), apatite (tr), sphene (tr). Zoned plagioclase shows incipient alteration to sericite; two chlorites are present, an olive-drab variety from alteration of, and replacing, olivine and a green variety fringing pyroxene and olivine; intensely red-brown biotite fringes magnetite; sphene is partly altered to leucoxene. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Sun #1 Herring core 10449-54 Bureau of Economic Geology

Andesine-labradorite (61%), chlorite (10%), augite (8%), magnetite or ilmenite (8%), olivine (8%), biotite (4%), apatite (1%), epidote (tr), pyrite or pyrrhotite (tr). Plagioclase shows a vague zoning and is partly sericitized; augite is pale pink-brown; olivine is partly altered to a highly birefringent green mineral (a chlorite?) and partly altered to a moderately birefringent olive-drab chlorite; biotite pleochroism is pale to intense red-brown and locally it grows around the opaque mineral; chlorite may be divided into (1) high-birefringent green chlorite (10%), (2) moderate-birefringent olive-drab chlorite (2%), and (3) low-birefringent green chlorite (tr); a substantial sericite content is included in the plagioclase total. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Sun #1 Herring cuttings 10460-10500 Stanolind Oil & Gas Co.

Labradorite (53%), augite (40%), magnetite or ilmenite (4%), biotite (2%), chlorite (1%), apatite (tr). Plagioclase is partly altered to epidote and sericite; augite is brownish and apparently titaniferous; biotite pleochroism is pale brown to dark red-brown; apatite occurs in grains and needles. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

Sun #1 Herring cuttings 10500 Shell Oil Co.

Labradorite? (69%), olivine (15%), alkali feldspar (5%), augite (3%), chlorite (3%), magnetite or ilmenite (3%), biotite (1%), apatite (1%). Plagioclase is zoned and partly altered to sericite, the outer zones of the zoned plagioclase grains are sodic and probably approach albite in composition; alkali feldspar occurs as small grains between plagioclase subhedrons and as rims on plagioclase grains; alkali feldspar is a dirty brown color as a result of incipient kaolinization; olivine is partly altered to a moderately birefringent chlorite; biotite is an intensely red-brown variety and rims the opaque mineral; some apatite occurs in needles. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

CHILDRESS COUNTY

Stanolind #1 Owens core 7380-84 Bureau of Economic Geology

Groundmass (86%), plagioclase (8%), magnetite or ilmenite (3%), red iron oxide (1%), chlorite (1%), calcite (1%), apatite (tr). Groundmass ranges from microspherulitic to microgranular; the spherulitic areas are mostly alkali feldspar and the microgranular material is mostly feldspar with subordinate quartz, magnetite, and red iron oxide; plagioclase phenocrysts are almost completely sericitized; magnetite or ilmenite is partly altered to red iron oxide; calcite occurs in grains and veinlets. Grain size: groundmass, spherulites up to 0.5 mm, microgranular material up to 0.1 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Owens cuttings 7380-84 Shell Oil Co.

Groundmass (87%), feldspar (5%), quartz (5%), sericite (3%), leucoxene (tr), brown iron oxide (tr). Micrographic groundmass is altered and stained; groundmass contains quartz, and some quartz is present as larger grains or groups of grains in a mosaic (probably secondary); phenocrysts are altered so as to obscure their mineralogy. Grain size; groundmass 0.05 to 0.1 mm; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Owens cuttings 7381-84 Stanolind Oil & Gas Co.

Groundmass (89%), albite? (5%), quartz (5%), chlorite (1%), leucoxene (tr), red iron oxide (tr), magnetite or ilmenite (tr), calcite (tr). Groundmass is obscured by heavy iron oxide stain; plagioclase phenocrysts are in advanced stage of sericitization; probably most of the larger quartz grains and mosaic are secondary. Grain size: groundmass less than 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

CLAY COUNTY

Bridwell #26 Edrington cuttings 3273 Humble Oil & Rfg. Co.

Quartz and plagioclase (82%), biotite (8%), sericite (7%), epidote (3%), leucoxene (tr), calcite (tr), sphene (tr), apatite (tr), zircon (tr). Quartz and partly sericitized plagioclase occur in angular fragments; biotite is present as tiny plates as a result of reconstitution of original argillaceous intergranular material; sericite occurs as fine oriented fibers; epidote occurs as fine scattered grains and some large masses. Grain size: 0.02 to 0.2 mm. Fabric: relict clastic—incipient crystalloblastic. Rock: *phyllitic metagraywacke.*

Bridwell #1-A Edrington core 2183-84½ Stanolind Oil & Gas Co.

Albite (38%), quartz (30%), alkali feldspar—mostly microcline microperthite (20%), sericite (6%), biotite (2%), epidote (2%), chlorite (2%), magnetite or ilmenite (tr), zircon (tr), apatite (tr), rhyolite? fragment (tr). Plagioclase occurs in finely twinned grains; epidote is in tiny clusters of grains and in larger grains throughout the slide; sericite occurs from alteration of feldspar (within feldspar grains) and as intergranular fibers; zircon is rounded; biotite pleochroism is pale brown to deep green. Grain size: 0.2 to 0.5 mm. Fabric: relict clastic—incipient crystalloblastic (a low-grade quartzofeldspathic rock with the micaceous-argillaceous constituents completely reconstituted but no recrystallization of quartz and feldspar). Rock: *meta-arkose.*

Goldsmith #1 Republic Nat. Gas cuttings 2560-65 Bureau of Economic Geology

Oligoclase (50%), microcline microperthite (35%), quartz (10%), biotite (3%), calcite (1%), chlorite (1%), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite is a deeply colored green-brown variety. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Perkins #1 Stine core 2935 Humble Oil & Rfg. Co.

Albite-oligoclase and microcline (60%), quartz (25%), chlorite (5%), sericite (4%), epidote (3%), chert (2%), leucoxene (1%), apatite (tr), zircon (tr). Plagioclase is partly sericitized; microcline is locally microperthitic; quartz occurs as individual grains and as fragments of mosaic; epidote occurs in strings and lines of tiny grains that outline quartz and feldspar grain boundaries. Quartz and feldspar grains occur in a fine intergranular mass of quartz-feldspar-epidote-chlorite-sericite. Grain size: quartz and feldspar grains 0.1 to 1 mm; reconstituted intergranular material 0.02 mm and less. Fabric: relict clastic—incipient crystalloblastic. Rock: *metagraywacke.*

Texas #41 Byers cuttings 4250-55 Bureau of Economic Geology

Microcline microperthite, quartz, chlorite, magnetite. Slide is composed mostly of individual mineral fragments; only two small rock fragments are present. Grain size: 0.5 to 2 mm. Fabric: ? Rock: *granite.*

COCHRAN COUNTY

Cosden #1 Barker cuttings 8600-10 Bureau of Economic Geology

Plagioclase (72%), magnetite or ilmenite (10%), chlorite (10%), augite (4%), apatite (2%), quartz (2%), rutile? (tr). Plagioclase occurs in non-oriented sericitized laths, index of refraction suggests it is albite but the habit indicates a more calcic variety—the high soda content may be a result of the alteration; chlorite occurs in very large masses and includes small grains of rutile?; quartz appears to be secondary; augite occurs as relicts surrounded by chlorite. Grain size: plagioclase laths average 0.5 mm and reach a maximum of 2 mm long. Fabric: hypidiomorphic granular. Rock: altered *leuco-albite gabbro.*

Humble #1 Masten cuttings 10775-88 Shell Oil Co.

Quartz and alkali feldspar (100%), leucoxene (tr), pyrite (tr), calcite (tr). Microcrystalline quartz-feldspar rock showing flowage structure. Grain size: less than 0.02 mm. Fabric: microgranular. Rock: *rhyolite.*

Humble #1 Masten cuttings 10775-88 Shell Oil Co.

Groundmass (70%), microperthite (25%), pyrite (4%), calcite (1%). Cryptocrystalline groundmass shows well-developed flowage structure; phenocrysts are microperthite. Grain size: groundmass less than 0.01 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Masten core 10788 Bureau of Economic Geology

Groundmass (93%), microperthite (4%), calcite (3%), albite (tr), sericite (tr), quartz (tr), leucoxene (tr), pyrite (tr), apatite (tr). Groundmass is microcrystalline to cryptocrystalline and shows well-developed flowage structure; microperthite, albite, and quartz occur as phenocrysts; calcite occurs in masses and veinlets parallel and normal to flowage structure. Grain size: groundmass less than 0.02 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.* (Photomicrograph, Pl. VIII, D.)

Humble #1 Westheimer core 7393-94 Bureau of Economic Geology

Groundmass (85%), microperthite (7%), calcite (3%), quartz (2%), anhydrite (1%), albite (1%), magnetite or ilmenite (1%), leucoxene (tr), sericite (tr), hematite (tr), zircon (tr). Microcrystalline to cryptocrystalline groundmass shows flowage structure; microperthite and albite occur as phenocrysts; anhydrite occurs with quartz and calcite in a vug. Grain size: groundmass mostly less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Westheimer core 7393-94 Honolulu Oil Corp.

Groundmass (74%), microperthite (10%), quartz (10%), calcite (2%), anhydrite (2%), sericite (1%), magnetite or ilmenite (1%), leucoxene (tr), sphene (tr), zircon (tr). Groundmass is microcrystalline to cryptocrystalline with flowage structure well developed in cryptocrystalline areas; there is considerable secondary? quartz in the coarser areas; phenocrysts are mostly microperthite; some are anti-perthitic; one phenocryst has an albite core and a microperthite border; calcite and anhydrite occur in local coarse areas that originally may have been vesicles or pumicy openings; most of the quartz is in veinlets and local coarsenings. Grain size: groundmass cryptocrystalline to 0.2 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Shell #1 Pittman cuttings 11490-94 Bureau of Economic Geology

Plagioclase (55%), quartz (25%), microperthite (15%), leucoxene (4%), chlorite (1%), apatite (tr). Plagioclase is almost completely sericitized; microperthite is partly kaolinized; quartz occurs as masses of small grains between feldspar subhedrons. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *granodiorite.*

Stanolind #5 Edwards cuttings 12620-30 Shell Oil Co.

Quartz and feldspar (100%), chlorite (tr), leucoxene (tr). Microcrystalline to cryptocrystalline mass shows very pronounced flow structure; some coarser quartz is in augen and elongate lenses up to 0.2 mm long. Grain size: mostly less than 0.01 mm. Fabric: microgranular?; large part of rock is cryptocrystalline. Rock: *rhyolite?.*

Stanolind #5 Edwards cuttings 12620-30 Shell Oil Co.

Microperthite (95%), sericite (3%), calcite (1%), leucoxene (1%). Only one very small fragment. Grain size: 1 mm. Fabric: ?. Rock: probably a *rhyolite phenocryst.*

Stanolind #1 Reed core 12678 Bureau of Economic Geology

Groundmass (85%), quartz (8%), microperthite (3%), oligoclase (3%), leucoxene (1%), chlorite (tr), zircon (tr). Quartz-alkali feldspar groundmass is in part microspherulitic and in part micrographic with, locally, a vague flowage structure; quartz is in embayed phenocrysts; plagioclase and microperthite occur as phenocrysts. Grain size: groundmass cryptocrystalline to 0.05 mm but mostly less than 0.01 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Slaughter cuttings 10770 Shell Oil Co.

Groundmass (89%), microperthite (5%), leucoxene (4%), quartz (2%), magnetite or ilmenite (tr), sericite (tr). Groundmass is micrographic quartz-feldspar intergrowth; microperthite occurs as phenocrysts; quartz (2%) occurs also as local coarsenings. Grain size: groundmass less than 0.05 mm; phenocrysts up to 0.3 mm. Fabric: porphyritic. Rock: *rhyolite.*

Stanolind #1 Slaughter cuttings 10820-39 Shell Oil Co.

Groundmass (83%), albite (15%), sericite (1%), chlorite (1%), magnetite or ilmenite (tr), leucoxene (tr), zircon (tr), apatite (tr). Micrographic groundmass contains twinned partly kaolinized albite phenocrysts veined with sericite. Grain size: groundmass less than 0.01 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Slaughter core 10839-40 Stanolind Oil & Gas Co.

Groundmass (82%), albite (10%), biotite (1%), chlorite (3%), quartz (2%), magnetite or ilmenite (2%), leucoxene (tr), epidote (tr), zircon (tr), rutile (tr), apatite (tr), red iron oxide (tr). Microcrystalline to cryptocrystalline groundmass shows micrographic structure and is pervaded with red iron oxide stain; biotite is almost completely altered to chlorite; quartz occurs in a cross-cutting veinlet; albite phenocrysts show incipient kaolinization. Grain size: groundmass is microcrystalline to cryptocrystalline (less than 0.02 mm), phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Superior #1 Cameron core 11205-14 Shell Oil Co.

Groundmass (88%), albite (5%), microperthite (3%), quartz (2%), calcite (1%), leucoxene (1%), chlorite (tr), red iron oxide (tr). Microcrystalline to cryptocrystalline groundmass shows apparent relict vitroclastic structure and probably has a high chlorite content; feldspar and quartz fragments are scattered in groundmass like "phenocrysts." Grain size: groundmass mostly cryptocrystalline; "phenocrysts" up to 1 mm. Fabric: obscure—relict vitroclastic? Rock: *rhyolite tuff?*

COKE COUNTY

Barnsdall #2 Davenport core 5716-28 Humble Oil & Rfg. Co.

Albite-oligoclase (35%), microcline (24%), quartz (20%), biotite (12%), chlorite (7%), ilmenite and sphene (2%), calcite (tr), pyrite (tr), apatite (tr), zircon (tr). Plagioclase shows incipient alteration to sericite; microcline is locally microperthitic and, locally, occurs in large poikilitic masses including quartz grains; brown biotite is partly altered to chlorite; chlorite is locally associated with calcite and may be after hornblende; ilmenite envelops sphene. Grain size: 0.2 to 2 mm. Fabric: xenomorphic granular. Rock: *granodiorite.*

Hickock & Reynolds #1 Rawling cuttings 5630-35 Shell Oil Co.

Three slides show small fragments composed of alkali feldspar—microperthite?, quartz, calcite, leucoxene, sphene. Feldspar is partly sericitized. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular?. Rock: *granite* or *microgranite.*

Hickock & Reynolds #1 Rawling cuttings 5670-75 Shell Oil Co.

Microcline microperthite (77%), quartz (15%), albite (5%), myrmekite (2%), biotite (1%), leucoxene (tr). Quartz and feldspar grains show mutual embayment; biotite is partly altered. Grain size: 0.2 to 1 mm. Fabric: xenomorphic granular. Rock: *micrografite.*

Humble #9 Odam core 5517-25 Humble Oil & Rfg. Co.

Albite-oligoclase (40%), microcline microperthite (20%), quartz (18%), biotite (10%), chlorite (8%), ilmenite and sphene (2%), red iron oxide (1%), calcite (1%), pyrite (tr), zircon (tr), apatite (tr). Albite is locally partly sericitized; biotite is very dark red-brown; chlorite occurs with calcite, probably as a result of alteration of hornblende. Grain size: 0.5 to 6 mm. Fabric: hypidiomorphic to xenomorphic granular—poorly developed. Rock: *granodiorite.*

Humble #10 Odam core 6708-09 Humble Oil & Rfg. Co.

Albite-oligoclase (40%), microcline (30%), quartz (15%), biotite (7%), hornblende (5%), sphene (2%), magnetite or ilmenite (1%), chlorite (tr), calcite (tr), pyrite (tr), apatite (tr), zircon (tr). Plagioclase shows zonation and incipient alteration to sericite; microcline is locally microperthitic; biotite pleochroism is yellow-brown to dark brown; hornblende is deeply colored green-brown. Grain size: 0.5 to 5 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *granodiorite.*

COLEMAN COUNTY

Killam (Chandler) #1 Gill cuttings 3445-50 Bureau of Economic Geology

Oligoclase, quartz, microcline, biotite, hornblende, chlorite, calcite, sphene, apatite, zircon. Amounts of various minerals differ widely in different fragments. Quartz and feldspar occur in fractured, crushed, and strained grains, microcline is locally poikilitic; biotite is red-brown; hornblende is green; calcite and chlorite are derived from alteration of hornblende. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular—cataclastic. Rock: *granodiorite gneiss.*

Killam (Chandler) #1 Gill cuttings 3515-20 Bureau of Economic Geology

(1) Same as 3445-50.
(2) Quartz (43%), microperthite and oligoclase (40%), biotite (15%), pyrite (2%), apatite (tr). Red-brown biotite is in oriented plates; undulose quartz shows dimensional orientation. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *biotite schist.*

Killam (Chandler) #1 Gill cuttings 3575-80 Bureau of Economic Geology

(1) Fragments similar to those in 3515-20.
(2) Quartz, microcline and plagioclase, biotite, amphibole, diopside, scapolite, zoisite, pyrite, sphene, apatite. Amounts of various minerals differ widely in different fragments. Quartz shows dimensional orientation; plagioclase is partly sericitized; red-brown biotite is in oriented plates; amphibole is colorless. Grain size: 0.1 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *scapolite-diopside gneiss.*

Killam (Chandler) #1 Gill cuttings 3735-37 Bureau of Economic Geology

Andesine (41%), microcline (25%), quartz (10%), diopside (8%), amphibole (5%), calcite (3%), sericite-muscovite (3%), biotite (2%), zoisite (1%), sphene (1%), pyrite (1%), chlorite (tr), apatite (tr). Microcline is sporadically microperthitic; in some fragments diopside grains and red-brown biotite plates are oriented and more or less concentrated in layers—biotite seems to occur mostly in fragments poor in augite; locally pale brown or colorless amphibole includes diopside grains; a trace of secondary green hornblende is the result of alteration of diopside; sericite-muscovite locally replaces feldspar. The rock in general shows a layering expressed by variations in mineral content and grain size. Grain size: 0.1 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *diopside-quartz-microcline-andesine gneiss.*

Killam (Chandler) #1 Gill cuttings 3765-70 Bureau of Economic Geology

Microcline and oligoclase, diopside, scapolite, quartz, biotite, calcite, pyrite, sphene. Quartz and feldspar are in strained and dimensionally oriented grains; plagioclase is sericitized; large optically continuous masses of scapolite include oriented plates of red-brown biotite and grains of diopside; pyrite is in grains and veinlets. Grain size: 0.2 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *scapolite-diopside gneiss.*

Killam (Chandler) #1 Gill cuttings 3940-45 Bureau of Economic Geology

Same as 3765-70 but with an increase in calcite; slide also contains fragments of brecciated quartz-feldspar rock.

Killam (Chandler) #1 Gill cuttings 4045-50 Bureau of Economic Geology

Essentially same as 3940-45 but calcite is abundant and rock is a *diopside-calcite gneiss;* slide also contains fragments of brecciated quartz-feldspar rock.

Killam (Chandler) #1 Gill cuttings 4195-4200 Bureau of Economic Geology

Essentially same as 4045-50 but calcite predominates and rock is a *diopside marble;* slide also contains a cataclastically altered microcline-quartz-chlorite-sphene-calcite-pyrite rock.

Killam (Chandler) #1 Gill cuttings 4285-90 Bureau of Economic Geology

Similar to 4045-50 but with higher scapolite content.

Killam (Chandler) #1 Gill cuttings 4390-95 Bureau of Economic Geology

Similar to 3765-70 but rock is more coarsely crystalline; fragments of cataclastically altered quartz-microperthite-hornblende-sphene rock are present.

Killam (Chandler) #1 Gill cuttings 4525-30 Bureau of Economic Geology

Calcite-scapolite-diopside gneiss similar to 3940-45.

Naylor #1 Stone core 5338-48 Bureau of Economic Geology

Quartz (40%), microcline (35%), albite-oligoclase (25%), muscovite (tr), hornblende (tr), magnetite or ilmenite (tr), zircon (tr). Microcline is locally poikilitic and finely perthitic; plagioclase occurs in twinned subhedrons; some of the quartz is in large strained but optically continuous masses that include feldspar grains; feldspar shows incipient kaolinization. Grain size: 0.2 to 2 mm with poikilitic quartz grains up to 6 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *leuco-alkali granite.*

COLLINGSWORTH COUNTY

Superior of Cal. #1 Brown cuttings 5685-5710 Bureau of Economic Geology

Oligoclase-andesine (73%), quartz (10%), hornblende (10%), alkali feldspar (3%), biotite (2%), chlorite (1%), pyrite and magnetite or ilmenite (1%), apatite (tr), zircon (tr). Zoned plagioclase is locally in an advanced stage of sericitization; quartz shows incipient suturing and granulation; hornblende pleochroism is yellow-green to green; biotite is red-brown and locally partly altered to chlorite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

COMANCHE COUNTY

Gallagher & Lawson #1 Terry cuttings 5255-57 Bureau of Economic Geology

Fragments are mostly individual mineral grains, mostly alkali feldspar, plagioclase, apatite, muscovite, pyrite, magnetite or ilmenite, and red iron oxide. One rock fragment is composed of quartz and microperthite. Rock: *granite?*

COOKE COUNTY

Continental #1 Berry core 6032-33 Bureau of Economic Geology

Oligoclase-andesine (45%), microcline microperthite (20%), pyroxene? (10%), hornblende (6%), augite (6%), quartz (5%), biotite (3%), magnetite or ilmenite (2%), pyrite or pyrrhotite (1%), myrmekite (1%), chlorite (1%), apatite (tr), zircon (tr). Microcline microperthite occurs as discrete grains and as masses engulfing, embaying, and corroding plagioclase; magnetite or ilmenite, commonly associated with pyrite or pyrrhotite, occurs with ferromagnesian minerals; locally it is fringed with hornblende showing olive-green to brown pleochroism; biotite is a red-brown variety and locally contains vermicularly intergrown quartz; augite commonly contains blebs of opaque mineral in a closely spaced parallel orientation (schiller structure); pyroxene? is a pale brownish mineral locally showing anomalous extinction colors and commonly fringed with a fibrous green mineral. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *syenodiorite.*

Continental #1 Berry core 6032-33 Bureau of Economic Geology

Andesine (45%), microcline microperthite (20%), pyroxene? (10%), augite (6%), hornblende (6%), quartz (5%), biotite (3%), magnetite or ilmenite (2%), pyrite or pyrrhotite (1%), myrmekite (1%), chlorite (1%), apatite (tr), zircon (tr). Plagioclase is about An_{30} and occurs as twinned subhedrons; microcline microperthite shows very fine perthitic structure and occurs as discrete grains and as large masses engulfing and corroding plagioclase; the unidentified pyroxene is a brownish, optically negative mineral that shows anomalous extinction colors, two nearly right angle cleavages, a birefringence of about 0.016 and a small angle between Z and one cleavage; augite is tinted pale green and shows a parallel schiller structure in some grains; red-brown biotite locally contains myrmekitically intergrown quartz; hornblende occurs in irregular masses and its pleochroism is olive-green to brown; quartz is in myrmekite and in discrete grains; hornblende is in part altered to a moderately birefringent chlorite. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *syenodiorite.*

Continental #1 Whaley core 4277-87 Bureau of Economic Geology

Albite (40%), quartz (33%), biotite (15%), chlorite (10%), calcite (1%), opaque mineral (1%), zircon (tr), apatite (tr), sphene (tr), zeolite? (tr), zoisite (tr), tourmaline (tr), amphibole relicts (tr). Severely strained quartz occurs in a poorly sized mosaic with partly sericitized albite; albite is in part subhedral; biotite, pleochroism from pale tan to rich brown, occurs in plates and "nests"—although the biotite is very irregularly distributed and apparently not oriented in microscopic examination, megascopic view of the section shows a very rude orientation; chlorite occurs in large skeletal masses derived from alteration of poikilitic hornblende, in plates derived from alteration of biotite, and in veinlets; the apatite in this rock causes pleochroic halos in biotite; the opaque mineral, occurring in biotite cleavages, has a peculiar sparkling reflection and is probably hematite; zeolite or alkali feldspar occurs in a cross-cutting veinlet. Grain size: 0.2 to 1 mm. Fabric: granoblastic—poikiloblastic—gneissic. Rock: *biotite-quartz-albite gneiss.* (This rock is difficult to classify; possibly it is an igneous rock of dioritic composition that has suffered hydrothermal and cataclastic metamorphism; possibly it is a metasedimentary rock.)

Gulf Prod. #1 Donald cuttings 3010-15 Bureau of Economic Geology

(1) Quartz (70%), albite-oligoclase and alkali feldspar (20%), hornblende (7%), biotite (2%), magnetite or ilmenite (1%), chlorite (tr), apatite (tr). Quartz, locally showing dimensional orientation, occurs in a granoblastic mosaic with feldspar; oriented hornblende prisms show pale green rims and brownish cores—alteration is advanced in the cores; biotite is reddish brown. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *hornblendic metaquartzite.*

(2) Albite-oligoclase (58%), hornblende (30%), quartz (5%), biotite (5%), magnetite or ilmenite (2%), chlorite (tr), calcite (tr), apatite (tr). Oriented prisms of pale green, locally blue-green, hornblende with altered brownish cores occur in a plagioclase mosaic; the hornblende is partly altered to chlorite and calcite; biotite is red-brown; magnetite or ilmenite is in scattered grains. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *hornblende-oligoclase schist* or *amphibolite.*

Hollandsworth #31 Fette core 5000± Bureau of Economic Geology

Quartz (62%), dolomite (20%), chlorite (7%), sericite-muscovite (5%), pyrite (4%), albite (2%), apatite (tr). Quartz is in a granular aggregate with dolomite and shows orientation of long axes; dolomite also occurs in veinlets; sericite and muscovite are intimately associated with chlorite and occur in oriented frayed plates and fibers; chlorite is in frayed plates and in fine granular habit in veinlets. Grain size: 0.2 to 0.5 mm. Fabric: granoblastic—cataclastic. Rock: schistose *metaquartzite.*

Hollandsworth #31 Fette core 5105± Bureau of Economic Geology

Quartz (65%), biotite or phlogopite (15%), albite (5%), chlorite (4%), sillimanite (4%), epidote (3%), amphibole? (3%), calcite (1%), apatite (tr), monazite (tr). Quartz occurs in an aggregate of strained grains with fair dimensional orientation; biotite or phlogopite, almost colorless to pale green-brown, occurs in oriented plates and shows halos around monazite?; chlorite occurs in smeared masses with altered remnants of sillimanite; sillimanite is present as fibrous, locally folded, altered relicts in bundles of needles; epidote, possibly including some clinozoisite, occurs in very small grains forming "fuzzy strings" around pockets of altered minerals and along grain boundaries; pale green amphibole needles occur throughout the slide; albite forms the mosaic with quartz. Grain size: 0.2 to 0.8 mm. Fabric: crystalloblastic. Rock: *sillimanite-biotite schist.* (Photomicrograph, Pl. VI, A.)

Kadane & Sons #1 Coursey core 2960-62 Humble Oil & Rfg. Co.

Quartz (54%), albite-oligoclase (25%), hornblende (15%), chlorite (4%), epidote (1%), magnetite or ilmenite (1%), sphene (tr), biotite (tr). Plagioclase may also include some alkali feldspar; hornblende, pleochroism pale yellowish to green, occurs in prisms in parallel orientation; epidote, probably including some zoisite, occurs in tiny scattered grains; chlorite is in scattered patches. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *feldspathic hornblende schist.*

McElreath & Suggett #1 Whaley core 2312-40 Bureau of Economic Geology

Quartz and albite-oligoclase (66%), chlorite (12%), garnet (10%), biotite (8%), sericite (4%), magnetite or ilmenite (tr), leucoxene (tr), pyrite (tr), apatite (tr). Quartz and albite-oligoclase form a fractured mosaic in which quartz is predominant; chlorite is derived from alteration of biotite and garnet and occurs in sheaves, plates, and fibrous masses throughout the slide—locally it shows parallel orientation; garnet relicts occur in a mass of chlorite and sericite indicating a retrogressive metamorphism; biotite pleochroism is pale brown to very dark brown. Grain size: 0.2 to 1 mm with garnets up to 2 mm. Fabric: crystalloblastic—cataclastic (apparently a crystalloblastic medium-grade garnetiferous schist has suffered cataclastic retrograde metamorphism). Rock: *biotite-garnet schist.* (Photomicrograph, Pl. V, A.)

McElreath & Suggett #1 Whaley cuttings 2312-40 Bureau of Economic Geology

Quartz, feldspar, chlorite, biotite, magnetite or ilmenite, garnet. Mass of quartz and feldspar contains chlorite and biotite showing a rude orientation; garnet remnants occur in masses of dark chlorite. Grain size: 0.2 to 0.5 mm. Fabric: crystalloblastic. Rock: *biotite-garnet-chlorite schist.*

McElreath & Suggett #1 Whaley core 2330 Bureau of Economic Geology

Albite-oligoclase and quartz (66%), biotite (15%), chlorite (10%), garnet (8%), magnetite or ilmenite (1%), apatite (tr). Locally crushed plagioclase-quartz mosaic is composed predominantly of plagioclase; chlorite occurs in oriented plates, sheaves, and fibrous masses associated with relict garnets; biotite, yellow-brown to brown pleochroism, occurs in oriented plates partly altered to chlorite; relict garnet porphyroblasts occur in nests of chlorite-biotite-sericite and are more or less concentrated in layers. Grain size: 0.2 to 1 mm. Fabric: crystalloblastic—cataclastic (retrograde metamorphism, garnet→chlorite). Rock: *garnet-biotite-oligoclase schist.*

Muenster #1 Josten cuttings 3160 Bureau of Economic Geology

Quartz (40%), oligoclase (35%), hornblende (12%), biotite (6%), alkali feldspar (5%), calcite (1%), apatite (1%), magnetite or ilmenite (tr). Quartz-oligoclase mosaic contains oriented prisms of partly altered blue-green hornblende and oriented plates of brown biotite. Slide is composed of very small fragments and the mineral percentages above are only an estimate. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *hornblende-oligoclase schist.*

Muenster #1 Josten cuttings 3165 Bureau of Economic Geology

Quartz and albite-oligoclase (80%), biotite (12%), chlorite (5%), magnetite or ilmenite (1%), calcite (1%), apatite (1%). Plagioclase and quartz occur in a mosaic with grains showing dimensional orientation; green-brown biotite partly altered to chlorite occurs in oriented plates. Grain size: 0.1 to 0.2 mm. Fabric: lepidoblastic. Rock: *biotite schist.*

Muenster #1 Josten cuttings 3578-3652 Bureau of Economic Geology

Quartz and oligoclase (71%), hornblende (15%), biotite (7%), calcite (4%), magnetite or ilmenite (1%), red iron oxide (1%), apatite (1%), pyrite (tr), sphene (tr). The quartz-oligoclase mosaic is composed predominantly of quartz; oriented hornblende prisms are faded and in part altered to calcite; biotite forms oriented green-brown plates. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *hornblende-oligoclase schist.*

Phillips #1-CT Atcheson core 2263-71? Bureau of Economic Geology

Rock is a conglomerate. Rock and mineral fragments occur in a brown microcrystalline to cryptocrystalline matrix that is probably a micaceous, chloritic paste. (1) Rock fragment—1 cm long; essentially a monomineralic fragment composed of non-oriented colorless amphibole grains up to 1 mm and veined with chlorite. (2) Rock fragment—8 mm long; amphibole (87%), chlorite (10%), muscovite (3%); rock has pronounced schistosity. (3) Slate or phyllite fragments. (4) Fragments of quartz mosaic. (5) Grains of magnetite or ilmenite, sphene, and calcite. (6) Some completely sericitized fragments. The conglomerate is composed mostly of fragments of basic rocks—for the most part amphibole-rich rocks, schistose or massive, and amphibole fragments of varied grain size and in various stages of alteration to chlorite and, to a lesser extent, zoisite. Fragments are set in a brownish-green matrix which also contains quartz pebbles. Note lack of feldspar. Rock: weakly metamorphosed pebble conglomerate—*a conglomeratic metagraywacke.* (Photomicrograph, Pl. V, D.)

Phillips #3 Atcheson cuttings 2165-70 Bureau of Economic Geology

Quartz (77%), biotite (8%), epidote (8%), muscovite (5%), hornblende (1%), chlorite (1%), magnetite or ilmenite (tr). Quartz mosaic locally shows granulation and dimensional orientation; muscovite, biotite (red-brown), epidote, chlorite, and hornblende occur together in patches; muscovite tends to be porphyroblastic; biotite is locally bleached and sheared; hornblende pleochroism is yellow-green to green. Mineral percentages vary in different fragments. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic (granoblastic to sieve). Rock: *metaquartzite.*

Phillips #3 Dangle cuttings 2517-19 Bureau of Economic Geology

Microcline microperthite (69%), oligoclase (15%), quartz (10%), biotite (2%), calcite (2%), chlorite (1%), magnetite or ilmenite (1%), apatite (tr), zircon (tr). Microcline shows very fine perthitic development; quartz locally is myrmekitically to micrographically intergrown with feldspar; biotite pleochroism is yellow-brown to almost black; chlorite occurs with calcite as a result of alteration of a ferromagnesian mineral. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular—poikilitic. Rock: *granite.*

Phillips #3 Dangle core 2517-19 Humble Oil & Rfg. Co.

Microcline microperthite (64%), albite (15%), calcite (8%), quartz (7%), biotite (3%), magnetite or ilmenite (2%), chlorite (1%), apatite (tr), zircon (tr). Microcline shows extremely fine perthitic development and occurs in large grains with albite; ferromagnesian minerals and their alteration products plus the accessory minerals occur in "nests" between large feldspars; calcite occurs in part in veinlets and in part was derived from alteration of feldspar and hornblende?; biotite pleochroism is yellow-brown to very dark brown. Grain size: 1 to 6 mm. Fabric: xenomorphic granular. Rock: *granite.*

Phillips #1 Fielder cuttings 2935-40 Bureau of Economic Geology

Microcline microperthite (76%), quartz (15%), albite (5%), chlorite (3%), biotite (1%), calcite (tr), leucoxene (tr), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Microcline microperthite is in large poikilitic grains; red-brown biotite is considerably altered; fine granular chlorite occurs in veinlets with calcite and locally replaces feldspar. Grain size: 0.5 to 3 mm. Fabric: xenomorphic granular—poikilitic. Rock: *granite.*

Phillips #1 Reitar core 3216 Bureau of Economic Geology

Microcline microperthite (72%), quartz (15%), oligoclase (5%), chlorite (3%), myrmekite (2%), calcite (1%), magnetite or ilmenite (1%), biotite (1%), zircon (tr), leucoxene (tr), sphene (tr), apatite (tr). Quartz, plagioclase, and myrmekite for the most part occur as small grains along the borders of large microcline grains; biotite pleochroism is pale red-brown to almost black and, with the other heavy minerals, it occurs in nests between large microcline grains. Grain size: average 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Phillips #2-A Reitar core 3253-56 Bureau of Economic Geology

Microcline microperthite (65%), oligoclase (10%), quartz (10%), calcite (5%), myrmekite (3%), chlorite (2%), biotite (4%), magnetite or ilmenite (1%), zircon (tr), sphene (tr). Mineral relations same as 3216. Rock: *granite.*

COTTLE COUNTY

Anderson-Prichard #1 Lynch cuttings 5810-20 Shell Oil Co.

Albite (72%), quartz (15%), biotite (5%), chlorite (5%), magnetite or ilmenite (3%), apatite (tr), zircon (tr). Plagioclase is zoned and shows advanced sericitization; original ferromagnesian minerals have altered to chlorite and leucoxene. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-albite-quartz microdiorite.*

Anderson-Prichard #1 Lynch cuttings 5820-30 Bureau of Economic Geology

Albite-oligoclase (67%), quartz (15%), microcline (8%), chlorite (6%), biotite (2%), magnetite or ilmenite (2%), apatite (tr), red iron oxide (tr). Plagioclase is zoned and variably sericitized; chlorite is in large laths probably as a result of alteration of biotite; biotite pleochroism is yellow-brown to dark brown—it is partly altered to chlorite; microcline fills in around plagioclase and quartz grains. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

General Crude #13-1 Swenson core 5410-23 Bureau of Economic Geology

Albite-oligoclase (51%), chlorite (10%), alkali feldspar (8%), quartz (7%), epidote (5%), calcite (5%), biotite (5%), amphibole (4%), ilmenite (2%), leucoxene (1%), bleached biotite (1%), apatite (1%), sphene (tr). Plagioclase is in part altered to sericite or sericite and epidote; chlorite is in sheaves, spherulitic masses, and veinlets—it veins plagioclase and replaces ferromagnesian minerals; quartz, commonly associated with alkali feldspar, is interstitial to larger plagioclase subhedrons; calcite occurs in veinlets and masses and in close association with altered ferromagnesian minerals from which it was derived as an alteration product; epidote occurs as grains and masses as a result of alteration of plagioclase and ferromagnesian minerals; green-brown biotite occurs in aggregates of tiny non-oriented plates with chlorite and epidote and is apparently a secondary mineral; pale green amphibole relicts are engulfed by chlorite and calcite; bleached biotite is partly altered to chlorite. Grain size: 0.5 to 4 mm. Fabric: hypidiomorphic granular—metasomatic. Rock: altered *quartz diorite.*

General Crude #13-1 Swenson core 5719-22 Bureau of Economic Geology

Feldspar and sericite (79%), biotite (8%), quartz (7%), magnetite or ilmenite and leucoxene (5%), chalcedonic silica (1%), apatite (tr). Feldspar is mostly a partly sericitized plagioclase; sericite occurs as a result of plagioclase alteration and also forms a network of oriented intergranular fibers—locally these have developed into small muscovite plates; green-brown biotite occurs as small plates without preferred orientation; quartz is in angular to subangular scattered grains; chalcedonic silica showing spherulitic extinction fills cross-cutting veinlets. In summary, rock consists of clear angular quartz grains and "nests" of biotite in a mass of sericitized feldspar grains and intergranular sericite. Grain size: 0.01 to 0.1 mm. Fabric: relict clastic—crystalloblastic. Rock: very low grade *sericite phyllite.*

General Crude #33-1 Swenson core 5449-52 Bureau of Economic Geology

Microcline and albite (53%), quartz (38%), biotite (7%), magnetite or ilmenite (2%), chlorite (tr), apatite (tr), zircon (tr). Quartz, albite, and microcline form a mosaic in which there are large porphyroblasts of albite and, to a lesser extent, microcline partly replaced by albite; biotite showing pale to very dark brown pleochroism occurs in scattered plates; magnetite or ilmenite occurs in grains partly altered to red iron oxide; apatite is in clusters of prisms and grains. Some feldspathic material was probably introduced. Grain size: mosaic 0.1 to 0.2 mm; porphyroblasts 1 to 2 mm. Fabric: porphyroblastic. Rock: *metarkosite.*

Humble #1-J Matador core 8082-87 Humble Oil & Refg. Co.

Plagioclase (51%), quartz (20%), sericite (20%), microcline (5%), chlorite (3%), calcite (1%), pyrite (tr), leucoxene (tr), rock fragments (tr), apatite (tr), zircon (tr). Plagioclase is almost completely sericitized and grains merge with intergranular sericite so that their boundaries are difficult to distinguish; quartz is in scattered angular grains; sericite, locally showing rude parallel orientation, occurs as masses of fibers and originated through reconstitution of intergranular argillaceous material (some fine quartz and feldspar are included in this figure); microcline shows incipient kaolinization; calcite occurs with quartz in veinlets; rock fragments are granitic. Grain size: quartz and feldspar fragments 0.1 to 0.5 mm; intergranular material mostly less than 0.02. Fabric: relict clastic—incipient crystalloblastic. Rock: *sericite phyllite.*

Jones & Stasney #1 Wiley cuttings 4850-55 Bureau of Economic Geology

Albite (50%), sericite and very fine granular quartz and feldspar (32%), quartz (12%), rock fragments (3%), chlorite (2%), magnetite or ilmenite, leucoxene, and red iron oxide (1%), apatite (tr), zircon (tr). Quartz and albite occur as angular grains in a mat of finely fibrous sericite and as a fine granular mass of quartz and feldspar; sericite is also present as a result of plagioclase alteration; chlorite occurs with sericite as fine plates and fibers and in one fragment occurs abundantly as oriented fibers so that the rock might be called phyllite; rock fragments are mostly chert and quartzite. Grain size: 0.2 to 0.4 mm. Fabric: relict clastic—incipient crystalloblastic. Quartz and feldspar have not recrystallized but intergranular material has been reconstituted to sericite and chlorite. Rock: *meta-arkose.*

Jones & Stasney #1 Wiley cuttings 4900-05 Bureau of Economic Geology

Similar to 4850-55 but with calcite locally replacing part of the rock and an increase in the opaque iron and/or titanium minerals.

Jones & Stasney #1 Wiley cuttings 4950-55 Bureau of Economic Geology

Albite-oligoclase (73%), microcline microperthite (10%), quartz (10%), chlorite (3%), sericite and fine granular quartz and feldspar (3%), epidote (1%), magnetite or ilmenite (tr), muscovite (tr), apatite (tr), zircon (tr). Albite-oligoclase occurs as angular grains and locally is in an advanced stage of sericitization; quartz and microcline microperthite occur as angular grains; chlorite occurs with sericite as intergranular plates and fibers; muscovite is evidently a second cycle mineral and not, like sericite and chlorite, the result of reconstitution. Grain size: 0.2 to 0.4 mm. Fabric: relict clastic—incipient crystalloblastic. Rock: *meta-arkose.*

Jones & Stasney #1 Wiley cuttings 5000-05 Bureau of Economic Geology

(1) Fragments similar to 4850-55 and 4950-55; one fragment shows pronounced dimensional orientation of grains.
(2) A few fragments of altered igneous rock: plagioclase (59%), chlorite (20%), epidote (20%), magnetite or ilmenite (1%), calcite (tr). Plagioclase occurs as non-oriented laths and is partly altered to sericite and epidote—on basis of index of refraction it is albite, probably as a result of alteration (calcic plagioclase→albite and epidote); epidote occurs in masses and clusters of small grains, mostly from alteration of plagioclase. Grain size: plagioclase laths 0.2 to 0.5 mm long. Fabric: relict subophitic. Rock: altered *diabase.*

Jones & Stasney #1 Wiley cuttings 5050-55 Bureau of Economic Geology

Contains fragments similar to 4850-55 and 4950-55. (Photomicrograph, Pl. V, C.)

Jones & Stasney #1 Wiley cuttings 5100-05 Bureau of Economic Geology

Albite-oligoclase and microcline microperthite (83%), quartz (10%), hematite?, red iron oxide, and leucoxene (3%), sericite (3%), chlorite (1%), rock fragments (tr), epidote (tr), apatite (tr), zircon (tr). Partly sericitized plagioclase and partly kaolinized microcline microperthite occur with quartz as angular grains separated by fibers of sericite and chlorite and by rims of hematite? and grains of leucoxene. Rock fragments are apparently rhyolite? and chert. Grain size: 0.1 to 0.5 mm. Fabric: relict clastic—incipient crystalloblastic. Rock: *meta-arkose.*

Jones & Stasney #1 Wiley cuttings 5150-55 Bureau of Economic Geology

Contains fragments similar to types previously described.

Jones & Stasney #1 Wiley cuttings 5200-05 Bureau of Economic Geology

Contains fragments similar to those previously described, but a number of fragments show a higher hematite? content.

Jones & Stasney #1 Wiley cuttings 5245 Bureau of Economic Geology

Contains fragments similar to types previously described, but locally opaque iron and/or titanium minerals (magnetite or ilmenite, hematite?, leucoxene, and pyrite) are so concentrated as to comprise as much as 20 percent of the rock fragment.

Merry Bros. & Perini #1 Pursell cuttings 4659-4740 Humble Oil & Rfg. Co.

(1) Alkali feldspar and albite (62%), quartz (20%), biotite (8%), sericite (5%), epidote (2%), chlorite (2%), calcite (1%), ilmenite (tr), leucoxene (tr), zircon (tr), apatite (tr). Albite is partly sericitized; quartz and feldspar are in angular fragments which commonly show dimensional orientation; green-brown biotite occurs as reconstituted intergranular material, locally poorly developed plates have formed; sericite occurs as a result of alteration of feldspar and as reconstituted intergranular fibers. Grain size: 0.1 to 0.2 mm. Fabric: relict clastic—incipient crystalloblastic (quartz and feldspar are not recrystallized). Rock: *meta-arkose.*

(2) Feldspar (65%), quartz (25%), sericite and muscovite (6%), chlorite (4%), calcite (tr), epidote (tr), apatite (tr). Feldspar is mostly albite, locally porphyroblastic; sericite is in part from alteration of plagioclase and in part from reconstitution; there are some muscovite flakes. Grain size: 0.05 to 0.2 mm. Fabric: granoblastic. Rock: *metarkosite.* (This rock seems to be a more highly metamorphosed equivalent of (1) above in which quartz and feldspar have recrystallized.)

Ramsey #1 Lynch cuttings 5670-80 Bureau of Economic Geology

Oligoclase (52%), quartz (10%), biotite (10%), chlorite (10%), amphibole (8%), augite (4%), alkali feldspar (3%), epidote (2%), magnetite or ilmenite (1%), calcite (tr), two unidentified accessory minerals (tr). Zoned plagioclase is partly sericitized and locally contains inclusions of fine needles of an unidentified mineral; biotite pleochroism is yellow or red-brown to almost opaque; amphibole, pale brown to deep green-brown pleochroism, occurs in skeletal grains and is partly altered to chlorite; epidote is the result of alteration of amphibole. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Seaboard and Shamrock #1 Tapper core 6655 Humble Oil & Rfg. Co.

Albite and microcline microperthite (68%), quartz (20%), sericite (8%), chlorite (2%), chert (1%), epidote (1%), rhyolite (tr), carbonate (tr), sphene (tr), ilmenite (tr), leucoxene (tr), red iron oxide (tr), apatite (tr), zircon (tr). Feldspar and quartz occur as angular grains associated with chert and rhyolite rock fragments; grains are separated by sericite, chlorite, and epidote. Grain size: 0.1 to 0.5 mm. Fabric: relict clastic—incipient crystalloblastic (quartz and feldspar are not recrystallized). Rock: *meta-arkose.*

CRANE COUNTY

Atlantic #2-A University core 11642-45 Bureau of Economic Geology

Hornblende (35%), oligoclase-andesine (22%), alkali feldspar (15%), biotite (12%), quartz (10%), myrmekite (2%), sphene (2%), pyrite (1%), leucoxene (1%), calcite (tr), apatite (tr), zircon (tr). Hornblende, pleochroism yellow-green to green, commonly occurs in large poikilitic grains, and commonly it includes small highly birefringent needles of an unidentified mineral; biotite pleochroism is beige to rich brown; alkali feldspar is probably orthoclase; sphene is partly altered to leucoxene. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *mela-granodiorite.*

Loffland #3 Tubbs cuttings 7120-60 Stanolind Oil & Gas Co.

Microcline (60%), quartz (25%), albite (15%), muscovite (tr), calcite (tr), rutile (tr), zircon (tr). Slide is composed of only small fragments. Grain size: 2 to 3 mm. Fabric: ? Rock: *granite.*

CROCKETT COUNTY

Amerada #1-D Shannon cuttings 7825-30 Shell Oil Co

Albite (40%), microcline (29%), quartz (20%), muscovite and sericite (8%), biotite (2%), magnetite or ilmenite (1%), apatite (tr), leucoxene (tr). Plagioclase is partly sericitized; biotite is a green-brown variety. Grain size: 0.2 mm. Fabric: xenomorphic granular. Rock: *albite microgranodiorite.*

Amerada #1-D Shannon cuttings 7830-35 Shell Oil Co.

Microcline (37%), albite (32%), quartz (25%), muscovite and sericite (2%), magnetite or ilmenite (2%), biotite (1%), chlorite (1%), leucoxene (tr), calcite (tr), pyrite (tr), zircon (tr). Plagioclase is partly sericitized. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Amerada #1-D Shannon cuttings 7834-35 Bureau of Economic Geology

Microcline (36%), oligoclase (27%), quartz (25%), biotite (7%), chlorite (3%), magnetite or ilmenite (2%), muscovite (tr), pyrite (tr), apatite (tr), calcite (tr). Plagioclase is partly sericitized and kaolinized; biotite is very deeply colored; chlorite, bright green, was derived from alteration of biotite; muscovite apparently replaces plagioclase. Grain size: 0.5 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranite.*

CROSBY COUNTY

Deep Rock #2 Morgan Jones cuttings 8760-70 Bureau of Economic Geology

Fragments of quartz and microperthite; original rock probably granitic.

Humble #1 Irvin core 9947 Bureau of Economic Geology

Andesine-labradorite (60%), hornblende (28%), chlorite (4%), ilmenite (3%), alkali feldspar (3%), sphene (1%), epidote (1%), apatite (tr). Twinned plagioclase subhedrons show a vague zoning with sericitized cores; oriented prisms of hornblende, yellow-green to grass-green pleochroism, are partly altered to chlorite; alkali feldspar is in a sponge containing plagioclase inclusions; sphene occurs in large grains and as rims on ilmenite; the whole rock is fractured and brecciated. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—gneissic. Rock: *diorite gneiss.* (Photomicrograph, Pl. VI, B.) (Note: Hand specimen of the core shows a granitic stringer 1 inch thick cutting the diorite at a high angle.)

Humble #1 Montgomery cuttings 9700-07 Bureau of Economic Geology

Albite-oligoclase (34%), quartz (25%), microcline (20%), calcite (15%), chlorite (4%), muscovite (2%), apatite (tr). Plagioclase is in an advanced stage of sericitization; quartz is fractured, crushed, brecciated; calcite fills fractures and cements breccia; muscovite is warped and bent. Grain size: less than 0.05 mm (crushed) to 2 mm. Fabric: cataclastic. Rock: cataclastically altered *granodiorite.* (Note: Polished core section indicates the granodiorite occurs as pebbles in a conglomerate.)

Humble #1 Montgomery core 9704-07 Humble Oil & Rfg. Co.

Polished core section shows the rock to be a pebble conglomerate. Albite-oligoclase (57%), quartz (20%), calcite (7%), sericite (6%), rock fragments (5%), ilmenite (4%), leucoxene (1%), zircon (tr), amphibole (tr), apatite (tr). Fractured plagioclase grains and subordinate alkali feldspar are cut by a mesh of sericite veinlets; quartz occurs in patches of sutured mosaic and sporadic individual grains; calcite veinlets fill fractures and locally appear to be sheared; rock fragments are mostly volcanic rocks; ilmenite is rimmed with leucoxene. Grain size: 1 to 3 mm. Fabric: clastic—cataclastic. Rock: *metaconglomerate.*

Humble #1 Montgomery cuttings ? Shell Oil Co.

Albite (66%), quartz (20%), sericite (8%), biotite (4%), calcite (1%), leucoxene (1%), zircon (tr), apatite (tr). Plagioclase is partly sericitized; biotite is bleached. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-quartz diorite.*

Ohio #1 Morgan Jones cuttings 8635-36 Shell Oil Co.

Albite (85%), quartz (15%), magnetite or ilmenite (tr), apatite (tr). Grain size and fabric similar to 8635-36 (next below). Rock: *leuco-albite-quartz diorite?.*

Ohio #1 Morgan Jones cuttings 8635-36 Shell Oil Co.

Microperthite (84%), quartz (15%), amphibole (1%). Small fragment; plagioclase in microperthite occurs as irregular veins and irregular twinned masses; amphibole is deeply colored and only one grain is present. Grain size: 2 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Ohio #1 Morgan Jones cuttings 8636-38 Shell Oil Co.

Microperthite (88%), quartz (10%), altered biotite (2%). Grain size: 2 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Summation of the three poor thin sections of cuttings from the Ohio #1 Morgan Jones 8635-36 and 8636-38 indicates a rock that is probably a granite or granodiorite.

CULBERSON COUNTY

Magnolia #1-A Cowden core 8760-70 Bureau of Economic Geology

Oligoclase (73%), microcline microperthite (15%), biotite (5%), calcite (4%), chlorite (3%), apatite (tr), sericite (tr), quartz (tr), zircon (tr). Plagioclase is zoned and probably ranges from albite to andesine; there are a few flakes of sericite from alteration of feldspar but for the most part the feldspar is kaolinized; calcite is associated with and replaces biotite and chlorite and fills interstices between feldspar subhedrons; biotite is a pale brown to reddish-brown variety that is partly altered to chlorite; quartz occurs with calcite as a secondary open-space filling; apatite occurs in long needles and in more or less equant grains. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: *syenodiorite.* [This rock occurs as a tabular intrusive body within the Pennsylvanian section—not basement.]

DALLAM COUNTY

Pure #1 Sneed Heirs cuttings 6775-79 Bureau of Economic Geology

Microcline microperthite (63%), quartz (20%), plagioclase (15%), biotite (2%), magnetite or ilmenite (tr), leucoxene (tr), sphene (tr), pyrite (tr), apatite (tr). Plagioclase is partly sericitized; quartz is fractured and fractures are filled with pyrite; sphene is partly altered to leucoxene; biotite is red-brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Texas #1 Capitol Frechold Land Trust core 6168-69 Stanolind Oil & Gas Co.

Groundmass (76%), albite (15%), quartz (7%), magnetite (2%), calcite (tr), chlorite (tr), fluorite (tr), zircon (tr), apatite (tr). Microcrystalline micrographic groundmass is stained red and shot through with veinlets containing quartz, calcite, and fluorite; albite phenocrysts are partly altered to sericite; some of the quartz is in veinlets and some occurs as round phenocrysts. Grain size: groundmass up to 0.05 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Texas #1 Capitol Freehold Land Trust cuttings 6169 Bureau of Economic Geology

Groundmass (77%), plagioclase (15%), magnetite or ilmenite (5%), quartz (2%), chlorite (1%). Groundmass shows advanced kaolinization; it is mostly micrographic with equi-extinguishing patches 0.2 mm in diameter; plagioclase phenocrysts show advanced sericitization; magnetite or ilmenite occurs in large masses and in vugs with secondary quartz and apatite. Grain size: groundmass 0.1 to 0.2 mm; phenocrysts 1 to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

DEAF SMITH COUNTY

Humble #1 Hyslop | cuttings 7750-7800 | Humble Oil & Rfg. Co.

Labradorite (54%), augite (30%), magnetite or ilmenite (10%), chlorite (4%), calcite (2%), apatite (tr). Plagioclase is in zoned laths in a more or less triangular pattern; augite is locally in continuous large grains enclosing plagioclase laths and locally in small grains between plagioclase laths; chlorite occurs in masses and veinlets and has a rather high birefringence; apatite is in needles. Grain size: plagioclase 0.2 to 0.4 mm; continuous augite grains up to 2 mm. Fabric: ranges from ophitic to subophitic. Rock: *diabase.*

Humble #1 Hyslop | core 7803-05 | Humble Oil & Rfg. Co.

Groundmass (87%), albite (5%), microperthite (4%), quartz (3%), leucoxene (1%), red iron oxide (tr), ilmenite (tr), calcite (tr), apatite (tr), zircon (tr). Groundmass is a fine granular mass of quartz and alkali feldspar showing flowage structure around phenocrysts; albite is in twinned and corroded phenocrysts; microperthite with poor perthitic development occurs as phenocrysts; quartz is present as corroded and embayed phenocrysts. Grain size: groundmass 0.01 to 0.02 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

DENTON COUNTY

Hunt #1 Martin | core ? | Stanolind Oil & Gas Co.

Andesine (69%), augite (10%), hornblende (10%), chlorite (4%), magnetite or ilmenite (2%), epidote (3%), biotite (2%), pyrite (tr), apatite (tr). Plagioclase subhedrons show a rude orientation; augite is partly altered; hornblende pleochroism is pale brown to brown-green; epidote occurs in grains, groups of grains, and veinlets; magnetite or ilmenite accommodates itself to the other grains in the slide and is evidently late-magmatic; pyrite is in a veinlet. Grain size: 0.3 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microdiorite.*

Jenkins, Kelsey, Jones & Eubanks #1 Waide | core 1882 | Bureau of Economic Geology

Oligoclase and quartz (74%), biotite (12%), epidote (8%), garnet (4%), chlorite (1%), calcite (1%), sphene (tr), apatite (tr), zircon (tr). Vaguely zoned plagioclase and quartz form an aggregate in which plagioclase is predominant; euhedral and subhedral garnet crystals occur in nests of brown biotite and epidote—the biotite-epidote-garnet nests are more or less concentrated in layers. Grain size: 0.5 to 1 mm. Fabric: crystalloblastic—gneissic Rock: *garnet-epidote-biotite-quartz-oligoclase gneiss.*

Texas #1 Yeatts | core 2013 | Bureau of Economic Geology

Andesine (60%), amphibole (35%), magnetite or ilmenite (4%), biotite (1%), apatite (tr). Andesine forms a granular aggregate of twinned and untwinned grains; two varieties of amphibole are present: (1) green-brown hornblende in more or less oriented prisms and (2) colorless amphibole—cummingtonite? thinly rimmed with blue-green hornblende; the green-brown hornblende is more or less concentrated in layers; biotite commonly fringes the opaque mineral. Grain size: 0.2 mm. Fabric: crystalloblastic—gneissic. Rock: *hornblende-andesine gneiss* or *amphibolite.*

DICKENS COUNTY

Humble #3 Matador | core 7735-37 | Humble Oil & Rfg. Co.

Andesine (43%), biotite (20%), hornblende (15%), quartz (12%), alkali feldspar (8%), pyrite and magnetite or ilmenite (2%), apatite (tr), epidote (tr). Zoned plagioclase locally has sericitized cores; biotite is reddish brown; hornblende pleochroism is yellow-green to green; epidote is derived from alteration of plagioclase; alkali feldspar is apparently microperthite. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Humble #3 Matador | core 7735-37 | Humble Oil & Rfg. Co.

Micrographically intergrown quartz and microcline microperthite (99%), magnetite or ilmenite (1%), chlorite (tr), sphene (tr), muscovite (tr), calcite (tr), bleached biotite (tr), zircon (tr), pyrite (tr). Grain size: intergrowth 0.2 mm; equi-extinguishing patches up to 5 mm. Fabric: micrographic. Rock: *micrographic granite.*

Humble #2-F Matador core 7535-42 Humble Oil & Rfg. Co.

Rock is transversed by a distinct plane separating coarser and finer types.

(1) Plagioclase (54%), quartz (20%), microperthite (10%), sericite (10%), calcite (3%), red iron oxide (2%), leucoxene (1%), magnetite or ilmenite (tr), chlorite (tr), sphene (tr), epidote (tr), apatite (tr), zircon (tr). Rock is composed of angular grains of partly sericitized plagioclase, quartz, and microperthite in a mass of intergranular fibers of sericite; red iron oxide outlines grain boundaries; quartz-calcite veinlets are parallel to the bedding plane. Grain size: 0.01 to 0.1 mm. Fabric: clastic—crystalloblastic; no recrystallization of quartz and feldspar. Rock: *meta-arkose.*

(2) Similar to (1) above but with more sericite and epidote. Grain size: mostly less than 0.02 mm. Fabric: clastic—crystalloblastic. Rock: *meta-argillite.*

Humble #2-F Matador core 7535-42 Humble Oil & Rfg. Co.

Same as 7535-42.

Humble #1-G Matador cuttings 8230-40 Shell Oil Co.

Microperthite (69%), quartz (30%), altered ferromagnesian mineral (1%), biotite (tr), chlorite (tr), apatite (tr). Microperthite is partly kaolinized; one grain shows micrographic intergrowth with quartz; quartz is severely strained; biotite is partly altered to chlorite; ferromagnesian mineral is so altered as to be nearly opaque. Grain size: 0.1 to 2 mm. Fabric: ranges from hypidiomorphic granular to micrographic. Rock: *granite.*

Humble #1-G Matador core 8246-48 Humble Oil & Rfg. Co.

Quartz (52%), microcline microperthite (25%), oligoclase (18%), biotite (4%), chlorite (1%), ilmenite (tr), leucoxene (tr), fluorite (tr), sphene (tr), zircon (tr), apatite (tr). Quartz is in large grains showing strain and "welded" structure and in micrographic intergrowth with potassium feldspar; green-brown biotite is in thin deeply colored plates. Grain size: 2 to 6 mm. Fabric: ranges from hypidiomorphic granular to micrographic. Rock: *quartzose granite.*

Humble #1-G Matador core 8246-48 Humble Oil & Rfg. Co.

Quartz (50%), microcline microperthite (37%), albite (7%), biotite (4%), leucoxene (1%), sphene (1%), ilmenite (tr), chlorite (tr), apatite (tr). Quartz occurs as large grains and in a micrographic intergrowth with microcline microperthite; albite shows incipient alteration to sericite: biotite is in thin green-brown plate. Grain size: 1 to 6 mm. Fabric: ranges from hypidiomorphic granular to micrographic. Rock: *quartzose granite.*

Livermore #1 Bird core 8390 Humble Oil & Rfg. Co.

Quartz (52%), oligoclase (15%), microperthite (15%), biotite (6%), calcite (6%), chlorite (3%), magnetite or ilmenite (3%), hornblende (tr), apatite (tr), sphene (tr), zircon (tr). Quartz is in part in large grains that show strain and "welded" structure; zoned plagioclase is variably sericitized; chlorite and calcite are apparently derived from alteration of hornblende; biotite is reddish brown; sphene is in spongy networks. Grain size: 2 to 8 mm. Fabric: hypidiomorphic granular. Rock: *quartzose granite.*

Magnolia #1 Wiley cuttings 7700-16 Bureau of Economic Geology

Oligoclase-andesine? (50%), biotite (20%), quartz (20%), magnetite or ilmenite and red-brown iron oxide (7%), calcite (3%), epidote (tr), apatite (tr), chlorite (tr), pyrite (tr), leucoxene (tr). Slide is composed of only a few small grains. Red-brown iron oxide stains and obscures the slide; plagioclase shows incipient alteration to sericite; biotite is a deeply colored green-brown variety and is locally in a parallel orientation; grains are fractured and biotite is locally reduced to masses that are not easily resolved. Grain size: 0.05 to 0.2 mm. Fabric: cataclastic. Rock: *biotite phyllite.*

Magnolia #1 Wiley cuttings 7710-16 Bureau of Economic Geology

Quartz (75%), chlorite (16%), sericite (5%), magnetite or ilmenite (4%). Only one small fragment present. Quartz is fractured and crushed throughout; chlorite and sericite is intergranular. Grain size: 0.2 mm. Fabric: cataclastic. Rock: cataclastically altered *metaquartzite.*

Magnolia #1 Wiley cuttings 7710-16 Humble Oil & Rfg. Co.

Oligoclase (58%), biotite (20%), quartz (15%), chlorite (4%), alkali feldspar (3%), epidote (tr), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Plagioclase shows incipient sericitization and is anti-perthitic; green-brown biotite occurs in masses of small non-oriented plates;

most of alkali feldspar is present in anti-perthite; chlorite is derived from alteration of biotite; epidote is secondary in veinlets. Grain size: 0.1 mm. Fabric: granoblastic (recrystallized quartz and feldspar; reconstituted argillaceous fraction). Rock: *metarkosite.*

Magnolia #1 Wiley cuttings 7716 Shell Oil Co.

Albite (71%), quartz (15%), sericite (5%), chlorite (5%), epidote (3%), leucoxene (1%), magnetite or ilmenite (tr), apatite (tr), calcite (tr). Albite is in twinned and untwinned grains, partly sericitized, and may include some alkali feldspar; sericite is unequally distributed in the slide and there are barren areas, areas with sporadic flakes, and masses of sericite showing flowage structure; epidote is also unequally distributed through the slide. Grain size: 0.02 to 0.10 mm. Fabric: crystalloblastic (granoblastic to sieve). Rock: *phyllitic metarkosite.*

National Petroleum Association #1 Blackwell cuttings 8370-80 Shell Oil Co.

Microperthite (79%), plagioclase (10%), quartz (10%), sericite (1%), chlorite (tr), altered ferromagnesian mineral (tr). Plagioclase is zoned and rimmed with alkali feldspar; it probably ranges from oligoclase to albite; feldspar is partly sericitized. Grain size: 2.0 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

National Petroleum Association #1 Blackwell cuttings 8370-80 Shell Oil Co.

Quartz (40%), microperthite (39%), albite (15%), pyroxene? (4%), biotite (2%), magnetite or ilmenite (tr), calcite (tr), chlorite (tr). Small fragment is a quartz-rich chip in which high quartz content is not critical in light of preceding slide; biotite, brown to very dark brown pleochroism, is rimmed with magnetite or ilmenite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

National Petroleum Association #1 Blackwell cuttings 8380-84 Shell Oil Co.

Albite (66%), microcline (25%), quartz (5%), biotite (2%), sericite (2%), leucoxene (tr), chlorite (tr), red and yellow iron oxide (tr). Some microcline remnants are completely surrounded by albite; biotite, pale to dark brown pleochroism, is partly altered to chlorite. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *albite syenodiorite.*

Union of Cal. #1 Elliot cuttings 8110-17 Shell Oil Co.

Albite (85%), quartz (11%), biotite (2%), chlorite (1%), magnetite or ilmenite (1%), apatite (tr). Biotite is partly bleached. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *leuco-albite-quartz diorite.*

Woodward #1 Williamson cuttings 7780-87 Shell Oil Co.

Alkali feldspar (50%), albite (25%), quartz (20%), sericite (3%), leucoxene (1%), chlorite (1%), magnetite or ilmenite (tr), zircon (tr). Feldspar is largely kaolinized; quartz occurs in angular grains; there is less intergranular material than in the preceding slide. Grain size: 1 mm. Fabric: clastic. Rock: *meta-arkose.*

Woodward #1 Williamson cuttings 7780-87 Shell Oil Co.

Quartz (35%), albite (35%), fine intergranular quartz-feldspar-sericite mass containing epidote grains (15%), microcline (8%), epidote (4%), sericite (3%). Larger quartz and feldspar grains are surrounded by a fine mass of quartz-feldspar-sericite-epidote; sericite also occurs as scattered flakes; epidote also occurs as small grains around the periphery of the larger quartz and feldspar grains. Grain size: about 1 mm (fine quartz-feldspar-sericite mass is less than 0.02 mm). Fabric: clastic, but shows elements of reconstitution under low-grade metamorphism. Rock: *meta-arkose.*

DONLEY COUNTY

Doswell #1 McMurty cuttings 537075 Humble Oil & Rfg. Co.

Groundmass (58%), albite (27%), microperthite (8%), magnetite or ilmenite (3%), chlorite (2%), calcite (1%), red iron oxide (1%) apatite (tr), zircon (tr). Brown microspherulitic groundmass is apparently composed mostly of alkali feldspar and shows pronounced flowage structure; locally it is microgranular; corroded and embayed phenocrysts are albite, partly sericitized, and microperthite; calcite and chlorite replace an original ferromagnesian phenocryst; magnetite or ilmenite occurs as scattered grains and in veinlets mostly oxidized to red iron oxide. Grain size: groundmass microspherulites are mostly 0.01 to 0.02 mm but sporadic spherulites reach 1 mm in diameter; phenocrysts are up to 3 mm. Fabric: porphyritic. Rock: *trachyte porphyry.*

Honolulu #1 Ozier core ? Honolulu Oil Corp.

Microperthite (55%), quartz (20%), albite (20%), chlorite (2%), biotite (1%), sphene (1%), leucoxene (1%), fluorite (tr), apatite (tr), magnetite or ilmenite (tr), calcite (tr). Plagioclase shows incipient alteration to sericite; biotite, pale to drab-brown pleochroism, is partly altered to chlorite. Grain size: 0.5 mm to 1 cm, average 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Honolulu #1 Ozier core 5890-93 Stanolind Oil & Gas Co.

Oligoclase (60%), microperthite (20%), quartz (15%), chlorite (3%), biotite (1%), magnetite or ilmenite (1%), leucoxene (tr), fluorite (tr), zircon (tr), calcite (tr). Plagioclase is partly sericitized; biotite, a deep brown variety, is partly altered to chlorite. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Humble #1 Roach core 5265 Humble Oil & Rfg. Co.

Microperthite (43%), albite (30%), quartz (15%), chlorite (5%), sericite (3%), calcite (2%), magnetite or ilmenite (2%), leucoxene (tr), red iron oxide (tr), apatite (tr), zircon (tr). Partly kaolinized microperthite is locally micrographically intergrown with quartz; albite occurs in large subhedrons and smaller laths; quartz is in angular grains; sericite occurs from alteration of plagioclase and as intergranular fibers; calcite is in patches and veinlets; magnetite or ilmenite is in scattered grains; apatite forms small needles and prisms. Grain size: 0.2 to 0.5 mm with plagioclase subhedrons up to 2 mm. Fabric: hypidiomorphic granular. Rock: *microgranite porphyry.*

Hunt #5 Ritchie cuttings 6465-85 Bureau of Economic Geology

Groundmass (70%), albite (25%), biotite (2%), leucoxene (2%), magnetite or ilmenite (1%), calcite (tr). Micrographic quartz-alkali feldspar groundmass is obscured by red iron oxide; albite phenocrysts are altered and stained; biotite is green-brown; calcite replaces part of the groundmass. Grain size: phenocrysts 0.2 to 2 mm; groundmass 0.01 to 0.05 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Hunt #5 Ritchie cuttings 6485-95 Bureau of Economic Geology

Unmetamorphosed sandy dolomite.

Hunt #5 Ritchie cuttings 6495-6505 Bureau of Economic Geology

Groundmass (60%), feldspar (35%), red iron oxide (3%), biotite (2%), magnetite or ilmenite (tr), apatite (tr). Micrographic? quartz-alkali feldspar groundmass is heavily stained with red iron oxide and flecked with leucoxene; feldspar and biotite phenocrysts are stained and altered. Grain size: groundmass 0.01 to 0.05 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Placid #1 Kelly cuttings 6960-7050 Humble Oil & Rfg. Co.

Andesine-labradorite (42%), augite (25%), iddingsite? (8%), chlorite (8%), magnetite or ilmenite (5%), olivine (3%), alkali feldspar (2%), sericite (2%), hornblende (2%), biotite (2%), calcite (1%), apatite (tr). Zoned plagioclase shows incipient alteration to sericite; rare olivine relicts are present but most of it has converted to iddingsite?; biotite is red-brown; hornblende, secondary, shows pale green to green pleochroism, alkali feldspar is interstitial to plagioclase; sericite locally occurs as small masses; calcite replaces ferromagnesian minerals and plagioclase. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: altered *olivine gabbro.*

Placid #1 Kelly cuttings 7053-68 Humble Oil & Rfg. Co

(1) Altered gabbro similar to 6960-7050.
(2) Alkali feldspar and plagioclase (76%), quartz (12%), magnetite or ilmenite and leucoxene (5%), amphibole? (5%), epidote (1%), calcite (1%), chlorite (tr), sphene (tr), apatite (tr). Partly kaolinized fragments of alkali feldspar, subordinate plagioclase, and quartz constitute the mass of rock; amphibole? needles and prisms are unequally distributed—in some fragments they compose up to 15% of the rock and in others they are absent;

stratification is expressed in grain size and mineral percentages; rock is very similar to rocks in the Ritchie wells in Briscoe County. Grain size: variable 0.02 to 0.1 mm. Fabric: relict clastic—incipient crystalloblastic (sieve). Rock: *metasiltstone* or *hornfels.*

Shamrock #1 Adair cuttings 5345-50 Bureau of Economic Geology

Slide shows mostly mineral grains with only a few rock fragments. Albite (45%), quartz (30%), alkali feldspar (25%), magnetite or ilmenite (tr), apatite (tr), calcite (tr), zircon (tr). Quartz shows intense strain; alkali feldspar is kaolinized. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular with local cataclastic elements (crushing and brecciation). Rock: cataclastically altered *albite granodiorite.*

Shamrock #1 Adair core 5349-52; 5352-58 Stanolind Oil & Gas Co.

Quartz (40%), albite (36%), alkali feldspar (20%), calcite (3%), magnetite or ilmenite (1%), red iron oxide (tr), muscovite (tr), apatite (tr). Strained quartz shows lamellae extending to edge of grains; alkali feldspar is partly kaolinized and replaced by calcite; calcite also occurs in veinlets; parts of rock seem to have been brecciated. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

Shamrock #1 Adair core ? Honolulu Oil Corp.

Albite (40%), alkali feldspar (20%), quartz (15%), sericite (10%), chlorite (8%), epidote (4%), magnetite or ilmenite (2%), leucoxene (1%), zircon (tr). Plagioclase is partly sericitized; epidote occurs with chlorite in scattered grains and in veinlets and as very fine grains in plagioclase as a result of alteration; some chlorite is apparently also derived from alteration of biotite. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

Stanolind #1 Broome core 6748-53 Bureau of Economic Geology

Oligoclase (66%), quartz (15%), chlorite (10%), epidote (5%), alkali feldspar (3%), apatite (1%), magnetite or ilmenite (tr), sphene (tr), zircon (tr). Plagioclase is anti-perthite—some grains contain small rhombic or rectangular bodies, irregular masses, and veinlets of alkali feldspar, some plagioclase is in advanced stage of sericitization; biotite, green-brown to very dark brown pleochroism, is partly altered to chlorite. Grain size: 0.5 to 4 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Stanolind #1 Broome core 6748-53 Stanolind Oil & Gas Co.

Oligoclase (58%), quartz (35%), chlorite (4%), epidote (2%), magnetite or ilmenite (1%), red iron oxide (tr), pyrite (tr), zircon (tr), apatite (tr), biotite (tr). Plagioclase is partly sericitized (perhaps 7% of rock is sericite); biotite occurs in remnants and most of it is altered to chlorite; epidote commonly occurs in grains within the mass of chlorite; pyrite is in veinlets. Grain size: average 2 to 3 mm, maximum 1 cm. Fabric: xenomorphic granular. Rock: *leuco-quartz diorite.*

Stanolind #1 Broome core 6751-53 Stanolind Oil & Gas Co.

Oligoclase (50%), alkali feldspar (26%), quartz (15%), biotite (7%), chlorite (2%), apatite (tr), epidote (tr), pyrite (tr), leucoxene (tr), myrmekite (tr), magnetite or ilmenite (tr), calcite (tr). Biotite, pleochroism pale brown to deep red-brown, is partly altered to chlorite. Grain size: 2 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Stanolind #1 Lewis cuttings 4085-86 Bureau of Economic Geology

Oligoclase (57%), quartz (20%), alkali feldspar (15%), biotite (4%), chlorite (2%), leucoxene (1%), magnetite or ilmenite (1%), apatite (tr), myrmekite (tr). Plagioclase shows a variable degree of alteration to sericite; biotite, pale brown to dark reddish-brown pleochroism, is partly altered to chlorite. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Stanolind #1 Lewis core "top" Stanolind Oil & Gas Co.

Alkali feldspar (40%), oligoclase (34%), quartz (20%), biotite (5%), chlorite (1%), calcite (tr), zircon (tr), pyrite (tr). Biotite pleochroism is pale brown to deep red-brown; zircon forms halos in biotite. Grain size: 1 mm. Fabric: xenomorphic granular. Rock: *granite.*

Stanolind #1 Lewis core "middle" Stanolind Oil & Gas Co.

Alkali feldspar (42%), oligoclase (35%), quartz (15%), biotite (6%), magnetite or ilmenite (2%), pyrite (tr), apatite (tr), zircon (tr). Feldspar is partly kaolinized; biotite, pale red-brown to very dark brown pleochroism, shows incipient alteration to chlorite. Grain size: 1 mm. Fabric: xenomorphic granular. Rock: *granite.*

Stanolind #1 Lewis core "bottom" Stanolind Oil & Gas Co.

Oligoclase (48%), quartz (25%), hornblende (20%), pyroxene? (4%), magnetite or ilmenite (2%), calcite (1%), apatite (tr). Hornblende, yellow-brown to deep yellow-green pleochroism, occurs as poikilitic equant grains; pyroxene? is partly altered to calcite. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *quartz diorite.*

Welch #1 Lazy RG Ranch cuttings 5160-7020 Humble Oil & Rfg Co.

Albite (48%), microperthite (30%), quartz (13%), biotite (2%), chlorite (2%), magnetite or ilmenite (1%), hornblende (1%), sphene (1%), epidote (1%), calcite (1%), apatite (tr). Albite is partly sericitized; some microperthite occurs as large host grains containing inclusions of the other rock-making minerals including microperthite; biotite pleochroism is yellow-brown to very dark brown; epidote and chlorite occur together from alteration of ferromagnesian minerals; hornblende pleochroism is yellow-green to green. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *albite granodiorite.*

ECTOR COUNTY

Phillips #15 Embar cuttings 8503 Bureau of Economic Geology

Quartz (46%), microcline (30%), biotite (10%), calcite (10%), albite (3%), pyrite (1%), apatite (tr). Microcline is in small grains in a mosaic with quartz and in larger poikilitic grains; partly oxidized dark brown biotite is in oriented laths; calcite occurs in layers parallel to the foliation. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *biotite-calcite-microcline schist.*

Phillips #23 Embar cuttings 8550-55 Bureau of Economic Geology

Quartz (71%), microcline (15%), albite-oligoclase (5%), phlogopite or biotite (4%), calcite (4%), magnetite or ilmenite (1%), apatite (tr). Quartz shows parallel lines of inclusions and Boehm lamellae; mica pleochroism is colorless to very pale brown and it may be phlogopite or biotite; plagioclase is sericitized; mica locally shows a parallel orientation. Grain size: 0.2 to 0.5 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Phillips #1-J TXL cuttings 11170-80 Shell Oil Co.

Oligoclase (50%), quartz (30%), hornblende (13%), chlorite (5%), biotite (2%), calcite (tr), magnetite or ilmenite (tr), apatite (tr). Plagioclase is partly sericitized; hornblende pleochroism is deep yellow-green to deep green; biotite, green-brown, is partly altered to chlorite. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *leuco-quartz microdiorite.*

Phillips #1-J TXL cuttings 11190-11215 Shell Oil Co.

Albite (50%), quartz (35%), biotite (15%), microcline (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite is an intensely colored green-brown variety. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-albite-quartz microdiorite.*

Phillips #1-J TXL cuttings 11210-15 Bureau of Economic Geology

Oligoclase (57%), quartz (15%), biotite (10%), hornblende (10%), microcline (3%), magnetite or ilmenite (2%), chlorite (2%), apatite (1%), calcite (tr), epidote (tr). Plagioclase is partly sericitized; microcline occurs in part as inclusions in plagioclase; biotite, green-brown, is partly altered to chlorite; hornblende pleochroism is yellow-green to blue-green. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *quartz microdiorite.*

Texas #6 Cowden cuttings 8560-70 Bureau of Economic Geology

Microcline (30-100%), quartz (0-35%), plagioclase (0-5%), biotite (0-5%), pyrite (0-5%), muscovite (0-4%), magnetite or ilmenite (0-2%), apatite (1%), zircon (tr). Percentages of minerals vary widely in different fragments; biotite, pale brown to brown pleochroism, is locally in parallel orientation; plagioclase occurs in only one fragment and is sericitized. Grain size: 0.05 to 0.5 mm. Fabric: crystalloblastic. Rock: *granite gneiss* or *arkose gneiss.*

EL PASO COUNTY

Jones #1 Sorely — cuttings 2213-20 — Bureau of Economy Geology

Oligoclase-andesine (39%), hornblende (30%), quartz (12%), biotite (8%), chlorite? (6%), magnetite or ilmenite (3%), alkali feldspar (2%), apatite (tr). Zoned plagioclase is partly sericitized; green-brown hornblende is partly altered to blue-green hornblende; biotite pleochroism is pale to dark brown with a reddish tinge; greenish-brown moderately birefringent mineral in plagioclase cleavages and replacing plagioclase and hornblende may be a chlorite; alkali feldspar occurs as spongy masses and in veinlets between plagioclase grains. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

FISHER COUNTY

General Crude #1 Aiken — cuttings 7505 — Bureau of Economic Geology

Microcline microperthite (78%), albite (10%), quartz (10%), magnetite or ilmenite (2%), calcite (tr), sphene (tr), chlorite (tr), leucoxene (tr), apatite (tr). Plagioclase is partly altered to sericite; calcite occurs in veinlets. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

General Crude #12 Flanagan — cuttings 6743-46 — Bureau of Economic Geology

Quartz (61%), albite and microcline (20%), biotite (10%), epidote (7%), muscovite (2%), sphene (tr), chlorite (tr), apatite (tr). Quartz occurs in a mosaic with feldspar; albite is partly sericitized and may include some oligoclase; mica shows a parallel orientation; slide consists of very small fragments, and mineral percentages are a very rude estimate. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *epidote-biotite schist.* (Photomicrograph Pl. VII, C.)

Humble #1 Crowley — core 7085 — Humble Oil & Rfg. Co.

Quartz (52%), microcline (20%), oligoclase-andesine (12%), biotite (10%), epidote (4%), muscovite (2%), sphene (tr), apatite (tr). Quartz and feldspar form a mosaic; biotite is in non-oriented plates (apparently, in light of succeeeding slide, this section is cut nearly parallel to the foliation); epidote is in scattered grains. Grain size: 0.1 to 0.5 mm. Fabric: crystalloblastic. Rock: *biotite schist.*

Humble #1 Crowley — core 7085 — Humble Oil & Rfg. Co.

Quartz (42%), oligoclase (25%), microcline (15%), biotite (12%), epidote (3%), muscovite (2%), calcite (1%), magnetite (tr), chlorite (tr), apatite (tr). Oriented plates of green-brown biotite are dispersed in a quartz-feldspar mosaic. Grain size: 0.2 to 0.5 mm. Fabric: lepidoblastic. Rock: *biotite schist.*

Lion #1 Huddleston — cuttings 5920-40 — Bureau of Economic Geology

Quartz (60%), microcline (39%), calcite (1%), chlorite (tr), magnetite or ilmenite (tr), sericite (tr), fluorite (tr), leucoxene (tr), red iron oxide (tr), zircon (tr). Microcline, including minor sodic plagioclase, occurs in a mosaic with quartz. Mineral percentages are highly variable in different fragments; quartz and feldspar are unequally distributed in rude layers in some fragments. Grain size: 0.05 to 0.2 mm. Fabric: granoblastic—gneissic. Rock: *arkose gneiss.*

Skelly and Lion #1 Lanning — cuttings 6140-60 — Bureau of Economic Geology

Alkali feldspar (72%), quartz (20%), sericite-muscovite (2%), pyrite (2%), biotite (1%), leucoxene (1%), calcite (1%), chlorite (1%), apatite (tr). Alkali feldspar forms a mosaic with quartz, most probably it is microcline (vague quadrille twinning); quartz is more or less concentrated in layers; sericite-muscovite is in parallel oriented fibers and plates; pale green-brown biotite flakes show parallel orientation. Grain size: 0.02 to 0.1 mm. Fabric: granoblastic—gneissic. Rock: *arkose gneiss.*

Texas #7 Stephens cuttings 6151 Bureau of Economic Geology

Quartz (54%), oligoclase (25%), microcline (12%), biotite (7%), muscovite (1%), magnetite or ilmenite (1%), dolomite (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite, golden brown to almost black pleochroism, occurs in oriented plates. Grain size: 0.1 to 0.5 mm. Fabric: granoblastic—gneissic. Rock: *arkose gneiss.*

Texas #1-C Stephens cuttings 6280-90 Shell Oil Co.

Microcline and albite (50%), quartz (38%), chlorite (8%), epidote (4%), apatite (tr), calcite (tr), sphene (tr), zircon (tr). Microcline, albite, and quartz occur in a mosaic; the feldspar shows incipient kaolinization; chlorite occurs in rudely oriented fibers; epidote is in tiny grains between feldspar and quartz grains. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic—gneissic. Rock: *arkose gneiss.*

FLOYD COUNTY

Chiles #1 Strickler cuttings 7730-35 Shell Oil Co.

Oligoclase (95%), sericite (4%), calcite (1%), amphibole (tr), biotite (tr), epidote (tr), rutile (tr). Plagioclase is partly sericitized; amphibole pleochroism is pale tan to deep green. Grain size: 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microdiorite.*

Chiles #1 Strickler cuttings 7755-57 Shell Oil Co.

Oligoclase-andesine (95%), sericite (3%), biotite (1%), chlorite (1%), amphibole (tr), leucoxene (tr), apatite (tr). Biotite, pale to dark brown pleochroism, is partly altered to chlorite; amphibole pleochroism is pale to deep green. Grain size: 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microdiorite.*

Houston #1 Lackey cuttings 10390-95 Bureau of Economic Geology

Labradorite (59%), augite (25%), chlorite? (10%), biotite (3%), chlorite (1%), magnetite or ilmenite (1%), apatite (1%). Plagioclase is zoned and partly sericitized; chlorite? is an olive-green mineral with moderate birefringence that seems to have originated through alteration of olivine; biotite is red-brown; apatite is in needles. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

Livermore #1 Krause core 7834-35 Honolulu Oil Corp.

Oligoclase (64%), quartz (10%), chlorite (8%), calcite (8%), biotite (5%), sericite (3%), alkali feldspar (2%), pyrite (tr), apatite (tr), sphene (tr), magnetite or ilmenite (tr), leucoxene (tr), zircon (tr). Plagioclase occurs in large twinned subhedrons; chlorite is derived from alteration of biotite but also occurs in granular masses associated with calcite; calcite occurs in veinlets and with chlorite and sericite in a network of fine veinlets; biotite pleochroism is pale brown to dark green-brown; zircon forms weak halos in biotite; alkali feldspar is interstitial to plagioclase subhedrons. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-quartz diorite.*

Livermore #1 Krause core 7835-36 Honolulu Oil Corp.

(1) Similar to 7834-35.

(2) Microcrystalline to cryptocrystalline matrix containing carbonate grains, angular fragments of quartz and plagioclase, bent and altered biotite plates, zircon, and chlorite. This is probably a crushed phase of (1); it is composed mostly of very fine crushed quartz and feldspar. The calcite is largely secondary and fills cracks and replaces matrix.

Livermore #1 Krause core 7836-38 Honolulu Oil Corp.

Oligoclase (63%), calcite (10%), chlorite (10%), quartz (8%), biotite (7%), alkali feldspar (1%), leucoxene (1%), ilmenite (tr). Plagioclase is partly sericitized and weakly zoned; calcite and chlorite replace a ferromagnesian mineral of prismatic habit; leucoxene replaces sphene. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *leuco-quartz diorite.*

Livermore #1 Krause core 7838-40 Honolulu Oil Corp.

Oligoclase (63%), hornblende (15%), quartz (7%), biotite (5%), sericite (4%), chlorite (3%), epidote (1%), zeolite (1%), leucoxene (1%), apatite (tr). Indistinctly zoned plagioclase is partly altered to sericite and epidote; hornblende pleochroism is pale yellow-green to yellow-green; biotite, pale brown to deep green-brown pleochroism, is partly altered to chlorite. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-quartz diorite.*

Livermore #1 Krause core 7840-41 Honolulu Oil Corp.

Same as 7838-40.

Livermore #1 Krause core 7841-43 Honolulu Oil Corp.

Same as 7840-41 but shows a veinlet about 1 cm wide composed of calcite and the same finely crystalline crushed? matrix of quartz and feldspar as in slide 7435-36. Calcite has been introduced into the rock near the veinlet and replaces feldspar.

Sinclair #1 Massie core 10353-58 Bureau of Economic Geology

Quartz (50%), oligoclase (30%), muscovite (10%), chlorite (5%), calcite (3%), biotite (2%), apatite (tr), zircon (tr). Partly sericitized plagioclase forms a mosaic with quartz; muscovite and chlorite occur in parallel plates and frayed masses with unequal distribution in layers; chlorite is after biotite which is still present as partly altered green-brown relicts; calcite is in cross-cutting veinlets. Grain size: 0.2 mm. Fabric: lepidoblastic. Rock: *chlorite-muscovite-oligoclase-quartz schist.*

Standard of Texas #1 Daniel cuttings 6910-20 Bureau of Economic Geology

Albite-oligoclase (57%), quartz (25%), alkali feldspar (10%), biotite (7%), chlorite (1%), pyrite (tr), apatite (tr), zircon (tr). Plagioclase is zoned, some grains show turbid centers with incipient sericitization and clear albite rims, other grains show uniform partial sericitization; alkali feldspar is partly kaolinized and is interstitial to plagioclase; biotite is red-brown and partly altered to chlorite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Standard of Texas #1 Daniel core 7001 Stanolind Oil & Gas Co.

Microperthite and albite-oligoclase (57%), quartz (40%), chlorite (2%), biotite (1%), leucoxene (tr), pyrite (tr), magnetite or ilmenite (tr), zircon (tr), apatite (tr). Plagioclase is partly sericitized; quartz is strained and shows an alignment of long axes of grains in a mosaic with feldspar; biotite, red-brown, is partly altered to chlorite. Grain size: 0.3 to 0.5 mm. Fabric: ranges from xenomorphic granular to gneissic. Rock: *granodiorite gneiss.*

FOARD COUNTY

Phillips #1 Clemmie core 4475 Bureau of Economic Geology

Quartz (34%), microcline (25%), oligoclase (25%), biotite (8%), epidote (3%) magnetite or ilmenite (2%), leucoxene (1%), chlorite (1%), sericite (1%), sphene (tr), red iron oxide (tr), apatite (tr), zircon (tr). The long axes of quartz and feldspar grains are rudely aligned in a mosaic; plagioclase is partly sericitized and stained with iron; green-brown biotite occurs in oriented plates; sphene is altered to leucoxene; biotite, epidote, and sericite occur in veinlets or altered zones parallel to the foliation. Grain size: 0.2 to 0.5 mm, maximum 1 mm. Fabric: lepidoblastic. Rock: *feldspathic biotite schist.*

Roxana #1 Mathews cuttings 2410-20 Bureau of Economic Geology

Albite (47%), microcline (20%), quartz (20%), biotite (5%), chlorite (5%), magnetite or ilmenite, leucoxene, and red iron oxide (3%), apatite (tr), zircon (tr). Albite-microcline-quartz aggregate shows pronounced dimensional grain orientation in some fragments; layering is also present in some fragments; albite is partly kaolinized; bleached and altered biotite partly altered to chlorite is present as oriented plates. Grain size: 0.2 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *arkose gneiss.*

Roxana #1 Mathews cuttings 2585 Bureau of Economic Geology

Similar to 2410-20 but with oriented muscovite flakes in one fragment.

Roxana #1 Mathews — cuttings 2585 — Bureau of Economic Geology

Plagioclase (50%), quartz (40%), chlorite (5%), biotite (3%), magnetite or ilmenite (2%), apatite (tr). Completely sercitized plagioclase and quartz occur in a mosaic with grains showing dimensional orientation; chlorite is in oriented plates after biotite; unaltered green-brown biotite is in oriented plates. There are 28 slides on this well ranging from 2220 to 2585 feet. In other slides microcline is present in varying percentage but remains subordinate to plagioclase, locally it shows concentration in layers; zircon is locally present; apatite is abundant in some slides; layers and lenses of quartz and quartz augen occur locally. Grain size: 0.2 to 0.5 mm. Fabric: crystalloblastic. Rock: *biotite-chlorite schist.*

Texas #3 Johnson — cuttings 4558-60 — Bureau of Economic Geology

Microcline microperthite and plagioclase (70%), quartz (10%), sericite (10%), rock fragments (5%), biotite (4%), chlorite (1%), muscovite (tr), magnetite or ilmenite (tr), leucoxene (tr), zircon (tr). Feldspar occurs as angular grains; plagioclase is partly sericitized; quartz occurs in angular grains and fragments of mosaic; sericite and patches of green-brown biotite plates occur between quartz and feldspar grains and locally form a dense mat; some sericite is deiived from alteration of plagioclase but the greater part is the result of reconstitution; some very fine quartz and feldspar occur with the intergranular micas; rock fragments are chert and metaquartzite; worn muscovite wisps are second cycle minerals. Grain size: 0.1 to 0.4 mm. Fabric: relict clastic—incipient crystalloblastic. Rock: *meta-arkose.*

Texas #3 Johnson — cutting 4565-67 — Bureau of Economic Geology

(1) Fragments similar to 4558-60.
(2) Oligoclase-andesine (56%), hornblende (25%), biotite (10%), quartz (5%), magnetite or ilmenite and pyrite (3%), apatite (1%). Zoned plagioclase is partly sericitized; hornblende pleochroism is yellow-green to green; biotite is reddish brown; quartz locally shows incipient granulation. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *quaitz diorite.*

GAINES COUNTY

Amerada #2-A Jones — cuttings 12920 — Bureau of Economic Geology

Microperthite (65%), quartz (20%), albite (10%), epidote (3%), chlorite (2%), opaque mineral (tr), zircon (tr), sphene (tr). Microperthite occurs as large grains in a mass of smaller grains of quaitz and feldspar. Grain size: 0.2 mm with sporadic microperthite grains as much as 2 mm long. Fabric: ranges fiom hypidiomorphic granular to micrographic. Rock: *miciogianite.*

Amerada #1-D Jones — cuttings 13020-25 — Bureau of Economic Geology

Albite and alkali feldspar (83%), quartz (10%), chlorite (5%), leucoxene (2%), apatite (tr). Grain size: 0.5 mm. Fabric: two fragments hypidiomorphic granular, one fragment micrographic. Rock: *microgranite.*

Amerada #1-D Jones — cuttings 13020-25 — Bureau of Economic Geology

Microcline microperthite (82%), albite (5%), quartz (5%), chlorite (3%), red iron oxide (2%), magnetite or ilmenite (2%), leucoxene (1%), apatite (tr), zircon (tr). Slides are poor and contain only a few fragments of "basement." Grain size: 2 mm. Fabric: in some fragments hypidiomorphic granular, in some fragments clastic or cataclastic with fine-grained groundmass material. This may be a clastic rock composed of fragments of *granite;* alternative is that some of the granite is cataclastically altered.

Texas #1 Jenkins — core 11699 — Bureau of Economic Geology

Oligoclase (66%), microcline (15%), quartz (10%), biotite (5%), hornblende (3%), ilmenite (1%), sphene (tr), seiicite (tr), apatite (tr), zircon (tr). Plagioclase is zoned and partly sericitized; biotite pleochroism is pale to olive-green; poikilitic hornblende grains show yellow-green to blue-green pleochroism; sphene envelops ilmenite. Grain size: average 0.2 to 1 mm with sporadic feldspar subhedrons up to 5 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

GARZA COUNTY

Gulf #1-B Swenson — cuttings 8100-04 — Bureau of Economic Geology

Oligoclase (42%), microperthite (25%), quartz (20%), biotite (5%), hornblende (3%), magnetite or ilmenite (2%), pyrite (1%), chlorite (1%), calcite (1%), apatite (tr), zircon (tr).

Plagioclase is partly sericitized; hornblende, yellow-green to dark green pleochroism, is partly replaced by calcite; biotite is red-brown. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Honolulu #1 Altman cuttings 9600-06 Bureau of Economic Geology

Microcline microperthite (53%), albite (30%), quartz (15%), biotite (1%), chlorite (1%), zircon (tr). Plagioclase is partly sericitized; biotite is an intensely colored green-brown variety and is partly altered to chlorite. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Humble #1-G Fee cuttings 8351-53 Bureau of Economic Geology

Oligoclase (48%), quartz (20%), microcline (15%), biotite (8%), hornblende (6%), chlorite (2%), apatite (1%), sphene (tr), epidote (tr). Plagioclase is partly sericitized; hornblende pleochroism is dark yellow-green to very dark green; biotite pleochroism is pale brown to very dark brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Stanolind #1 Bird cuttings 8540-42 Bureau of Economic Geology

Microcline microperthite (51%), albite (20%), quartz (15%), hornblende (10%), magnetite or ilmenite (4%), chlorite (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; hornblende is a deeply colored green-brown variety. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Union and Cities Service #1-A Davies cuttings 8850-55 Bureau of Economic Geology

Oligoclase and microcline microperthite (77%), quartz (18%), biotite (3%), hornblende (2%), magnetite or ilmenite (tr), leucoxene (tr), pyrite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized and makes up most of the total feldspar; biotite pleochroism is very dark brown to almost black; hornblende, brown to very dark green pleochroism, locally is poikilitic. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

GILLESPIE COUNTY

Thousand Islands #1 Hayden cuttings 1446 Bureau of Economic Geology

Microcline microperthite (55%), albite-oligoclase (30%), quartz (10%), hornblende (3%), biotite (2%), apatite (tr). Microcline microperthite is mostly vein perthite but locally is patch perthite with very large patches; albite-oligoclase is locally partly sericitized; quartz is sporadically myrmekitic with plagioclase; hornblende is dark green-brown variety; biotite pleochroism is yellow-brown to very dark brown; apatite is in clusters of prisms. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

GLASSCOCK COUNTY

Shell #1 Clarke cuttings 10969 Shell Oil Co.

Microcline microperthite (60%), quartz (20%), albite (15%), biotite (4%), calcite (1%), chlorite (tr), sericite (tr), pyrite (tr), apatite (tr). Some quartz occurs as rims around feldspar, some quartz grains are connected by quartz veinlets; biotite is partly altered to chlorite; calcite is present in veinlets. Grain size: 1 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

GRAY COUNTY

Bock-Anderson #1 Beavers cuttings 3200-05 Bureau of Economic Geology

Albite-oligoclase (55%), microcline microperthite (25%), quartz (15%), chlorite (3%), magnetite or ilmenite (2%), biotite (tr), leucoxene (tr), zircon (tr), apatite (tr). Plagioclase is partly sericitized; quartz is locally micrographically intergrown with the potassium feldspar; the potassium feldspar, microcline microperthite, occurs with plagioclase and quartz as a granular aggregate except for one large poikilitic grain; biotite, partly altered to chlorite, occurs as faded and altered relicts. Grain size: 0.5 to 4 mm. Fabric: xenomorphic granular. Rock: *granodiorite.*

Bock-Anderson #1 Beavers cuttings 3200-05 Bureau of Economic Geology

Calcic plagioclase (53%), amphibole? (20%), analcite (10%), chlorite (10%), magnetite or ilmenite (6%), leucoxene (1%). Radially oriented calcic plagioclase laths are in advanced stage of sericitization and chloritization; green-brown moderately birefringent mineral that is probably amphibole replaces pyroxene which occurs as relicts; veinlets and masses of analcite occur throughout the rock. Grain size: 0.1 to 0.2 mm. Fabric: subophitic—metasomatic. Rock: altered *analcite diabase.*

Holt #3 Bailey cuttings 2290-2721 Humble Oil & Rfg. Co.

Microcline microperthite (67%), quartz (25%), chlorite (3%), albite (2%), amphibole (2%), red iron oxide (1%), apatite (tr), zircon (tr). Microcline microperthite is locally fractured and brecciated; quartz is locally fractured and brecciated; amphibole has an unusual green-brown to dark gray pleochroism and is perhaps an alkalic variety; red iron oxide occurs in a network of fine veins in fractured parts of the rock. Grain size: 0.5 to 5 mm. Fabric: xenomorphic granular with local brecciation and cataclasis. Rock: *granite.*

Magnolia #4 Latham cuttings 2991-95 Bureau of Economic Geology

Microcline microperthite, oligoclase, quartz, biotite, magnetite or ilmenite, chlorite, apatite, calcite. Feldspar is fractured and kaolinized; quartz, partly granulated in some fragments, occurs as distinct grains and in veinlets between feldspar grains; in crushed fragments biotite is bleached and altered in part to chlorite. Mineral percentages are highly variable and not significant except in a general way. Grain size: 0.5 to 3 mm. Fabric: cataclastic with relict hypidiomorphic granular elements. Rock: cataclastically altered *granite.*

Magnolia #4 Latham cuttings 3418-31 Bureau of Economic Geology

Microperthite (62%), plagioclase (10%), quartz (10%), hornblende (7%), chlorite (5%), magnetite or ilmenite (3%), biotite (1%), red iron oxide (1%), apatite (1%), sphene (tr). Microperthite is partly kaolinized; hornblende is green-brown and partly altered to chlorite; biotite is red-brown; apatite is in large prisms. Ferromagnesian accessory minerals are concentrated in clusters. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Magnolia #4 Latham cuttings 3418-31 Bureau of Economic Geology

Similar to 2991-95—crushed and brecciated granite invaded and partly replaced by chlorite.

Phillips #2 Keahey cuttings 2618-28 Bureau of Economic Geology

Groundmass, sodic plagioclase, microperthite, quartz, pyrite, leucoxene, chlorite, apatite, zircon. Amounts of various minerals vary widely in different fragments. Cryptocrystalline to microgranular quartz-alkali feldspar-sericite groundmass shows well-developed flowage structures and local patches of coarser irregular quartz-feldspar intergrowth; sodic plagioclase forms phenocrysts—one phenocryst is well zoned with a calcic sericitized core and a sodic mantle; microperthite and quartz also occur as phenocrysts; leucoxene is finely disseminated. Grain size: groundmass mostly cryptocrystalline but with local coarsenings up to 0.2 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Phillips #6 URB cuttings 3043-53 Bureau of Economic Geology

Albite-oligoclase (71%), chlorite (15%), magnetite or ilmenite (12%), leucoxene (1%), apatite (1%), unidentified vein mineral (tr). Twinned plagioclase tablets are fractured and broken; chlorite replaces plagioclase and original ferromagnesian constituents—there are two varieties present: (1) green low-birefringent chlorite and (2) brown chlorite; apatite is in abundant needles and elongate prisms. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *albite diorite.*

Phillips #6 URB cuttings 3043-53 Bureau of Economic Geology

Groundmass, feldspar phenocrysts, quartz phenocrysts, biotite, chlorite, apatite, zircon. Microgranular quartz-alkali feldspar groundmass is heavily stained with iron oxide and flecked with leucoxene, some fragments show no quartz, one fragment shows flowage structure, one fragment shows micrographic structure; feldspar phenocrysts are heavily stained and in advanced stage of kaolinization; biotite is red-brown. Mineral percentages not significant—some fragments are all groundmass, some fragments contain up to 30 percent phenocrysts. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: fragments of *trachyte* and *rhyolite porphyry.*

Phillips #6 URB cuttings 3065-70 Bureau of Economic Geology

Same as 3043-53 but with brecciation advanced. Chlorite, magnetite or ilmenite, and carbonate invade the crushed albite diorite. Some highly brecciated fragments also show fragments of rhyolite in a crushed and chloritic matrix.

Phillips #6 URB cuttings 3105-10 Bureau of Economic Geology

Some fragments are brecciated albite diorite invaded by secondary carbonate mineral; some fragments are volcanic rocks (tuff and flow rocks) invaded to varied degree by secondary carbonate mineral.

Phillips #6 URB cuttings 3175 Bureau of Economic Geology

Groundmass (75%), plagioclase (20%), alkali feldspar (4%), quartz (1%). Heavily stained and kaolinized micrographic quartz-alkali feldspar groundmass shows local cryptocrystalline areas and flowage structure; feldspar and quartz occur as phenocrysts; there are only a few fragments in slide and percentages are not significant. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Phillips #6 URB cuttings 3175 Bureau of Economic Geology

Microgranular to cryptocrystalline mass of alkali feldspar, chlorite, and minor quartz showing relict vitroclastic structure and containing sporadic larger grains of alkali feldspar, albite, and quartz; leucoxene, carbonate, and masses of semi-opaque argillaceous? material; quartz and calcite veinlets are common. Grain size: mostly less than 0.02 mm; fragments up to 0.1 mm. Fabric: relict vitroclastic. Rock: *rhyolite tuff.*

Phillips #1 Worley cuttings 2824-33 Humble Oil & Rfg. Co.

Microcline microperthite, quartz, albite-oligoclase, chlorite, calcite, bleached biotite, magnetite or ilmenite, apatite, zircon. Slide consists mostly of individual mineral fragments. Plagioclase is partly sericitized; calcite replaces parts of the rock. Grain size: 1 to 2 mm. Fabric: ? Rock: *granite.*

Shamrock #1 McCracken cuttings 2525-90 Humble Oil & Rfg. Co.

Andesine-labradorite (65%), amphibole (6%), magnetite or ilmenite (5%), augite (4%), microperthite (4%), biotite (3%), iddingsite? (3%), calcite (3%), chlorite (2%), nontronite? (2%), serpentine (2%), anhydrite (1%), apatite (tr). Indistinctly zoned plagioclase is mostly andesine-labradorite but locally is more sodic; amphibole is composed of a yellow-green to green pleochroic variety that fringes pyroxene and a secondary green variety in fibrous masses; augite is violet-brown in some fragments and colorless in others; a yellow-green chlorite replaces plagioclase. Alteration products throughout slide make modal estimations difficult. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-gabbro.*

Shamrock #1 Taylor cuttings 2410-2550 Stanolind Oil & Gas Co.

Labradorite (68%), dirty semi-opaque material (15%), magnetite or ilmenite (7%), chlorite (5%), ferromagnesian relicts (4%), zeolite (1%), sphene (tr). Plagioclase laths are partly sericitized; chlorite occurs in fibrous masses. Grain size: 0.2 mm. Fabric: ophitic. Rock: altered *diabase.*

Sidwell #1 Bowers cuttings 3253-93 Stanolind Oil & Gas Co.

Microperthite (80%), quartz (20%), biotite (tr), hornblende (tr), magnetite or ilmenite (tr), leucoxene (tr), zircon (tr). Slide is composed of individual mineral fragments. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Skelly #1 Heitholt cuttings 2935-48 Bureau of Economic Geology

Microcline microperthite (81%), quartz (10%), magnetite or ilmenite (5%), calcite (3%), yellow iron oxide (1%), sphene (tr), apatite (tr). Partly kaolinized microcline microperthite is in fractured and broken grains; calcite and iron oxide occur in brecciated zones. Mineral percentages are not too significant because of variation in mineral content in different fragments. Grain size: 1 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Skelly #1 Heitholt cuttings 2984-90 Bureau of Economic Geology

Mostly individual mineral fragments—partly kaolinized microline microperthite and quartz. Rock: *granite.*

Smith #1-E Johnson core ? Stanolind Oil & Gas Co.

Andesine? (75%), quartz (15%), epidote (4%), chlorite (4%), sphene (1%), leucoxene (1%), apatite (tr), zircon (tr). Plagioclase is almost completely sericitized and probably 50% of the mode figure for plagioclase is sericite; quartz is crushed and strained, some is secondary; epidote occurs in veinlets and masses. Grain size: from 0.05 mm for epidote to 4 mm for feldspar grains. Fabric: hypidiomorphic granular. Rock: *leuco-quartz diorite.*

HALE COUNTY

Amerada #1 Kurfees core 10245-50 Bureau of Economic Geology

Andesine-labradorite (57%), olivine (15%), augite (8%), magnetite or ilmenite (8%), chlorite (4%), nontronite? (4%), nontronite?-chlorite-chrysotile veinlet (2%), iddingsite (1%), biotite (1%), apatite (tr), sphene (tr), pyrrhotite? (tr). Zoned plagioclase is partly sericitized; olivine is in various stages of alteration to olive-brown chlorite (moderate to high birefringence), green chlorite, and iddingsite; augite is a brownish-violet titaniferous variety; nontronite? is a secondary mineral in vicinity of and within a veinlet which consists of a core of cross-fibered chrysotile, an intermediate chlorite zone, and a border of nontronite? diffusing outward irregularly. Grain size: 2 mm. Fabric hypidiomorphic granular. Rock: altered *olivine gabbro.*

Amerada #1 Kurfees core 10245-50 Bureau of Economic Geology

Labradorite or andesine (68%), alkali feldspar (10%), olivine (8%), augite (5%), chlorite (5%), magnetite or ilmenite (3%), biotite (1%), pyrite (tr), apatite (tr). Zoned plagioclase is partly altered to sericite (a substantial percentage of sericite is included in the modal figure for plagioclase); there are two chlorites in the slide: (1) a colorless to pale green moderately birefringent chlorite occurring in fibrous masses around olivine and also resulting from alteration of biotite and (2) (a trace only) low-birefringent yellow-green chlorite; biotite pleochroism is pale tan to deep red-brown. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine syenogabbro.*

Honolulu and Sinclair #1 Clements cuttings 10060-70 Bureau of Economic Geology

Labradorite? (63%), olivine (20%), magnetite or ilmenite (4%), augite (3%), biotite (3%), amphibole (3%), chlorite (3%), antigorite? (1%), apatite (tr). Zoned, partly sericitized plagioclase is probably labradorite (on estimation of relief); augite locally fringes olivine; biotite is red-brown and commonly surrounds opaque mineral; most of the chlorite is an olive-colored variety which locally envelops olivine; there is also a trace of common low-birefringent green chlorite derived from alteration of amphibole; amphibole, pale green to yellow-green pleochroism, is probably deuteric; antigorite? is locally present as a fine fibrolamellar mass; in one place the antigorite? surrounds a colorless highly birefringent mineral that was not identified. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Honolulu and Sinclair #1 Clements cuttings 10140-50 Bureau of Economic Geology

Labradorite? (58%), olivine (15%), augite (10%), magnetite or ilmenite (5%), amphibole (4%), biotite (4%), chlorite (3%), barite? (1%), calcite (tr), apatite (tr). Plagioclase is partly sericitized and estimated as labradorite on basis of relief and associated minerals; augite is violet-brown and probably titaniferous; red-brown biotite is in part a fringe on magnetite-ilmenite; chlorite is an olive-green variety replacing olivine (2%) and a green variety (1%); green amphibole is probably deuteric; calcite results from alteration of plagioclase. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Humble and Stanolind #1 Byrd cuttings 6750-60 Bureau of Economic Geology

Oligoclase (54%), quartz (20%), alkali feldspar (15%), hornblende (3%), biotite (3%), chlorite (3%), magnetite or ilmenite (1%), leucoxene (1%), apatite (tr), calcite (tr), sphene (tr). Plagioclase is in an advanced stage of sericitization; chlorite is derived in part from alteration of yellow-green hornblende and in part from alteration of brown biotite; alkali feldspar is partly kaolinized. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Humble and Stanolind #1 Byrd cuttings 6755-60 Bureau of Economic Geology

Microperthite, sericitized plagioclase, quartz, red-brown biotite (yellow-green to blue-green pleochroism), hornblende, chlorite, apatite, magnetite or ilmenite, pyrite, calcite. Slide is composed mostly of mineral fragments. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite* or *granodiorite.*

Standard of Texas #1 Keliehor cuttings 10080-90 Humble Oil & Rfg. Co.

(1) Microperthite (40%), quartz (39%), epidote-zoisite (15%), plagioclase (5%), calcite (1%), chlorite (tr), biotite (tr), zircon (tr). Quartz is locally micrographically intergrown with partly kaolinized microperthite; plagioclase is mostly altered to a fine granular mass of epidote-zoisite and remnants seem to be albite; biotite is green-brown. The original plagioclase content approximates the sum of the plagioclase and epidote-zoisite totals. Grain size: 0.2 to 1 mm. Fabric: ranges from micrographic to xenomorphic granular. Rock: altered *granite*.

(2) Albite (64%), chlorite (15%), quartz (10%), alkali feldspar (5%), calcite (4%), mica? (1%), leucoxene (1%), magnetite (tr), apatite (tr), sphene (tr). Plagioclase is partly sericitized; chlorite occurs in large masses containing flecks of leucoxene and, locally, is associated with calcite; a colorless highly birefringent mica-like mineral is present in some of the chlorite masses; sphene is partly altered to leucoxene. Grain size: 1 to 6 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-albite-quartz diorite*.

Standard of Texas #1 Keliehor cuttings 10140-70 Humble Oil & Rfg. Co.

(1) Albite (57%), microperthite (15%), quartz (10%), hornblende (6%), chlorite (5%), biotite (2%), calcite (2%), epidote (2%), myrmekite (1%), magnetite or ilmenite (tr), leucoxene (tr), sphene (tr), apatite (tr). Plagioclase is partly sericitized; microperthite is only slightly perthitic and most of it occurs in one large host grain containing inclusions of hornblende and plagioclase; chlorite occurs with calcite as result of alteration of ferromagnesian minerals (chlorite is unequally distributed in different fragments, depending on their state of alteration), myrmekite locally fringes plagioclase grains; biotite is brown and partly altered to chlorite; hornblende pleochroism is yellow-green to green; epidote occurs mostly in one fragment. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite*.

(2) Plagioclase (59%), chlorite (15%), augite (10%), calcite (8%), quartz (5%), magnetite or ilmenite (3%), hornblende (tr), sphene (tr), leucoxene (tr). Plagioclase occurs as sericitized laths with some unaltered remnants that seem to be albite; augite is partly altered to calcite and chlorite and, in part, occurs as phenocrysts; calcite replaces plagioclase and augite; hornblende is in brown tiny grains; secondary quartz fills cavities. Grain size: 0.1 to 0.2 mm with augite phenocrysts up to 1 mm. Fabric: subophitic—metasomatic. Rock: altered *leuco-albite diabase*.

Standard of Texas #1 Keliehor cuttings 10220-300 Humble Oil & Rfg. Co.

Similar to 10140-70 but contains a preponderance of diabase fragments over granodiorite fragments; diabase contains more brown hornblende and more leucoxene than in 10140-70.

Standard of Texas #1 Keliehor cuttings 10400-500 Humble Oil & Rfg. Co.

Albite (66%), quartz (10%), crushed zones (7%), alkali feldspar (5%), chlorite (5%), hornblende (3%), calcite (3%), sphene (1%), epidote (tr), leucoxene (tr), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Albite is partly sericitized and locally shows alteration to very fine granular epidote-zoisite; fine granular quartz and feldspar occur in crushed zones or fracture fillings (mostly in one fragment), hornblende, yellow-green to green pleochroism, is partly altered to calcite in some fragments; chlorite is probably the result of alteration of biotite; sphene is present as large grains. Grain size: in most fragments grain size is 1 to 3 mm; some fragments are a finer grained rock, about 1 mm, which is richer in alkali feldspar than the coarser variety. Fabric: hypidiomorphic granular. Rock: *albite granodiorite*.

Standard of Texas #1 Keliehor cuttings 10400-500 Humble Oil & Rfg. Co.

Similar to 10300-400 but richer in ferromagnesian minerals and their alteration products.

Standard of Texas #1 Keliehor cuttings 10610-780 Humble Oil & Rfg. Co.

Similar to 10400-500 but also contains one fragment of diabase similar to that in 10140-70.

Standard of Texas #1 Keliehor cuttings 10500-600 Humble Oil & Rfg. Co.

Similar to 10400-500.

Stanolind #2 Fisher cuttings 8045-50 Shell Oil Co.

Slide is composed equally of three well-defined areas of contrasting texture and mineralogy: (1) cryptocrystalline groundmass showing flowage structure and containing albite phenocrysts up to

0.5 mm long—separated from rest of slide by a calcite veinlet; (2) brown cryptocrystalline material showing spherulitic extinction and enveloping a mass of chlorite and a fragment of quartz mosaic; (3) dark gray cryptocrystalline material containing tiny angular fragments of quartz and feldspar. A second slide from this depth is similar to above but contains areas of micrographic intergrowth surrounded by brown cryptocystalline material. Rock: *rhyolite flow-breccia.*

Stanolind #2 Fisher core 8048 Stanolind Oil & Gas Co.

Groundmass (62%), albite (20%), rock fragments—trachyte and rhyolite (10%), quartz (5%), chlorite (2%), leucoxene (1%), apatite (tr), calcite (tr). Brown cryptocrystalline groundmass shows flowage structure and spherulites; plagioclase phenocrysts are in part angular fragments and in part are corroded and embayed; most of the visible quartz is in cavity fillings. Slide shows crystal and rock fragments in a microspherulitic groundmass. Grain size: rock fragments and phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite flow-breccia.*

Stanolind #2 Fisher core 8300-05 Stanolind Oil & Gas Co.

Slide can be separated into 3 areas megascopically on the basis of color and texture.

(1) Groundmass (38%), albite (25%), carbonate (25%), quartz (10%), sericite (2%), leucoxene (tr), zircon (tr), rutile (tr). Cryptocrystalline quartz-feldspar groundmass contains albite phenocrysts partly replaced by carbonate; carbonate also fills cavities. Grain size: groundmass cryptocrystalline to 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

(2) Groundmass (59%), carbonate (15%), albite (10%), quartz (5%), sericite (5%), chlorite (3%), rhyolite rock fragment (2%), chert? (1%), magnetite or ilmenite (tr), leucoxene (tr), apatite (tr). Red-stained cryptocrystalline groundmass contains angular fragments of quartz and feldspar; carbonate replaces feldspar and groundmass and occurs in veinlets. Grain size: groundmass cryptocrystalline; quartz and feldspar fragments up to 0.5 mm. Fabric: vitroclastic? Rock: altered *rhyolite tuff.* Note: This rock seems to partly enclose (1) above as if (1) were a pebble fragment in (2).

(3) This rock is separated from (2) by a sharp color line. It consists of a deep red-stained cryptocrystalline groundmass containing albite phenocrysts, the whole almost completely replaced by carbonate. Sericite, chlorite, leucoxene, and magnetite or ilmenite are present in traces. This, like (1), is probably a fragment of rhyolite porphyry in a rhyolite tuff (2).

Summary: The rock is a *rhyolite tuff* containing pebbles of rhyolite porphyry up to 2 cm in diameter.

Stanolind #2 Fisher cuttings 8370-80 Shell Oil Co.

Brown cryptocrystalline material containing angular fragments of quartz and feldspar 0.1 mm and cavities filled with epidote, chlorite, or carbonate. Cavities are up to 0.5 mm in diameter and commonly show a drusy interior surface. Magnetite or ilmenite and leucoxene are present in minor amounts. A second slide from the same depth is composed of angular fragments of quartz and feldspar in a brown cryptocrystalline mass that is partly altered to chlorite. Traces of leucoxene and zircon are present. Rock is either a *rhyolite* flow with fragments of tuff included or a *rhyolite tuff-breccia* including pieces of rhyolite.

Stanolind #2 Fisher cuttings 8370-90 Bureau of Economic Geology

Groundmass (64%), albite (10%), sericite (10%), chlorite (5%), epidote (5%), calcite (4%), magnetite or ilmenite (2%), apatite (tr). Brown cryptocrystalline to microcrystalline groundmass shows flowage structure and contains coarser stringers and "eyes" of quartz; locally it is vuggy, partly epidotized, sericitized, or chloritized; plagioclase occurs as sericitized phenocrysts; epidote and chlorite occur in vugs and, locally, replace parts of the groundmass; calcite is in a cross-cutting veinlet. Some fragments in the slide appear to have a vague "shard" fabric and may be tuff. Grain size: groundmass mostly cryptocrystalline; phenocrysts up to 1 mm. Fabric: porphyritic (some fragments pyroclastic?). Rock: *rhyolite porphyry* and *rhyolite tuff?.*

Stanolind #1 Hegi core 9974-74½ Stanolind Oil & Gas Co.

Groundmass (89%), microperthite (5%), albite (5%), opaque mineral, no metallic luster (1%), apatite (tr), zircon (tr). Groundmass is a microcrystalline microgranular aggregate of quartz and feldspar in a brown cryptocrystalline mass that is partly altered to chlorite. Traces of leucox- talline to 0.02 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

HALL COUNTY

Amerada #1 Hughes cuttings 8108 Bureau of Economic Geology

Oligoclase (65%), quartz (20%), alkali feldspar (10%), biotite (2%), magnetite or ilmenite (2%), chlorite (1%), epidote (tr), apatite (tr), red iron oxide (tr). Plagioclase is partly sericitized; alkali feldspar is interstitial to plagioclase subhedrons; biotite is in altered relicts. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Humble #1 Weaver core 4820-40 Stanolind Oil & Gas Co.

Albite (74%), quartz (10%), microperthite (5%), hornblende (5%), chlorite (3%), magnetite or ilmenite (3%), epidote (tr), sphene (tr), calcite (tr), zircon (tr), apatite (tr). Plagioclase is partly sericitized; hornblende pleochroism is pale yellow-green to green; chlorite and epidote are derived from alteration of the hornblende; calcite occurs in veinlets. Grain size: average 1 to 3 mm, maximum 8 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

Humble #1 Weaver cuttings 4839-40 Bureau of Economic Geology

Albite-oligoclase (63%), quartz (20%), microperthite (10%), chlorite (5%), sericite (2%), apatite (tr), calcite (tr), biotite (tr), zircon (tr). Plagioclase is partly sericitized and shows bent twin lamellae; quartz shows marked strain and occurs in mosaics of grains showing dimensional orientation; microperthite occurs as large grains, in veinlets and crack fillings, and as spongy masses; chlorite is in small oriented plates after biotite; biotite relicts are present; sericite, apart from that in plagioclase, occurs as flakes and fibers. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular—gneissic—cataclastic. Rock: *granodiorite gneiss.*

HARTLEY COUNTY

Bridwell #1 Houghton cuttings 4450-60 Humble Oil & Rfg. Co.

Groundmass (86%), albite (10%), quartz (1%), chlorite (1%), leucoxene (1%), red iron oxide (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Cryptocrystalline to microgranular groundmass, showing pronounced flowage, contains microspherulitic areas, with sporadic large spherulites, and filled vesicles with devitrified rims—apparently the groundmass is mostly alkali feldspar but quartz is visible in coarse areas; albite occurs as phenocrysts; chlorite is in part in oriented plates after biotite phenocrysts and in part replaces feldspar; quartz is limited to small grains in coarser parts of the groundmass. Grain size: groundmass cryptocrystalline to 0.02 mm; phenocrysts 0.5 to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Bridwell #1-A Houghton cuttings 4430-58 Humble Oil & Rfg. Co.

Groundmass (85%), microperthite and albite (10%), calcite (3%), magnetite or ilmenite (1%), chlorite (1%), leucoxene (tr), quartz (tr), apatite (tr), zircon (tr). Groundmass shows varied textures in an over-all cryptocrystalline matrix; locally it is microgranular, perlitic, microspherulitic; flowage structures and trichitic crystallites are also present; albite and microperthite form phenocrysts; quartz is present in local coarsenings in the groundmass in only a few fragments; calcite veinlets transect the rock. Perlitic structure indicates a siliceous rock though quartz is not visible in the cryptocrystalline groundmass. Grain size: groundmass cryptocrystalline to 0.05 mm; phenocrysts 0.2 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Bridwell #2-A Houghton cuttings 4080-4110 Humble Oil & Rfg. Co.

Groundmass (87%), microperthite and albite (12%), magnetite or ilmenite (1%), leucoxene (tr), chlorite (tr), red iron oxide (tr), apatite (tr), zircon (tr). Quartz-alkali feldspar groundmass is microgranular to micrographic and contains local coarsenings of quartz; microperthite and albite are phenocrysts. Grain size: groundmass less than 0.01 to 0.1 mm; phenocrysts 0.2 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #2 Shelton cuttings 2990 Bureau of Economic Geology

Albite (53%), microperthite (25%), quartz (20%), magnetite or ilmenite and red iron oxide (2%), leucoxene (tr), calcite (tr), chlorite (tr). Albite is partly altered to sericite and kaolinite; quartz is in part in micrographic intergrowth with partly kaolinized alkali feldspar. Grain size: 0.2 to 2 mm; micrographic intergrowth 0.02 to 0.1 mm. Fabric: ranges from hypidiomorphic granular to micrographic. Rock: *albite granodiorite.*

Humble #2 Shelton cuttings 3048 Bureau of Economic Geology

Microperthite and albite (78%), quartz (20%), magnetite or ilmenite (1%), leucoxene (1%), fluorite (tr), chlorite (tr), apatite (tr). Feldspar is partly kaolinized—albite is the predominant feldspar; quartz is in part in micrographic intergrowth with alkali feldspar. Grain size: 0.2 to 2 mm; intergrowth 0.1 to 0.2 mm. Fabric: ranges from hypidiomorphic granular to micrographic. Rock: *albite granodiorite.*

Kerr-McGee #2 Berneta cuttings ? Bureau of Economic Geology

Groundmass (75%), albite (10%), quartz (7%), microperthite (5%), leucoxene and magnetite or ilmenite (2%), chlorite (1%), sericite (tr), zircon (tr). Microgranular groundmass is apparently composed mostly of quartz and alkali feldspar, locally it is microspherulitic; albite and microperthite form phenocrysts; quartz phenocrysts are round and embayed; chlorite is probably after biotite. Grain size: groundmass less than 0.02 with spherulites up to 0.2 mm; phenocrysts are up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Kerr-McGee #3 Berneta core 5878-81 Bureau of Economic Geology

Microperthite (38%), albite-oligoclase (25%), quartz (15%), chlorite (7%), biotite (6%), red iron oxide (4%), magnetite or ilmenite (2%), leucoxene (2%), apatite (1%), calcite (tr), zircon (tr). Plagioclase is zoned, partly kaolinized, and locally mantled with alkali feldspar; biotite, pale to reddish brown pleochroism, is partly altered to chlorite; chlorite is derived from alteration of biotite but also occurs in granular masses replacing feldspar; leucoxene replaces sphene; red iron oxide forms irregular masses in plagioclase grains. Grain size: 1 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granite.* (Photomicrograph, Pl. X, C.)

Kerr-McGee #1 Shelton core 3892 Bureau of Economic Geology

Groundmass (87%), albite phenocrysts (10%), magnetite or ilmenite (2%), quartz (1%), leucoxene (tr), chlorite (tr), sericite-muscovite (tr), apatite (tr), zircon (tr). Quartz-alkali feldspar groundmass is microgranular; albite phenocrysts are partly sericitized; quartz occurs as phenocrysts and as mosaics of smaller grains in local coarsenings in the groundmass; chlorite and sericite-muscovite also occur in local coarsenings in the groundmass. Grain size: groundmass 0.01 to 0.05 mm; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Phillips #1-GG Bivins cuttings 6130-76 Humble Oil & Rfg. Co.

Microperthite (40%), albite (34%), quartz (20%), bleached biotite (2%), magnetite or ilmenite (2%), red-brown iron oxide (1%), leucoxene (1%), chlorite (tr), apatite (tr), zircon (tr). Rock is composed of a granular mass of quartz and feldspar containing feldspar phenocrysts; about 4 percent of the microperthite and 8 percent of the albite exist as phenocrysts; plagioclase phenocrysts are zoned and partly sericitized. Grain size: groundmass 0.2 to 0.5 mm; phenocrysts 1 to 2 mm. Fabric: hypidiomorphic granular—porphyritic. Rock: *microgranite porphyry.*

Pure #1 Lankford core 7848 Stanolind Oil & Gas Co.

Microperthite (60%), quartz (25%), albite (10%), chlorite (3%), sericite (1%), magnetite or ilmenite (1%), leucoxene (tr), zircon (tr). Microperthite, partly kaolinized, occurs in subhedrons and as crack fillings; it apparently has crystallized around embayed and corroded quartz grains; albite is partly sericitized. Grain size: 3 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Stanolind #1 Beck core 5955-59 Stanolind Oil & Gas Co.

Groundmass (89%), sericite (5%), feldspar (4%), chlorite (2%), leucoxene (tr), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Microcrystalline groundmass shows sub-micrographic and sub-myrmekitic quartz-feldspar intergrowths; relict phenocrysts of feldspar are in advanced stage of sericitization and the nature of the feldspar cannot be determined; sericite is from alteration of feldspar phenocrysts; chlorite and leucoxene were derived from alteration of biotite. Grain size: groundmass about 0.01 mm; relict phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: altered *rhyolite porphyry.*

Texas Gulf #1 Matador core 4800-02 Bureau of Economic Geology

Groundmass (82%), albite-oligoclase (9%), quartz (5%), magnetite or ilmenite (2%), leucoxene (1%), alkali feldspar (1%), red iron oxide (tr), zircon (tr), apatite (tr). Quartz-alkali feldspar-chlorite groundmass is microgranular to micrographic; alkali feldspar and albite-oligoclase form phenocrysts; quartz is in cross-cutting veinlets. Grain size: groundmass 0.01 to 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

HOCKLEY COUNTY

Big Chief #1 Deloache cuttings 11445-50 Bureau of Economic Geology

Groundmass (74%), albite (20%), leucoxene (3%), bleached biotite? (2%), magnetite or ilmenite (1%), apatite (tr), zircon (tr). Brown, partly kaolinized groundmass is in part micrographic and locally shows vague indications of microspherulitic structure—throughout it contains minute scattered grains of opaque mineral; leucoxene occurs as tiny dispersed grains and perhaps much of the opaque mineral in groundmass is leucoxene; plagioclase occurs as partly sericitized phenocrysts and is probably albite; colorless altered mica containing specks of leucoxene is bleached biotite. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.2 to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1-A Lockett cuttings 12214 Bureau of Economic Geology

Microcline microperthite (65%), quartz (30%), plagioclase (4%), chlorite (1%), leucoxene (tr), zircon (tr), calcite (tr). Kaolinized microcline microperthite is micrographically intergrown with quartz—intergrowth is irregular to cuneiform; plagioclase, likewise kaolinized, occurs as small tablets between larger grains of potassium feldspar and quartz; calcite occurs in veinlets. Grain size: 1 to 3 mm; intergrowth 0.1 to 0.2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Honolulu and Signal #1 Elwood Est. cuttings 11630-32 Shell Oil Co.

Groundmass (90%), quartz, albite, chlorite (10%). Microcrystalline micrognanular groundmass shows flowage structure and local coarsenings of quartz and alkali feldspar. Grain size: less than 0.02 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu and Sunray #1 Moore core 11304-05 Bureau of Economic Geology

Groundmass (90%), albite (4%), microperthite (4%), calcite (1%), leucoxene (1%), chlorite (tr), zircon (tr). Microgranular quartz-alkali feldspar groundmass contains local microspherulitic coarsenings and shows flowage structure; calcite occurs in local coarsenings; feldspar occurs as phenocrysts. Grain size: groundmass is mostly less than 0.02 mm with local coarse areas up to 0.2 mm; phenocrysts 1 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Campbell cuttings 11621 Shell Oil Co.

Plagioclase (50%), chlorite (30%), red iron oxide (10%), unidentified fibrous mineral (5%), leucoxene (4%), magnetite or ilmenite (1%), apatite (tr). Rock is in advanced stages of alteration; lath-like habit of feldspar is still discernible; low index of refraction of feldspar (less than 1.54) indicates it is albite—this is probably the result of alteration of a more calcic variety; the other minerals in the rock have altered to a mass of chlorite and leucoxene; red iron oxide has flooded the rock, obscuring relations of minerals. Grain size: originally 0.5 to 1.0 mm. Fabric: relict subophitic. Rock: altered *albite diabase.*

Humble #1 Campbell cuttings 11690-00 Shell Oil Co.

Albite (68%), chlorite (15%), magnetite or ilmenite, leucoxene, and red iron oxide (8%), quartz (5%), epidote (4%), rutile? (tr). Rutile? occurs as very fine needles in quartz; albite is probably the result of alteration of a more calcic plagioclase. Grain size: 0.1 to 0.5 mm. Fabric: subophitic. Rock: altered *albite diabase.*

Humble #1 Campbell cuttings 11710-20 Bureau of Economic Geology

Albite or oligoclase (54%), chlorite (30%), magnetite or ilmenite (8%), epidote (4%), calcite (3%), augite (1%). Plagioclase laths are in a triangular orientation and are partly altered to chlorite and stained with iron oxide; chlorite is a fine granular variety replacing augite in the ophitic fabric; augite relicts occur in the chlorite; epidote occurs with chlorite; magnetite or ilmente is partly altered to red iron oxide. Plagioclase in this rock shows a variable soda content (range from albite to oligoclase) which is the result of alteration; the original plagioclase was probably more calcic. Grain size: 0.2 to 0.5 mm. Fabric: relict ophitic. Rock: altered *albite diabase.*

Humble #1 Campbell core 11720 Stanolind Oil & Gas Co.

Albite (72%), chlorite (10%), epidote (7%), augite (5%), magnetite or ilmenite (4%), calcite (2%), red iron oxide (tr), apatite (tr). Chlorite occurs in fine granular masses replacing the original ferromagnesian minerals and, in part, plagioclase; augite is brownish and probably titaniferous; original calcic plagioclase is apparently altered to albite and epidote. Grain size: 0.3 to 0.5 mm. Fabric: subophitic. Rock: altered *albite diabase.*

Humble #1 Hobgood cuttings 9060-9250 Humble Oil & Rfg. Co.

Albite? (59%), chlorite (20%), sericite (10%), magnetite or ilmenite (5%), leucoxene (3%), quartz (2%), biotite and hornblende relicts (1%), apatite (tr). Plagioclase is in advanced stage of sericitization, its sodic nature is probably the result of alteration of a more calcic variety; chlorite occurs in granular masses and is pseudomorphous after a primary ferromagnesian mineral; magnetite or ilmenite is partly altered to red iron oxide; biotite and hornblende relicts are engulfed in masses of chlorite. Grain size: 0.5 to 1 mm. Fabric: relict hypidiomorphic granular. Rock: sericitized, chloritized *albite microdiorite.*

Humble #1 Hobgood cuttings 9250-65 Humble Oil & Rfg. Co.

Labradorite (59%), chlorite (13%), augite (10%), amphibole (5%), magnetite or ilmenite (7%), leucoxene (3%), calcite (2%), apatite (1%), pyrite (tr). Plagioclase is zoned; two kinds of chlorite are present—a green variety (5%) and a more highly birefringent brown variety that occurs with calcite as a result of alteration of ferromagnesian minerals (8%); the amphibole, brownish to blue-green pleochroism, is secondary, occurs with chlorite, and is a result of alteration of pyroxene and/or olivine—it occurs in fibrous masses. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *gabbro.*

Humble #1 Hobgood cuttings 9465-90 Humble Oil & Rfg. Co.

More altered than 9250-65 with masses of vuggy chlorite and some epidote—no unaltered pyroxene.

Humble #1 Hobgood cuttings 9595-? Humble Oil & Rfg. Co.

Same as 9465-90—advanced chloritization and epidotization of an original gabbroic rock.

Humble #1 Hobgood core 9917 Bureau of Economic Geology

Epidote (45%), quartz? (40%), chlorite (7%), quartz (3%), leucoxene (3%), magnetite or ilmenite (1%), zeolite? (1%). Spongy quartz? filled with myriad inclusions occurs with epidote to make up the mass of the rock; clear quartz occurs in chlorite-lined cavitites; zeolite fills some chlorite-lined cavities; leucoxene occurs in fine scattered grains. Grain size: 0.1 to 0.2 mm. Fabric: metasomatic. Rock: *quartz-epidote rock.*

Humble #1 Hobgood core 9919 (cut normal to core) Bureau of Economic Geology

Quartz and feldspar (53%), epidote (30%), chlorite (10%), sphene (4%), red-brown iron oxide (3%). Quartz is cloudy and turbid with inclusions but there are some clear grains; feldspar is brownish and partly sericitized; sphene occurs in finely divided small aggregates cloudy with leucoxene alteration; chlorite occurs in large masses. Grain size: 0.2 mm. Fabric: crystalloblastic (sieve). Rock: altered *feldspar-epidote-quartz* rock.

Humble #1 Hobgood core 9919 (cut parallel to core) Humble Oil & Rfg. Co.

Same as preceding 9919 but with veinlets of very low relief material = zeolite?.

Humble #1 Hobgood core 9924 (cut normal to core) Humble Oil & Rfg. Co.

Albite (73%), chlorite (10%), epidote and sphene (10%), calcite (4%), magnetite or ilmenite (2%), hematite (1%). Plagioclase occurs as non-oriented laths; the sodic plagioclase, albite, may be a result of alteration of a more calcic feldspar; sphene and epidote occur in very small scattered grains; calcite is present as grains and in veinlets; chlorite occurs in fine-grained masses. Grain size: plagioclase laths 0.02 x 0.1 mm. Fabric: microlitic—a felt of non-oriented feldspar microlites. Rock: altered *albite andesite.*

Humble #1 Hobgood core 9924 (cut parallel to core) Humble Oil & Rfg. Co.

Similar to preceding 9924.

Humble #1 Hobgood core 10174 Humble Oil & Rfg. Co.

Groundmass (90%), alkali feldspar (4%), plagioclase (4%), quartz (1%), leucoxene (1%), apatite (tr), red iron oxide (tr). Rust-colored mostly cryptocrystalline groundmass contains scattered equi-extinguishing masses apparently of feldspar grains; flowage is pronounced and defined in part by strings of feldspar grains; phenocrysts of alkali feldspar show minor perthitic development and plagioclase phenocrysts are partly sericitized; quartz occurs in veinlets parallel to the flow structure and in local coarser areas; probably it is mostly secondary. Grain size: groundmass mostly cryptocrystalline; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Hobgood core 10174 Bureau of Economic Geology

Groundmass (87%), albite (5%), microperthite (5%), sericite (1%), calcite (1%), quartz (1%), ilmenite (tr), leucoxene (tr), apatite (tr), zircon (tr), red iron oxide (tr). Micrographic groundmass is partly kaolinized; albite, partly sericitized, and microperthite occur as phenocrysts; calcite occurs in veinlets and masses and locally cements brecciated zones; quartz occurs in veinlets. Grain size: groundmass less than 0.04 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Hobgood core 10175 Humble Oil & Rfg. Co.

Similar to 10174 but with more microcrystalline material in the groundmass which is micrographic in some areas. A zircon (tr) was seen in this slide.

Humble #1 Hobgood core 10177 Humble Oil & Rfg. Co.

Similar to 10175 but with a layer of cryptocrystalline material through the center of the slide.

Humble #1 Hobgood core 10179 Humble Oil & Rfg. Co.

Groundmass (81%), quartz (10%), microperthite (5%), albite (3%), red iron oxide (1%), apatite (tr), zircon (tr). Brown cryptocrystalline to microcrystalline groundmass contains elongated vesicles filled with secondary quartz parallel to the flow structure. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

HUDSPETH COUNTY

American Land #1 Roseborough cuttings 1600-10 Stanolind Oil & Gas Co.

Groundmass (82%), feldspar (15%), quartz (3%), zircon (tr), pyrite (tr), red iron oxide (tr). Groundmass is microgranular and composed mostly of kaolinized alkali feldspar partly replaced by calcite; it also contains some sericite fibers; feldspar phenocrysts are altered and probably both alkali feldspar and albite are present; quartz occurs in veinlets and as sporadic small phenocrysts. Grain size: groundmass 0.05 to 0.2 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: altered *rhyolite porphyry.*

American Land #1 Roseborough cuttings 1625-1787 Stanolind Oil & Gas Co.

Similar to 1600-10 but contains traces of magnetite or ilmenite, apatite, and biotite partly altered to chlorite.

California #1 Theison cuttings 4844-48 Bureau of Economic Geology

Microperthite (66%), quartz (25%), biotite (4%), albite (3%), magnetite or ilmenite (2%), apatite (tr), fluorite (tr), zircon (tr), calcite (tr). Microperthite is in part kaolinized and is in part micrographically intergrown with quartz—intergrowth is mostly irregular but locally it is cuneiform; quartz also occurs as large clear grains; biotite is intensely colored red-brown and is partly altered; zircons are large. Grain size: 0.5 to 2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Seaboard and Shamrock #1 University "C" cuttings ±1300 Shell Oil Co.

Alkali feldspar (68%), albite (15%), aegirine or aegirine augite (15%), analcite (2%). Feldspar is in non-oriented laths. Grain size: 0.2 mm. Fabric: microlitic. Rock: *analcitic aegirine trachyte.* [Rock occurs in a 70-foot thick sill. Tertiary?—not basement.]

JEFF DAVIS COUNTY

Continental #1 McCutcheon — cuttings 7620-30 — Bureau of Economic Geology

Augite (35%), alkali feldspar groundmass (31%), calcic plagioclase (20%), magnetite or ilmenite (5%), chlorite? (3%), biotite (3%), olivine (2%), calcite (1%), apatite (tr). Strongly tinted augite occurs as larger grains or phenocrysts and as smaller grains; alkali feldspar groundmass acts as a host or mesostasis to the earlier forming constituents; biotite is red-brown; olivine is partly altered to a green fibrous mineral with moderate but variable birefringence that is probably a chlorite. Grain size: 0.1 to 0.2 mm. Fabric: hypidiomorphic granular. Rock: *olivine microsyenogabbro.* [Tertiary?—not basement.]

JONES COUNTY

Hunter & Hunter #1 Steele — cuttings 5090-93 — Bureau of Economic Geology

Groundmass (96%), magnetite or ilmenite (3%), sericite and muscovite (1%). Microgranular quartz-alkali feldspar groundmass shows vague parallel or layered structure—flowage structure? bedding?. Some plagioclase is included in the groundmass and is distinguished by development of fine sericite fibers; magnetite or ilmenite is in fine dispersed grains. Grain size: groundmass less than 0.02 mm but locally as much as 0.1 mm with sporadic quartz grains up to 0.5 mm. Fabric: microgranular. Rock: *rhyolite?; metarkosite?.*

Hunter #1 Steele — cuttings 5093-95 — Bureau of Economic Geology
Same as 5090-93.

KENT COUNTY

General Crude #1 P. Jones — cuttings 7580-90 — Bureau of Economic Geology

Feldspar—plagioclase? (59%), groundmass (30%), rock fragments (5%), quartz (3%), leucoxene (2%), magnetite or ilmenite (1%), apatite (tr), epidote (tr), calcite (tr). Completely sericitized feldspar phenocrysts were probably originally plagioclase; groundmass, microgranular, is composed of quartz-alkali feldspar, biotite (green-brown), and sericite, more coarsely crystalline in the stress lees of phenocrysts; quartz is largely secondary; rock fragments are micrographic rhyolite; rock has apparently been brecciated and "healed" with secondary quartz. Grain size: groundmass less than 0.02 mm; phenocrysts 0.2 to 1 mm. Fabric: porphyritic—cataclastic. Rock: *brecciated rhyolite porphyry.*

General Crude #82-1 Jones — core 7669-84 — Bureau of Economic Geology

Microcline and albite-oligoclase (52%), argillaceous material (25%), quartz (10%), chlorite (8%), epidote (2%), leucoxene (2%), calcite (1%), magnetite or ilmenite (tr), sphene (tr), apatite (tr), zircon (tr). Feldspar, about equal amounts of microcline and albite-oligoclase, occurs in bent, fractured, and partly crushed grains; a whitish semi-opaque argillaceous material forms a breccia matrix in parts of the rock; quartz occurs in fractured and crushed grains and in veinlets; chlorite, with epidote, invades brecciated and crushed zones; leucoxene occurs in chlorite masses. Grain size: from fine crush material up to 5 mm. Fabric: cataclastic. Rock: cataclastically altered *granite.*

Humble #14 Spires — cuttings 8260-70 — Bureau of Economic Geology

Microcline and albite (67%), quartz (25%), biotite (5%), ilmenite (2%), epidote (1%), muscovite (tr), calcite (tr), leucoxene (tr), sphene (tr). Feldspar is probably mostly microcline, albite is locally poikilitic (porphyroblastic?) and partly sericitized; quartz occurs as discrete equant grains as inclusions in feldspar and between feldspar; biotite pleochroism is yellow-brown to very dark brown. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular-poikilitic. Rock: *microgranite.* Two fragments in this slide are composed of coarser quartz, microcline microperthite, and albite. Grain size: 4 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Superior #8 Wood "194" — cuttings 7890-7900 — Bureau of Economic Geology

Microcline (50%), andesine (35%), quartz (10%), hornblende (3%), biotite (1%), epidote (1%), apatite (tr). Plagioclase is partly sericitized, variety was determined by relief estimation; hornblende pleochroism is yellow-green to green; biotite is green-brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

KIMBLE COUNTY

Humble #1 Bolt core 4167-70 Humble Oil & Rfg. Co.

Plagioclase (61%), hornblende (20%), biotite (10%), epidote (5%), magnetite or ilmenite (4%), apatite (tr). Hornblende, almost colorless to pale yellow-green-brown pleochroism, is in part altered to epidote and shows a rude parallel orientation; biotite is a red-brown variety and likewise rudely oriented. Grain size: 0.1 to 0.2 mm. Fabric: crystalloblastic. Rock: *biotite amphibolite.*

Humble #1 Bolt core 4167-70 Humble Oil & Rfg. Co.

Similar to above, but hornblende shows alteration to a fibrous, colorless, moderate to highly birefringent mineral.

Phillips #1 Spiller cuttings 4255-60 Bureau of Economic Geology

Microcline (43%), oligoclase (25%), quartz (25%), biotite (5%), chlorite (1%), ilmenite (1%), leucoxene (tr), myrmekite (tr), apatite (tr). Microcline is locally microperthitic; plagioclase is variably altered to sericite and is locally anti-perthitic; biotite is green-brown to very dark brown; ilmenite is enveloped by leucoxene. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

KING COUNTY

Continental #1 Martin cuttings 6980-90 Shell Oil Co.

Albite (68%), biotite (20%), chlorite (5%), quartz (5%), calcite (2%), apatite (tr), zircon (tr). Biotite is partly altered to chlorite. Grain size: 0.2 to 0.4 mm. Fabric: hypidiomorphic granular. Rock: *albite microdiorite.*

Continental #1 Martin cuttings 6990-7000 Shell Oil Co.

Two grains of microcline microperthite 1 mm in size.

Continental #1 Martin cuttings 7010-20 Shell Oil Co.

Microcline microperthite (85%), albite (10%), quartz (3%), sericite (2%), calcite (tr). Grain size: 3 mm. Fabric: hypidiomorphic granular.

Continental #1 Martin cuttings 7045-50 Shell Oil Co.

Microcline microperthite (91%), magnetite or ilmenite (5%), muscovite or sericite (2%), chlorite (2%), biotite (tr). Albite includes patches of microcline.

Continental #1 Martin cuttings 6980-90; 7165-70; 7200-01 Shell Oil Co.

Slides show scattered individual grains of microperthite, albite, quartz, and biotite altered to chlorite. Grain size: about 2 mm. Fabric: hypidiomorphic granular. Rock probably a *granite.*
Summary for 6980-7201: plutonic rock, probably of *granitic* or *syenitic* composition.

Continental #1 Martin cuttings 7220 Bureau of Economic Geology

Microcline microperthite (78%), albite (10%), quartz (8%), biotite (3%), calcite (1%), red iron oxide (tr), apatite (tr), zircon (tr). Microcline microperthite is locally micrographically intergrown with quartz; albite shows incipient alteration to sericite and locally is myrmekitic; biotite, yellow-brown to dark brown pleochroism, is commonly so oxidized as to be almost opaque; calcite is in veinlets. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Humble #4 Bateman core 6388 Humble Oil & Rfg. Co.

Microcline microperthite (66%), quartz (12%), oligoclase (10%), biotite (10%), leucoxene (2%), zircon (tr), sphene (tr), apatite (tr). Perthite is a patch variety with large patches of twinned albite and a very fine vein variety; biotite is deeply colored brown; sphene occurs as masses of small crystals in leucoxene. Grain size: 0.5 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Humble #1 Ross | core 6600-01 | Humble Oil & Rfg. Co.

Microcline (54%), albite-oligoclase (20%), quartz (18%), biotite (7%), chlorite (1%), calcite (tr), fluorite (tr), apatite (tr), zircon (tr). Plagioclase shows incipient alteration to sericite; biotite, pale green-brown to dark brown pleochroism, is partly altered to chlorite; zircon shows distinct zonation. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Ohio #1 Burnett | cuttings 6430-38 | Bureau of Economic Geology

Microcline microperthite (47%), albite (30%), quartz (18%), biotite (3%), chlorite (2%), zircon (tr), fluorite (tr). Microcline microperthite is partly kaolinized; albite is partly sericitized and shows a vague zoning; biotite is a very intensely colored green-brown variety partly altered to chlorite. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranite.*

Ohio #1 Pitchfork | cuttings 6970-75 | Shell Oil Co.

Scattered grains of albite, microcline, quartz, and altered biotite. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: probably a *microgranite.*

Ohio #2-A Ross | cuttings 6473-74 | Bureau of Economic Geology

Microcline microperthite (67%), quartz (20%), albite-oligoclase (10%), magnetite or ilmenite (3%), biotite (tr), hornblende (tr), zircon (tr). Microcline is only sporadically microperthitic; it occurs in large poikilitic grains and it is partly kaolinized; magnetite or ilmenite is in large masses partly altered to red iron oxide; biotite is in bleached relicts partly altered to chlorite; hornblende pleochroism is yellow-green to dark green. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Superior #1 Pitchfork | cuttings 7145 | Shell Oil Co.

Microcline microperthite (90%), quartz (10%). One small fragment. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Superior #2 Pitchfork | cuttings 7041 | Bureau of Economic Geology

Albite-oligoclase and microperthite (85%), quartz (15%), chlorite (tr), apatite (tr). Feldspar is so sericitized and kaolinized as to be almost opaque. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *granite* or *granodiorite.*

KNOX COUNTY

Seaboard #1 Big Four Ranch | cuttings 7030-40 | Bureau of Economic Geology

Microcline (60%), oligoclase (20%), quartz (12%), biotite (5%), chlorite (2%), leucoxene (1%), magnetite or ilmenite (tr). Large poikilitic microcline host grains include plagioclase, biotite, and quartz grains; oligoclase is partly sericitized; biotite is a dark green-brown variety partly altered to chlorite; leucoxene is after sphene. Grain size: host microclines up to 5 mm; inclusions 0.2 to 0.5 mm. Fabric: poikilitic. Rock: *granite.*

LAMB COUNTY

Anderson-Prichard #1 Gettys | cuttings 9300-10 | Bureau of Economic Geology

Albite, alkali feldspar, hornblende, chlorite, magnetite or ilmenite, calcite, biotite, leucoxene, and apatite. Slide is poor and contains only a few fragments. Feldspar is partly kaolinized; calcite occurs as veinlets. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *albite syenodiorite.*

Honolulu #1 Halsell | cuttings 9120-30 | Bureau of Economic Geology

Groundmass (86%), quartz (10%), relict feldspar phenocrysts (3%), leucoxene (1%), apatite (tr), magnetite or ilmenite (tr), biotite relicts (tr). Red-stained microcrystalline groundmass is composed of feldspar-quartz-sericite-finely divided opaque mineral and red iron oxide and contains oriented quartz-filled vesicles; it is predominantly microgranular but locally it is micrographic; quartz fills vesicles and forms cross-cutting veinlets; rock shows abrupt changes in grain size and intensity of staining. Grain size: groundmass ranges from cryptocrystalline to 0.2 mm but most of it is less than 0.05 mm. Fabric: microgranular, very sparsely porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 Halsell core 9137 Honolulu Oil Corp.

Rocks shows layers 2 to 4 mm wide which are distinguished by difference in grain size. Groundmass (92%), altered relicts of feldspar phenocrysts (5%), leucoxene (2%), sericite (1%), apatite (tr), zircon (tr), magnetite or ilmenite (tr). Two types of groundmass material, arranged in layers, are present: (a) micrographic intergrowth of quartz and alkali feldspar with grain size up to 0.2 mm and (b) cryptocrystalline groundmass with oriented lenses and veinlets of quartz (15%); relict feldspar phenocrysts appear to be a fine granular mass of alkali feldspar; sericite occurs in scattered flakes and as larger fibrous masses. Grain size: groundmass is cryptocrystalline to 0.2 mm, relict phenocrysts are up to 2 mm, quartz patches are 0.1 to 0.3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 Halsell core 9137 Honolulu Oil Corp.

Same as 9137 above.

Honolulu #1 Halsell core 9137 Honolulu Oil Corp.

Groundmass (76%), quartz (15%), relict phenocrysts (7%), biotite (1%), leucoxene (1%), red iron oxide (tr), apatite (tr), zircon (tr), magnetite or ilmenite (tr). Groundmass is mostly cryptocrystalline and apparently composed mostly of alkali feldspar; outline of relict phenocrysts is visible but the bulk of the phenocrysts seems to be very finely crystalline alkali feldspar similar to that in groundmass; quartz occurs as grains and patches of grains with an irregular edge; in large view quartz shows a vague alignment that might be flowage structure; one relict biotite plate is altered to leucoxene and sericite; finely divided leucoxene occurs throughout the slide. Grain size: groundmass less than 0.01 mm to cryptocrystalline; relict phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Jackson core ? Honolulu Oil Corp.

Groundmass (82%), albite (15%), magnetite or ilmenite (3%), chlorite (tr), apatite (tr), zircon (tr), red iron oxide (tr), calcite (tr). Micrographic quartz-feldspar groundmass is mostly feldspar in tiny subhedrons with quartz more or less interstitial—micrographic texture is poorly developed; plagioclase phenocrysts show a vague zoning and incipient alteration to sericite; magnetite or ilmenite occurs in large grains and as small grains scattered throughout the slide. Grain size: groundmass 0.05 to 0.1 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Jackson cuttings 7186 Shell Oil Co.

Groundmass (94%), albite (5%), magnetite or ilmenite (1%). Groundmass is micrographic; albite occurs as phenocrysts. Grain size: groundmass 0.02 to 0.04 mm; phenocrysts up to 0.2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Jackson core 7186-91 Stanolind Oil & Gas Co.

Groundmass (81%), albite (12%), microperthite (5%), magnetite (2%), apatite (tr), chlorite (tr), calcite (tr). Microgranular quartz-alkali feldspar-finely divided opaque mineral groundmass is partly kaolinized and stained with red iron oxide; albite and microperthite occur as phenocrysts. Grain size: groundmass 0.02 to 0.05 mm; phenocrysts 1 to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

San Juan #1 Jones cuttings 8990-9000 Bureau of Economic Geology

Groundmass (85%), albite (10%), chlorite (3%), leucoxene (1%), calcite (1%), quartz (tr), apatite (tr). Red-stained, micrographic quartz-alkali feldspar groundmass contains finely dispersed chlorite fibers; fractured albite phenocrysts are veined with chlorite which also forms fibrous masses; calcite and quartz occur as veinlets. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Seaboard #1 Jackson cuttings 9300-10 Bureau of Economic Geology

Groundmass (80%), albite and alkali feldspar (10%), calcite (4%), leucoxene (3%), red iron oxide (2%), pyrite (1%), apatite (tr), zircon (tr). Groundmass consists of patches of brown cryptocrystalline low-relief material showing flowage structure or vitroclastic structure that appear to be fragments of devitrified flow rock or tuff set in a coarser microcrystalline aggregate of albite-sericite-quartz; in some fragments there are banded and concentric structures formed by secondary silica; larger grains of plagioclase and alkali feldspar occur in the microcrystalline material. Grain size: groundmass less than 0.1 mm; feldspar grains up to 1 mm. Fabric: pyroclastic. Rock: *rhyodacite tuff.*

Stanolind #1 Hopping core 9600-24 Bureau of Economic Geology

Albite and fine interstitial material (71%), magnetite or ilmenite (7%), sericite (5%), clay minerals (5%), rock fragments (5%), chlorite (3%), leucoxene (2%), red iron oxide (2%), apatite (tr). Plagioclase occurs as partly sericitized lath fragments which grade downward in size without distinct break to a feldspathic groundmass (20%); magnetite or ilmenite occurs as large grains and fine scattered grains; sericite and clay mineral are throughout the slide as an alteration product; rock fragments are volcanic; viewed megascopically the slide shows a parallel layering that may be stratification. Grain size: 0.02 to 0.2 mm. Fabric: pyroclastic?. Rock: altered *albite andesite tuff* or *flow*.

Stanolind #1 Hopping core 9602-14 Bureau of Economic Geology

Groundmass (81%), albite (10%), calcite (3%), magnetite or ilmenite (3%), red iron oxide (2%), chlorite (1%), quartz (tr). Rock shows a stratification when the thin section is viewed megascopically but this is not apparent under the microscope; albite occurs as angular, broken grains and as round embayed grains. Grain size: albite fragments less than 0.2 mm; groundmass less than 0.02 mm. Fabric: pyroclastic. Rock: *albite andesite? tuff.*

Stanolind #1 Hopping core 9606-14 Bureau of Economic Geology

Albite-oligoclase (48%), groundmass (22%), chlorite (8%), montmorillonite? (5%), sericite (5%), amygdules—epidote-chlorite-albite-montmorillonite? (5%), magnetite or ilmenite (3%), calcite (2%), red iron oxide (1%), leucoxene (1%), apatite (tr). Plagioclase occurs as partly sericitized phenocrysts and as amygdule fillings; the latter are more sodic; groundmass is mostly plagioclase and there is no sharp break between phenocrysts and groundmass; sericite, chlorite, and montmorillonite? are widespread as alteration products; amygdules are filled with epidote, commonly as a core, chlorite, albite, and montmorillonite?. Grain size: groundmass less than 0.02 mm; phenocrysts 0.2 mm and less; amygdules up to 2 mm. Fabric: porphyritic. Rock: altered *andesite porphyry.*

Stanolind #1 Hopping cuttings 9622-24 Bureau of Economic Geology

Albite (76%), magnetite or ilmenite (15%), leucoxene (5%), red iron oxide (3%), chlorite (1%). Albite is partly sericitized and occurs as large subhedrons in a matrix of smaller grains of the same mineral; magnetite or ilmenite occurs as large masses and as fine scattered grains with leucoxene; some filled-cavity structures are present; the whole is obscured by red iron oxide. Grain size: 0.1 to 0.2 mm. Fabric: pyroclastic?. Rock: *magnetite-albite tuff.*

LAMPASAS COUNTY

Texoleum Trust #1 White cuttings 3000 Bureau of Economic Geology

Quartz (50%), albite (30%), microcline (12%), muscovite (4%), chlorite (2%), calcite (1%), magnetite or ilmenite (1%), pyrite (tr), rutile (tr), hornblende (tr), biotite (tr), sphene (tr). Quartz and feldspar form a granular aggregate; albite is sericitized; muscovite plates are rudely oriented; green-brown hornblende is mostly altered to chlorite. Grain size: 0.2 to 1 mm. Fabric: granoblastic. Rock: *arkose gneiss* or *metarkosite* (Valley Spring gneiss?).

Western Lampasas Oil #1 Whittenburg cuttings 3558-80 Bureau of Economic Geology

Microcline microperthite, quartz, albite, magnetite or ilmenite, fine-crush material, apatite. Only a few fragments in slide and these are mostly mineral fragments. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

LUBBOCK COUNTY

Amerada #1 Stribling cuttings 10650-60; 10650-79; 10675-79 Shell Oil Co.

Groundmass, albite, quartz, apatite, red iron oxide. Quartz-alkali feldspar groundmass shows flowage structure; albite occurs as phenocrysts and is partly sericitized; angular quartz phenocrysts are present in one slide; fragments were so small as to make percentage estimates impractical. Grain size: groundmass 0.05 mm to cryptocrystalline; phenocrysts up to 1 mm long. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Bankline #1-A Elliott cuttings 11400-06 Bureau of Economic Geology

Groundmass (100%), chlorite (tr), leucoxene (tr), red iron oxide (tr), apatite (tr). Brown to gray mostly cryptocrystalline groundmass shows vague obscure shard-like structures that may suggest a relict vitroclastic fabric. Kaolinized areas are apparently altered feldspar grains and there are sporadic unkaolinized remnants; probably 25 percent of the groundmass is composed of these kaolinized feldspar grains. Grain size: groundmass is mostly cryptocrystalline but kaolinized feldspar grains reach 0.2 mm in diameter. Fabric: ? Rock: *tuff* or *flow.*

Honolulu #1 Rhoades cuttings 10450-60 Shell Oil Co.

Alkali feldspar and albite (76%), chlorite (10%), sericite (5%), amphibole (3%), calcite (3%), magnetite or ilmenite (2%), leucoxene (1%), apatite (tr), sphene (tr), fluorite? (tr). Original rock constituents are partly altered—plagioclase to sericite, amphibole to chlorite and calcite, sphene to leucoxene: apatite occurs in needles: amphibole is a brown variety. Grain size: 0.2 mm. Fabric: hypidiomorphic granular. Rock: *microsyenite.*

Honolulu #1 Rhoades cuttings 10450-60 Shell Oil Co.

Albite (72%), chlorite (15%), sericite (5%), leucoxene (5%), magnetite or ilmenite (3%), calcite (tr), apatite (tr). The rock is fine grained with original relations obscured by alteration products. Grain size: 0.2 to 0.5 mm. Fabric: metasomatic. Rock: altered igneous rock—*albite microdiorite.*

Honolulu #1 Rhoades core "top" Honolulu Oil Corp.

Oligoclase (42%), chlorite (15%), calcite (15%), sericite (10%), quartz (5%), magnetite or ilmenite (5%), amphibole (4%), epidote (2%), sphene (1%), apatite (1%). Oligoclase is in advanced stage of sericitization (sodic plagioclase probably results from alteration of more calcic primary plagioclase); calcite-chlorite-epidote is apparently derived from alteration of a ferromagnesian mineral other than amphibole; quartz may be largely secondary; amphibole pleochroism is pale brown to brown; epidote occurs in small scattered grains and in fine granular masses; apatite occurs in long needles. Grain size: 0.2 to 0.5 mm. Fabric: relict hypidiomorphic granular. Rock: altered *quartz microdiorite.*

Honolulu #1 Rhoades core "middle" Honolulu Oil Corp.

Albite (55%), sericite (15%), chlorite (10%), magnetite or ilmenite (8%), calcite (5%), quartz (5%), apatite (1%), sphene (1%), leucoxene (tr). Albite is in advanced stage of sericitization and is probably the result of alteration of more calcic plagioclase; calcite occurs as small grains with chlorite as result of alteration of ferromagnesian minerals and as large grains filling cavities; quartz is interstitial to altered feldspar subhedrons and may be partly secondary; sphene is partly altered to leucoxene. Grain size: 0.2 to 1 mm. Fabric: relict hypidiomorphic granular. Rock: *albite-quartz microdiorite.*

Honolulu #1 Rhoades core "bottom" Honolulu Oil Corp.

Albite (62%), chlorite (15%), sericite (10%), calcite (4%), leucoxene (3%), quartz (3%), magnetite or ilmenite (1%), apatite (1%), sphene (1%). Albite, partly sericitized, occurs in small laths and as larger phenocrysts; quartz occurs as clusters of grains that may be secondary; leucoxene occurs as finely divided grains throughout slide probably as a result of alteration of sphene. Grain size: groundmass 0.2 to 0.4 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *albite microdiorite porphyry.*

Humble #1 Farris core 11778-83 Humble Oil & Rfg. Co.

Groundmass (53%), plagioclase and microperthite (30%), filled vesicles (4%), magnetite or ilmenite (4%), chlorite (4%), quartz (3%), red iron oxide (1%), calcite (1%), leucoxene (tr), myrmekite (tr), muscovite (tr), apatite (tr), zircon (tr). Cryptocrystalline to micrographic red-stained groundmass shows flowage structure; plagioclase is partly sericitized and is probably albite: it occurs with microperthite as phenocrysts; quartz occurs as embayed phenocrysts; vesicles are criss-crossed with open lattice work of feldspar laths and the cavities are filled with iron oxide, calcite, and quartz. Grain size: groundmass cryptocrystalline to 0.2 mm; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Farris core 11780 Bureau of Economic Geology

Groundmass (71%), albite (8%), microperthite (7%), quartz (3%), magnetite or ilmenite (3%), clay mineral (3%), rock fragment? (2%), leucoxene (1%), red iron oxide (1%), calcite (1%), muscovite (tr), apatite (tr), zircon (tr). Micrographic groundmass shows wide variation in grain size from areas where the micrographic character is barely discernible to equi-extinguishing patches up to 0.5 mm in diameter; around the edges of some of the larger quartz phenocrysts are fine grains of micrographically intergrown feldspar up to 0.1 mm;

quartz, albite, and microperthite occur as phenocrysts; apatite is associated with the opaque mineral and with grayish-brown fine granular material that occurs in round patches and may be a clay mineral. Grain size: groundmass up to 0.5 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Magnolia #1 Johnson core 10171-78 Stanolind Oil & Gas Co.

Alkali feldspar (58%), albite (25%), quartz (10%), biotite (4%), chlorite (2%), magnetite or ilmenite (1%), zircon (tr), pyrite (tr), apatite (tr), leucoxene (tr), calcite (tr). Biotite, yellow-brown to very dark brown pleochroism, occurs in large plates and is partly altered to chlorite. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Magnolia #1 Johnson core 10171-78 Bureau of Economic Geology

Microperthite (38%), oligoclase (30%), quartz (15%), biotite (8%), chlorite (4%), magnetite or ilmenite (3%), leucoxene (1%), calcite (1%), sphene (tr), pyrite (tr), zircon (tr), apatite (tr). Large grains of microperthite include plagioclase and biotite; plagioclase is partly sericitized and is engulfed, corroded, and embayed by microperthite; biotite, pale to dark brown pleochroism, is partly altered to chlorite; leucoxene occurs in myriad small grains in chlorite formed by alteration of biotite; sphene rims opaque mineral. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Phillips #1 Kary cuttings 11440 Bureau of Economic Geology

Groundmass (73%), feldspar (15%), quartz (4%), red iron oxide (3%), calcite (2%), magnetite or ilmenite (2%), chlorite (1%), apatite (tr). Cryptocrystalline groundmass is heavily stained with iron oxide and shows well-developed flowage structure emphasized by parallel secondary quartz veinlets; it is in part micrographic and in part microspherulitic; phenocrysts are altered to chlorite and sericite and the original nature of the feldspar is indeterminate, although some seems to have been albite; chlorite occurs as a result of alteration of feldspar and in masses in the groundmass. Grain size: groundmass is cryptocrystalline; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

LYNN COUNTY

Honolulu #1 King core 10746-56 Honolulu Oil Corp.

Groundmass (92%), microperthite (5%), leucoxene (2%), zeolite? (1%), bleached biotite (tr), zircon (tr), pyrite (tr), quartz (tr), chlorite (tr), sericite (tr). Microcrystalline feldspar-quartz-sericite groundmass shows a vague flowage structure and contains microperthite phenocrysts veined by and partly altered to sericite and chlorite; zeolite? occurs in sporadic patches with quartz. Grain size: groundmass less than 0.04 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 King 10746-56 Honolulu Oil Corp.

Groundmass (87%), feldspar (5%), pyrite (3%), quartz (2%), sericite (2%), chlorite (1%), leucoxene (tr). Groundmass is a microcrystalline aggregate of feldspar-quartz-sericite; feldspar phenocrysts are in advance stage of sericitization; quartz occurs in corroded, embayed phenocrysts. Grain size: groundmass less than 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 King core 10746-56 Honolulu Oil Corp.

Groundmass (67%), alkali feldspar (15%), sericite (15%), chlorite (1%), pyrite (1%), leucoxene (1%), apatite (tr). Microcrystalline to cryptocrystalline quartz-alkali feldspar groundmass shows flowage structure which is more pronounced in the cryptocrystalline areas; phenocrysts of alkali feldspar, probably microperthite, are broken and veined with sericite; sericite occurs in veins and masses and emphasizes the flowage structure. Grain size: groundmass less than 0.02 mm; phenocrysts 2 to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 King core 10754-56 Honolulu Oil Corp.

Alkali feldspar (59%), quartz (20%), sericite (20%), leucoxene (1%), pyrite (tr), apatite (tr), zircon (tr). Alkali feldspar occurs in a poorly developed micrographic intergrowth with quartz and as phenocrysts; sericite occurs as fibers in the groundmass and as masses completely replacing some phenocrysts. Grain size: groundmass 0.1 to 0.2 mm; phenocrysts up to 4 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Phillips #1-A Bartley cuttings 9908-10 Bureau of Economic Geology

Albite (40%), microperthite (39%), quartz (15%), hornblende (5%), biotite (1%), zircon (tr), calcite (tr). Albite is partly sericitized; hornblende pleochroism is yellow-brown to very dark green-brown; biotite pleochroism is brown to black. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

MASON COUNTY

Cochran & Steward #1 Brandenburger cuttings 1900 Bureau of Economic Geology

Alkali feldspar and quartz (73%), biotite (15%), pyrite (4%), graphite? (4%), sericite-muscovite (2%), chlorite (1%), calcite (1%), zircon (tr). Alkali feldspar and quartz form a fine granular aggregate showing dimensional orientation of constituent grains; red-brown biotite occurs as oriented plates and as plates growing normal to the foliation; pyrite and finely divided graphite? are in lenses and layers parallel to the foliation; calcite occurs in a lens elongated parallel to the foliation. Grain size: 0.02 to 0.05 mm. Fabric: lepidoblastic. Rock: *graphite-biotite schist* (Packsaddle schist?).

McCULLOCH COUNTY

Prairie #1 Zelle core 3450 Bureau of Economic Geology

Alkali feldspar, quartz, clay material, red iron oxide, leucoxene, sericite, zircon. Fractured and broken grains of alkali feldspar show incipient kaolinization; quartz is in fractured and broken grains; whitish semi-opaque clay material obscures large parts of slide; finely fibrous sericite veins the rock. Grain size: crushed and broken fragments up to 0.5 mm. Fabric: cataclastic. Rock: cataclastically altered *granite.*

Thomas #1 White cuttings 3035 Bureau of Economic Geology

Andesine, hornblende, magnetite or ilmenite, biotite, apatite. Indistinctly zoned plagioclase forms a fine granular aggregate; hornblende, yellow-green to green pleochroism, is in oriented prisms that are locally poikiloblastic; biotite is red-brown; magnetite or ilmenite is partly altered to red iron oxide; slide is composed mostly of individual mineral fragments and mineral percentages are not significant. Grain size: plagioclase 0.05 to 0.1 mm; hornblende up to 1 mm. Fabric: crystalloblastic. Rock: *hornblende-andesine schist* or *amphibolite.*

MENARD COUNTY

Phillips #1 Meta cuttings 3900-05 Bureau of Economic Geology

Microcline microperthite (40%), oligoclase (33%), quartz (15%), biotite (5%), myrmekite (4%), chlorite (2%), calcite (1%), rutile (tr), zircon (tr), sphene (tr), apatite (tr). Plagioclase locally shows incipient alteration to sericite; biotite pleochroism is yellow-brown to brown; chlorite and calcite are apparently derived from alteration of hornblende. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranite.*

MITCHELL COUNTY

Humble #1 Pratt cuttings 8125-30 Bureau of Economic Geology

Microcline (70%), quartz (15%), albite (10%), biotite (2%), chlorite (1%), magnetite or ilmenite (1%), muscovite (1%), apatite (tr). Plagioclase is partly altered to sericite. Biotite, a dark brown variety, is partly altered to chlorite. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Sun #2 Elwood core 8464-74 Bureau of Economic Geology

Microperthite (53%), quartz (20%), albite (10%), biotite (10%), chlorite (4%), magnetite or ilmenite (3%), zircon (tr), apatite (tr). Perthitic structure in microperthite is very finely developed; biotite, yellow-brown to dark brown pleochroism, is partly altered to chlorite—it occurs in oriented plates; plagioclase is partly sericitized and locally shows relict myrmekitic structure; zircons occur in long round grains. Grain size: 0.5 to 1 mm. Fabric: ranges from xenomorphic granular to gneissic. Rock: *granite gneiss.*

Sun #2 Elwood core 8520-24 Bureau of Economic Geology

Microperthite (45%), quartz (15%), biotite (12%), oligoclase (10%), calcite (5%), chlorite (5%), magnetite (3%), myrmekite (3%), red iron oxide (2%), zircon (tr). Microperthite shows very fine development of perthitic structure; quartz occurs in a mosaic with feldspar grains; biotite is so oxidized as to be opaque—identified by shape of grains; magnetite is partly altered to red iron oxide; calcite occurs in veinlets and also replaces feldspar; plagioclase shows incipient alteration to sericite. Grain size: 1 to 3 mm. Fabric: xenomorphic granular. Rock: *granite.*

MONTAGUE COUNTY

Humphreys #1 Hinton core 1839-40 Bureau of Economic Geology

Microcline microperthite (60%), oligoclase (18%), quartz (12%), biotite and chlorite (10%), sphene (tr), apatite (tr), zircon (tr). Microcline microperthite and plagioclase are in cracked and strained grains, plagioclase is partly sericitized and partly kaolinized; quartz is granulated and smeared out into strained lenses between larger feldspar grains; green-brown biotite is sheared into frayed masses and is partly altered to chlorite. Grain size: feldspar 2 mm to 1 cm; crushed quartz 0.05 to 0.5 mm. Fabric: cataclastic—relict hypidiomorphic granular. Rock: cataclastically altered *granite.*

Lesh-McCall #7 Davenport core 2733-34 Humble Oil & Rfg. Co.

Quartz (42%), microcline microperthite (35%), albite-oligoclase (20%), biotite (2%), sericite (1%), leucoxene (tr), chlorite (tr), magnetite or ilmenite (tr), zircon (tr). Quartz is in part granulated (and apparently recrystallized) and in part drawn out into elongated and strained masses with granulated borders; microcline microperthite occurs in larger fractured grains that appear to be incipient augen; green-brown biotite is irregularly distributed as concentrations of tiny plates in some crush zones and around larger feldspar grains; sericite occurs as clouds of small fibers, but some small muscovite plates are also present. Grain size: granulated and recrystallized material 0.1 mm; larger feldspar grains up to 2 mm. Fabric: cataclastic. Rock: *oligoclase-microcline-quartz gneiss* or *granite gneiss.*

Nu-Enamel #1 Agee cuttings 5340-50 Bureau of Economic Geology

Microcline microperthite and albite (74%), quartz (25%), calcite (1%), biotite (tr), muscovite (tr), leucoxene (tr), zircon (tr). Partly kaolinized microcline microperthite is the predominant feldspar; quartz is locally sheared; biotite is green-brown. Mineral percentages differ considerably in the fragments studied and their estimated percentages cannot be regarded as significant except in a general way. Grain size: 0.2 to 5 mm, mostly 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *granite.*

Phillips #1 Fields cuttings 3813 Bureau of Economic Geology

Microcline microperthite, quartz, biotite, calcite. Slide is composed mostly of individual mineral fragments. Microcline microperthite is partly altered to calcite; biotite is green-brown. Grain size: 1 to 3 mm. Fabric: ? Rock: *granite.*

Sztykgold #1 Charles cuttings 4500-10 Bureau of Economic Geology

Plagioclase (53%), augite (25%), magnetite or ilmenite (12%), chlorite (5%), chlorite? (3%), calcite (2%). Partly sericitized intermediate to calcic plagioclase occurs in radially oriented laths, sporadic plagioclase phenocrysts are calcic; augite is in part altered to a brownish semi-opaque mineral that may be a clay; for the most part the augite is interstitial to plagioclase; magnetite or ilmenite is interstitial to plagioclase and occurs with augite; chlorite occurs in dispersed patches and in veinlets; chlorite? is a dirty green fibrous mineral with moderate birefringence that is derived from alteration of pyroxene. Mineral percentages differ widely in different fragments. Grain size: 0.1 to 0.2 mm. Fabric: subophitic. Rock: altered *diabase.*

Sztykgold #1 Charles cuttings 4650-60 Bureau of Economic Geology

Similar to 4500-10 but in advanced stage of alteration to chlorite, clay minerals, and micaceous minerals. Grain size: 0.1 to 0.2 mm. Fabric: relict subophitic. Rock: altered *diabase.*

Sztykgold #1 Charles cuttings 5000-10 Bureau of Economic Geology

Microcline (44%), albite-oligoclase (40%), quartz (12%), biotite (2%), hornblende (1%), ilmenite (1%), sphene (tr), apatite (tr). Microcline is sparsely microperthitic; plagioclase is partly sericitized; biotite is red-brown; hornblende, partly altered to chlorite, is a green-brown variety. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Sztykgold #1 Charles cuttings 5200-10 Bureau of Economic Geology

Labradorite (59%), augite (30%), magnetite or ilmenite (8%), chlorite (2%), biotite (1%), pyrite (tr), apatite (tr). Plagioclase shows vague zoning; lavender-tinted augite is in part in large individuals enclosing plagioclase grains and in part interstitial to plagioclase grains; biotite is dark brown. Grain size: 0.5 to 1 mm. Fabric: ranges from ophitic to subophitic. Rock: *diabase.*

Sztykgold #1 Charles cuttings 5380-84 Bureau of Economic Geology

Microcline microperthite (70%), quartz (15%), albite (12%), calcite (2%), red iron oxide (1%), sphene (tr), hornblende (tr), chlorite (tr), apatite (tr), zircon (tr). Albite is partly sericitized; hornblende is green-brown. Grain size: 0.5 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Sztykgold #1 Charles cuttings 5380-84 Bureau of Economic Geology

Calcic plagioclase (59%), augite (25%), magnetite or ilmenite (10%), chlorite (3%), biotite (2%), hornblende (1%), apatite (tr). Plagioclase is completely sericitized in some fragments; in others it appears to be labradorite on basis of relief; augite is in part altered to brownish semi-opaque material that is probably a clay; biotite is red-brown and locally is partly oxidized; hornblende is a secondary green variety. Grain size: 0.5 mm. Fabric: subophitic. Rock: *diabase.*

Texas #1 Cobb cuttings 3394 Bureau of Economic Geology

Microcline microperthite (68%), quartz (20%), plagioclase (6%), chlorite (4%), magnetite or ilmenite (1%), leucoxene (1%), calcite (tr), apatite (tr), zircon (tr). Sodic plagioclase occurs as small grains and patches of grains in large microcline individuals; chlorite is present in masses as result of alteration of ferromagnesian mineral and in small irregular patches in feldspar. Grain size: 1 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Texas #1 Cobb cuttings 3394 Bureau of Economic Geology

Microcline microperthite, quartz, sericite?, calcite, chlorite, epidote, pyrite, magnetite or ilmenite, albite, zircon. Slide is composed mostly of fragments of one or two minerals and percentages are not significant. Quartz is filled with inclusions of chlorite and sericite?; chlorite occurs with epidote and calcite as a result of alteration of ferromagnesian mineral and as inclusions in quartz. Grain size: 1 to 2 mm. Fabric: ? Rock: *granite.*

Texas #1 Lemons cuttings 2755 Bureau of Economic Geology

Labradorite (75%), magnetite or ilmenite (7%), chlorite? (5%), hornblende (4%), zeolite? (4%), calcite (3%), augite (1%), leucoxene (1%). Radially oriented plagioclase laths are variably sericitized and show a vague zoning; a moderately birefringent olive-brown mineral derived from alteration of pyrogenic ferromagnesian minerals is probably a chlorite; augite and green-brown biotite are relicts surrounded by alteration minerals; masses of low relief mineral in one fragment are probably a zeolite. Grain size: 0.2 to 0.5 mm. Fabric: subophitic. Rock: altered *leuco-diabase.*

Texas #1 Lemons cuttings 2835 Bureau of Economic Geology

Similar to 2755 but with (1) higher magnetite or ilmenite content and (2) more advanced alteration; clay material? obscures slide.

Texas #1 Lemons core 2890 Bureau of Economic Geology

Calcic plagioclase (65%), chlorite (15%), augite (12%), magnetite or ilmenite (8%), amphibole (tr), calcite (tr). Zoned plagioclase laths are in triangular or radial orientation; augite is partly altered to chlorite; two kinds of chlorite are present—a pale brown to green variety with moderate to high birefringence that occurs in discrete masses (after olivine?) and a low to moderately birefringent green variety that replaces augite and feldspar; secondary amphibole occurs in fine needles. Grain size: 0.1 to 0.2 mm. Fabric: subophitic. Rock: *diabase.* There are 15 *slides of this same rock in various stages of alteration from the interval 2789 to 2903.*

Texas #1 Lemons cuttings 2898 Bureau of Economic Geology

(1) Altered diabase similar to 2835.
(2) Microcline microperthite, quartz, sericite-muscovite, leucoxene, sphene, zircon. Feldspar and quartz are in strained, broken, and granulated grains; sericite-muscovite forms scattered fibers and frayed plates. Grain size: 0.2 to 2 mm. Fabric: cataclastic. Rock: cataclastically altered *granite.*

Warner #1 Monroe cuttings 2953-55 Bureau of Economic Geology

Andesine-labradorite (70%), hornblende (20%), biotite (10%), apatite (tr). Plagioclase shows zonation; hornblende is an altered green-brown variety; biotite is red-brown. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *diorite.*

Warner #1 Monroe cuttings 2960-65 Bureau of Economic Geology

Andesine (48%), hornblende (40%), biotite (10%), magnetite or ilmenite (2%), apatite (tr). Twinned, zoned subhedrons of plagioclase contain fine acicular inclusions of a highly birefringent mineral—rutile?; hornblende, pale green to green pleochroism, occurs in frayed and bent prisms; reddish-brown biotite is in nests. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular with some evidence of cataclasis in bent and frayed ferromagnesian minerals and incipient granulation around feldspars. Rock: *diorite.* The 11 slides of this rock from the interval 2970 to 3052 show little variation except in the presence of chlorite and leucoxene in more altered rocks and, in some sections, brown hornblende as well as green.

Warner #1 Monroe cuttings 2995-3000 Bureau of Economic Geology

Andesine-labradorite, hornblende, biotite, magnetite or ilmenite, sphene. Slide is composed mostly of individual mineral fragments and mineral percentages are not significant. Plagioclase shows vague zoning; hornblende, mostly pleochroic in yellow-green to green, is in prisms that show faded, patchy, brownish centers—locally it is altered to fibrous colorless amphibole; in some fragments the amphibole prisms are oriented; biotite is red-brown. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular—gneissic. Rock: *diorite* or *diorite gneiss.*

Warner #1 Monroe cuttings 3020-25 Bureau of Economic Geology

Andesine-labradorite (60%), hornblende (30%), clay material (6%), biotite (3%), augite (1%), magnetite or ilmenite (tr), pyrite (tr), apatite (tr). Indistinctly zoned plagioclase subhedrons show parallel orientation in some fragments; locally they are partly sericitized; the pyrogenic hornblende is a green-brown variety which is locally fringed with green hornblende—both have been altered to a faded unevenly colored or colorless amphibole which commonly occurs in fibrous masses; hornblende grains show rude parallel orientation in some fragments; red-brown and green-brown biotite plates are present; dirty brown argillaceous material obscures the rock in some fragments; sporadic pyroxene remnants are enveloped by hornblende. Grain size: 0.5 to 2 mm. Fabric: ranges from hypidiomorphic granular to gneissic. Rock: *diorite* or *diorite gneiss.*

Warner #1 Monroe cuttings 3038-52 Bureau of Economic Geology

Similar to 3020-25 but an inferior slide.

MOORE COUNTY

Gulf #1 Kilgore cuttings 3524-32 Bureau of Economic Geology

Groundmass, kaolinized feldspar phenocrysts, quartz phenocrysts, chlorite, magnetite or ilmenite, zircon. Microgranular quartz-alkali feldspar groundmass shows flowage structure; kaolinized feldspar and embayed quartz occur as phenocrysts; magnetite or ilmenite occurs as larger scattered grains and as fine dispersed grains in the groundmass. Cuttings are largely mineral fragments and mineral percentages cannot be estimated with any degree of certainty. Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Gulf #1 Kilgore cuttings 3617-21 Bureau of Economic Geology

Intermediate plagioclase, augite, hornblende, unidentified yellow alteration mineral, chlorite, magnetite or ilmenite, sericite, nontronite?, biotite, sodic plagioclase, calcite, apatite. Fragments show a wide variation in amounts of minerals present and degree of alteration. Vaguely zoned intermediate plagioclase appears to be more sodic in highly altered fragments; augite is in part altered to a greenish semi-opaque material; hornblende pleochroism is yellow-green to green—it occurs with sodic plagioclase and chlorite in altered fragments; alteration of ferromagnesian minerals has also produced a golden yellow mineral with moderate but variable birefringence; biotite is red-brown; sericite occurs in masses with granular magnetite or ilmenite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *diorite* or *gabbro.*

MOTLEY COUNTY

Amerada #1 Birney | cuttings 10010 | Bureau of Economic Geology

Quartz (50%), microperthite and albite (46%), ilmenite (2%), leucoxene (1%), sericite-muscovite (1%), dolomite and calcite (tr), zircon (tr). Quartz is sheared, granulated, and shows dimensional orientation; feldspar is probably mostly microperthite, crushed and broken and showing incipient kaolinization; muscovite-sericite occurs in shreds and plates; ilmenite is enveloped by leucoxene. Grain size: less than 0.02 to 1 mm. Fabric: cataclastic. Rock: *arkose gneiss* or *granite gneiss.*

General Crude #43-1 Swenson | core 4789-92 | Bureau of Economic Geology

Oligoclase (40%), quartz (40%), alkali feldspar (15%), biotite (4%), magnetite or ilmenite (1%), leucoxene (tr), brookite (tr), sphene (tr), apatite (tr), zircon (tr). Quartz and feldspar form a mosaic which shows a vague layering expressed in grain size and mineral content; heavy minerals are concentrated in layers. The alkali feldspar appears to be orthoclase but some grains show a very faint indication of quadrille twinning before extinction; plagioclase is partly sericitized; green-brown biotite occurs in scattered plates showing a rude orientation. Grain size: 0.1 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *arkose gneiss.*

Humble #1-D Matador | core 6269 | Humble Oil & Rfg. Co.

Groundmass (87%), albite (12%), ilmenite (1%), sphene (tr), leucoxene (tr), fluorite (tr), apatite (tr). Microgranular groundmass consists of a granular aggregate of quartz and alkali feldspar containing tiny plates of green-brown biotite and chlorite (oriented) and small epidote grains; albite occurs as partly sericitized phenocrysts; apatite is in prisms. Grain size: groundmass 0.01 to 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1-H Matador | core 8610-16 | Stanolind Oil & Gas Co.

Quartz (50%), sericite (30%), albite (14%), chlorite (2%), leucoxene (2%), microperthite (1%), calcite (1%), apatite (tr), zircon (tr). Quartz occurs as angular grains in a finer matrix of quartz-sericite-feldspar; sericite is matted, fibrous and intergranular in habit. Grain size: up to 0.02 mm. Fabric: relict clastic—incipient lepidoblastic. Rock: *sericite phyllite.*

Humble #2-H Matador | cuttings 7875 | Shell Oil Co.

Alkali feldspar? (63%), chlorite (20%), calcite (10%), magnetite or ilmenite (5%), leucoxene (2%). Rock is thoroughly altered and original character is not apparent. Grain size: original rock probably 0.2 mm. Fabric: obscured by alteration products. Rock name: altered *microsyenite?.*

Humble #2-H Matador | core 7878-82 | Bureau of Economic Geology

Sericite (31%), quartz (20%), albite (20%), alkali feldspar (15%), microcline microperthite (5%), chlorite (5%), calcite (2%), leucoxene (1%), red iron oxide (1%), magnetite or ilmenite (tr), zircon (tr), apatite (tr), bleached biotite (tr), rock fragment (tr). Sericite and chlorite fibers with fair orientation constitute a groundmass; alkali feldspar is orthoclase with a minor perthitic development; the rock fragment is a piece of quartz mosaic. Grain size: quartz-feldspar 0.1 to 0.5 mm with the sericite fibers somewhat smaller. Fabric: relict clastic—incipient lepidoblastic. Rock: *feldspathic sericite phyllite.*

NOLAN COUNTY

Honolulu #2 Whittaker | core 5687-88 | Bureau of Economic Geology

Microcline and quartz (85%), bleached biotite and chlorite (12%), calcite (2%), magnetite or ilmenite (1%), sphene (tr), opaline silica? (tr), apatite (tr), zircon (tr). Microcline and quartz form a granoblastic aggregate in which microcline (probably including some albite) is predominant; bleached biotite and chlorite are in oriented fibers and plates; calcite occurs in masses commonly associated with chlorite; opaline silica? occurs in cross-cutting veinlets. Grain size: 0.02 to 0.1 mm. Fabric: crystalloblastic. Rock: *chlorite schist.*

Honolulu #2 Whittaker | core 5296-97 | Bureau of Economic Geology

Quartz (50%), microcline and albite (42%), chlorite (4%), muscovite (3%), calcite (1%), magnetite or ilmenite (tr), fluorite (tr), apatite (tr). Quartz forms an unevenly sized granoblastic mosaic with feldspar; albite is partly sericitized and locally contains masses of small mica plates and chlorite; muscovite is in local concentrations where it shows a more or less parallel orientation. Rock shows folded layers of different grain size and mineral composition. Grain size: 0.02 to 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *arkose gneiss.*

Honolulu #3 Whittaker | core 5656-59 | Bureau of Economic Geology

Microcline (45%), quartz (40%), chlorite (4%), calcite (4%), sericite-muscovite (3%), apatite (2%), sphene and leucoxene (1%), red iron oxide (1%), magnetite or ilmenite (tr), zircon (tr). Microcline is fractured and fractures are healed with alkali feldspar; quartz occurs unequally distributed in patches of grains; chlorite includes some bleached biotite; calcite occurs in patches within feldspar grains and with chlorite in veinlets; sericite-muscovite occurs in masses and in veinlets, commonly it is associated with chlorite. Locally there is a rude foliation. In this rock fractured large microcline grains and patches of quartz were invaded by a finer microcline-chlorite-mica-calcite assemblage. Grain size: broken microcline and coarse quartz 0.5 to 2 mm; fine microcline-chlorite-mica-calcite assemblage 0.2 mm. Fabric: ranges from xenomorphic granular to gneissic (protoclastic?). Rock: *granite gneiss.*

Honolulu #4 Whittaker | core 5840 | Bureau of Economic Geology

Quartz (73%), microcline and albite (20%), chlorite (3%), magnetite or ilmenite (2%), biotite (1%), calcite (1%), muscovite (tr), sphene (tr), apatite (tr). Quartz forms a well-sized granoblastic mosaic with feldspar; microcline is predominant over albite; chlorite is after biotite and is also in veinlets with calcite; green-brown biotite and chlorite are both in skeletal poikilitic grains showing rude orientation. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Hunt #1 McElmurray | cuttings 5443-5561 | Humble Oil & Rfg. Co.

Quartz (54%), microcline (35%), plagioclase (8%), muscovite (3%), calcite (tr), magnetite or ilmenite (tr), apatite (tr). Plagioclase is completely sericitized; quartz and feldspar form a mosaic showing a crude dimensional orientation. Grain size: mostly 0.1 to 0.2 mm. Fabric: granoblastic (recrystallized quartz and feldspar). Rock: *metarkosite.*

Seaboard #1 Earwood | cuttings 6886-90 | Bureau of Economic Geology

Microcline and albite (50%), quartz (41%), biotite, chlorite, and hornblende (5%), magnetite or ilmenite (3%), calcite (1%), apatite (tr). Feldspar is predominantly microcline; quartz, showing dimensional orientation in some fragments, forms a granoblastic aggregate with feldspar; green-brown biotite is partly altered to chlorite; green hornblende is partly altered to chlorite and shows parallel orientation in some fragments. Mineral percentages vary widely in different fragments. Grain size: 0.1 to 0.5 mm. Fabric: granoblastic (foliation very poorly developed). Rock: *metarkosite* or *arkose gneiss.*

Seaboard #1-A Hanks | cuttings 6100-10 | Bureau of Economic Geology

Microcline microperthite (65%), oligoclase (20%), biotite (8%), quartz (7%), apatite (tr), pyrite (tr), zircon (tr). Microcline microperthite is locally poikilitic and includes quartz and oriented biotite plates; red-brown biotite shows sub-parallel orientation; apatite is in rods that cross grain boundaries. Grain size: 0.5 mm. Fabric: xenomorphic granular—poikilitic. Rock: *microgranite.* (Contains one fragment similar to #1-A Hanks 6140).

Seaboard #1-A Hanks | cuttings 6140 | Bureau of Economic Geology

Microcline microperthite (60%), quartz (20%), oligoclase (20%), apatite (tr). Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic to xenomorphic granular. Rock: *granite.* (Also contains fragments similar to #1-A Hanks 6100-6110.)

Seaboard #1 Jordan | cuttings 6430-34 | Bureau of Economic Geology

Alkali feldspar (45%), plagioclase (25%), biotite (15%), calcite (12%), magnetite or ilmenite (3%), pyroxene (tr), apatite (tr). Alkali feldspar shows a vague quadrille twinning; intermediate plagioclase is in part sericitized; pyroxene is completely altered to calcite. Rock is similar to 6445 but contains more alkali feldspar, shows sericitization of plagioclase, and contains no unaltered pyroxene. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular—gneissic. Rock: *syenite gneiss.*

Seaboard #1 Jordan cuttings 6445 Bureau of Economic Geology

Andesine (35%), alkali feldspar (24%), augite (20%), biotite (15%), magnetite or ilmenite (3%), calcite (3%), apatite (tr). Plagioclase shows a vague zoning; alkali feldspar has a vague and blurred extinction that suggests quadrille twinning; augite has a faint greenish pleochroism; biotite, golden-brown to very dark brown pleochroism, shows a rude orientation in some fragments; calcite occurs in veinlets and masses. Mineral percentages vary considerably in different fragments. Grain size: 0.5 to 1 mm. Fabric: gneissic. Rock: *biotite-augite-andesine gneiss* or *syenodiorite gneiss.*

OLDHAM COUNTY

Albough #1 Matador cuttings 4850-4915 Bureau of Economic Geology

Microcline microperthite (78%), quartz (20%), chlorite (1%), leucoxene (1%), bleached biotite (tr), magnetite or ilmenite (tr). Microcline microperthite, in advanced stage of kaolinization, is micrographically intergrown with quartz—intergrowth is mostly irregular but locally cuneiform; fine acicular inclusions in the quartz and feldspar were not identified. Grain size: 1 to 2 mm; intergrowth 0.1 to 0.2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Albough #1 Matador cuttings 4850-4910 Humble Oil & Rfg. Co.

Microperthite (78%), quartz (20%), magnetite or ilmenite (1%), chlorite (1%), bleached biotite (tr), leucoxene (tr), biotite (tr), amphibole (tr), fluorite (tr), apatite (tr). Microperthite is in part intergrown with quartz in an irregular to cuneiform pattern; biotite is red-brown; amphibole is yellow-green. Grain size: 1 to 2 mm; intergrowth 0.01 to 0.5 mm. Fabric: micrographic. Rock: *micrographic granite.*

Albough #2 Matador cuttings 4090-4115 Humble Oil & Rfg. Co.

Microcline microperthite (76%), quartz (20%), magnetite or ilmenite (2%), chlorite (1%), calcite (1%), leucoxene (tr), sphene (tr), fluorite (tr), zircon (tr). Microcline microperthite is in part intergrown with quartz in an irregular to cuneiform pattern; calcite occurs as veinlets and scattered grains. Grain size: 0.5 to 2 mm; intergrowth 0.02 to 0.2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Humble #1-E Matador core 6280 Stanolind Oil & Gas Co.

Microperthite (67%), quartz (20%), albite (10%), magnetite (2%), chlorite (1%), red iron oxide (tr), epidote (tr). Epidote is in veinlets and radiating structures. Grain size: 3 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Livermore #1 Moser cuttings 6880 Humble Oil & Rfg. Co.

Groundmass (86%), albite (7%), chlorite (4%), ilmenite (1%), leucoxene (1%), red iron oxide (1%), epidote (tr), sphene (tr), apatite (tr). Microgranular quartz-alkali feldspar groundmass is locally cryptocrystalline and locally contains pods of interlocking feldspar laths; albite phenocrysts are locally fractured; leucoxene occurs as scattered masses and surrounds ilmenite; epidote occurs as veinlets and replacement bodies. Grain size: groundmass 0.01 to 0.1 mm; phenocrysts 0.5 to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Livermore #1 Moser cuttings 6880-84 Humble Oil & Rfg. Co.

Groundmass (80%), chlorite (8%), albite (8%), quartz (1%), ilmenite (1%), leucoxene (1%), red iron oxide (1%), apatite (tr), zircon (tr). Most of the groundmass is composed of large areas of interlocking grains, plates, and laths of alkali feldspar, but there are smaller microgranular areas that contain quartz; albite phenocrysts are zoned; chlorite occurs in masses; quartz forms a veinlet. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.1 to 0.5 mm. Fabric: porphyritic. Rock: *trachyte porphyry.*

Stanolind #1 Green core 6112-14 Stanolind Oil & Gas Co.

Microperthite (75%), quartz (20%), chlorite (2%), fluorite (2%), magnetite (1%), pyrite (tr), biotite (tr), zircon (tr), apatite (tr), red iron oxide (tr). Microperthite is partly kaolinized, stained red, and micrographically intergrown with quartz—intergrowth is irregular to cuneiform; biotite is mostly altered to chlorite. Grain size: 0.5 to 2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Stanolind #1 Green | core 6112-14 | Bureau of Economic Geology

Microperthite (73%), quartz (20%), magnetite or ilmenite (3%), chlorite (3%), red iron oxide (1%), apatite (tr), biotite relicts (tr), zircon (tr). Microperthite is partly kaolinized; quartz is in part micrographically intergrown with feldspar—intergrowth is irregular to cuneiform; red iron oxide is present as stain and in veinlets. Grain size: 0.5 to 3 mm. Fabric: micrographic. Rock: *micrographic granite.*

Superior #54-9 Gray Ranch | core 7181-87 | Humble Oil & Rfg. Co.

Groundmass (75%), albite (20%), microperthite (2%), magnetite or ilmenite (2%), quartz (1%), calcite (tr), red iron oxide (tr), apatite (tr), zircon (tr). Groundmass consists of spherulites and inter-areas of microgranular quartz, microperthite, albite, and chlorite; albite and microperthite also are present as phenocrysts; sporadic round quartz phenocrysts are present; large zircons are plentigul. Grain size: groundmass 0.2 to 0.5 mm; phenocrysts 1 to 6 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.* (Photomicrograph, Pl. VIII, A.)

Superior #54-9 Gray Ranch | core 7208-14 | Humble Oil & Rfg. Co.

Same as 7181-87.

Superior #54-9 Gray Ranch | core 7181-87 | Bureau of Economic Geology

Groundmass (71%), microperthite (10%), albite (10%), quartz (4%), chlorite (3%), magnetite or ilmenite (2%), calcite (tr), red iron oxide (tr), apatite (tr), zircon (tr). Partly kaolinized reddish-brown-stained groundmass is in part microspherulitic and in part very finely micrographic; small irregular patches of quartz occur between micrographic grains and between spherulites; microperthite phenocrysts are partly kaolinized; albite phenocrysts are locally zoned; some feldspar phenocrysts are rounded with micrographic borders and some are tabular; quartz phenocrysts are rounded and embayed; chlorite is in granular masses; apatite is in grains and elongate prisms; two minerals occurring in traces in the slide were not identified: (1) a very finely acicular mineral and (2) a mineral with radial structure, moderately high relief, and low birefringence. Grain size: groundmass 0.05 to 0.5 mm; phenocrysts 1 to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Superior #54-9 Gray Ranch | core 7208-14 | Bureau of Economic Geology

Groundmass (68%), albite (15%), microperthite (5%), quartz (5%), chlorite (3%), magnetite or ilmenite (2%), red iron oxide (1%), calcite (1%), leucoxene (tr), rutile (tr), apatite (tr), zircon (tr). Red-stained groundmass is microspherulitic and very finely micrographic; quartz occurs between spherulites and between micrographic grains; albite, microperthite, and quartz occur as phenocrysts; chlorite is in scattered patches; calcite fills cavities; fine needles partly altered to leucoxene are most probably rutile. Grain size: groundmass 0.02 to 0.2 mm with spherulites up to 0.5 mm in diameter; phenocrysts 1 to 4 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Superior #1 Howard | core 8636 | Humble Oil & Rfg. Co.

Microcline microperthite (64%), quartz (20%), albite-oligoclase (10%), chlorite (4%), magnetite or ilmenite (2%), leucoxene (tr), apatite (tr), zircon (tr). Microcline microperthite is in part micrographically intergrown with quartz; chlorite occurs in plates and granular masses; zircon occurs with chlorite and magnetite or ilmenite in "nests." Large non-micrographic microcline microperthite grains occur in a mass of micrographic quartz and feldspar grains. Grain size: 0.5 to 2 mm; non-micrographic feldspar up to 8 mm; micrographic intergrowth 0.01 to 0.2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Superior #1 Matador | core 6892-97 | Bureau of Economic Geology

Microperthite (80%), quartz (15%), magnetite or ilmenite (3%), albite (2%), red iron oxide (tr), apatite (tr), zircon (tr). Partly kaolinized microperthite is intergrown with quartz in an irregular to cuneiform pattern. Grain size: 2 to 5 mm; intergrowth 0.05 to 1 mm. Fabric: micrographic. Rock: *micrographic granite.*

Superior #2 Matador | core 6167-73 | Bureau of Economic Geology

Microperthite (78%), quartz (15%), chlorite (3%), albite (2%), magnetite or ilmenite (1%), red iron oxide (1%), leucoxene (tr), bleached biotite (tr), apatite (tr), zircon (tr). Partly kaolinized microperthite occurs (1) as large rounded individuals 4 to 6 mm long and (2) smaller grains (2 mm) micrographically intergrown with quartz and surrounding larger individuals—the intergrowth is mostly cuneiform but locally is irregular; bleached biotite is associated with magnetite-ilmenite and locally is replaced by leucoxene; zircons are locally markedly elongate. Grain size: 1 to 6 mm; intergrowth 0.05 to 0.3 mm. Fabric: micrographic. Rock: *micrographic granite.*

Superior #3 Matador core 5992-98 Bureau of Economic Geology

Microperthite (67%), quartz (25%), fluorite (2%), calcite (2%), magnetite or ilmenite (2%), chlorite (2%), rutile? (tr), sphene (tr), zircon (tr). Microperthite and quartz occur in large grains; the remainder of the constituents, with fine-grained quartz, occur between the large quartz and feldspar grains; fluorite commonly shows cubic overgrowths over round cores. Grain size: larger quartz and feldspar grains 2 to 8 mm; fine interstitial material 0.05 to 0.3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Superior #4 Matador core 7074 Bureau of Economic Geology

Microcline microperthite (76%), quartz (18%), magnetite or ilmenite and red iron oxide (4%), bleached biotite (2%), chlorite (tr), zircon (tr). One large grain (6 mm) of partly kaolinized microcline microperthite occurs in a mass of smaller grains (2 mm) micrographically intergrown with quartz—intergrowth is mostly cuneiform; bleached biotite locally is nearly opaque because of alteration to red iron oxide. Grain size: grains mostly 2 mm; intergrowth from less than 0.02 to 0.2 mm. Fabric: micrographic. Rock: *micrographic granite.* (Photomicrograph, Pl. X, D.)

PARKER COUNTY

Garland-Anthony #1 Hammons core 7790± Bureau of Economic Geology

Andesine and quartz (60%), hornblende (25%), biotite (15%), magnetite or ilmenite (tr), apatite (tr). Quartz is subordinate to plagioclase; oriented prisms of hornblende with yellow-green to green pleochroism are locally poikilitic; biotite is in oriented dark brown plates. Grain size: 0.5 to 1 mm. Fabric: crystalloblastic. Rock: *biotite-hornblende schist.*

PARMER COUNTY

Gulf #1-A Keliehor core 9578-84 Bureau of Economic Geology

Labradorite (43%), augite (30%), olivine (7%), magnetite or ilmenite (7%), biotite (4%), amphibole (4%), serpentine (3%), chlorite (1%), zeolite (1%), feldspathoid (tr), sphene (tr), apatite (tr). Large twinned labradorite tablets show an indistinct zoning; lavender-tinted augite occurs as large optically continuous but very irregular individual grains which to a large degree accommodate themselves to plagioclase subhedrons; olivine is partly altered to chlorite and serpentine; magnetite or ilmenite occurs in scattered grains which locally are skeletal, spongy, or plumose—mostly it is associated with red-brown biotite; fibrous green amphibole is a secondary alteration mineral derived from augite; chlorite is (1) a common green variety and (2) an olive-colored variety from alteration of olivine; zeolite—thompsonite and an unidentified feldspathoid fill a vug and constitute an amygdule. Grain size: 1 to 6 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Gulf #1-A Keliehor core 9627-28 Bureau of Economic Geology

Augite (42%), labradorite (32%), olivine (7%), magnetite or ilmenite (5%), iddingsite? (5%), serpentine (3%), amphibole (3%), chlorite (2%), red-brown biotite (1%), apatite (tr). Plagioclase shows vague zonation; augite is tinted brown; olivine is altered to serpentine and iddingsite?; secondary amphibole is pale green; red-brown biotite occurs in association with magnetite or ilmenite grains; pale green-brown biotite occurs in sheaves. Grain size: 1 mm to 1 cm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.* (Photomicrograph, Pl. IX, B.)

Stanolind #1 Jarrell core 8160-61½ Stanolind Oil & Gas Co.

Groundmass (82%), alkali feldspar (12%), albite (3%), chlorite (3%), magnetite or ilmenite (tr), epidote (tr), sericite (tr), leucoxene (tr), zircon (tr), red iron oxide (tr). Microcrystalline to cryptocrystalline quartz-feldspar groundmass shows flowage structure and locally is micrographic; cryptocrystalline areas surround phenocrysts; albite and alkali feldspar phenocrysts occur as rounded and corroded subhedrons. Grain size: groundmass is microcrystalline to cryptocrystalline; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Jarrell cuttings 8161½ Bureau of Economic Geology

Groundmass (88%), plagioclase (10%), chlorite (1%), leucoxene (1%), apatite (tr). Brown microcrystalline to cryptocrystalline groundmass is micrographic to microspherulitic and shows pronounced flowage structure; plagioclase phenocrysts are completely sericitized; chlorite is derived from biotite. Grain size: groundmass in large part cryptocrystalline, equi-extinguishing micrographic areas reach 0.1 mm; phenocrysts 0.2 to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Sunray #1 Kimbrough cuttings 8870-80 Shell Oil Co.

Grains of altered feldspar, quartz, chloritized biotite, apatite, leucoxene, and magnetite or ilmenite. Grain size: 0.1 to 1 mm. Fabric: sub-micrographic. Rock: *micrographic granite.*

U. S. Smelting & Refining #1-A Osborner cuttings 9700-10 Bureau of Economic Geology

Groundmass (79%), plagioclase (20%), leuxocene (1%), apatite (tr), zircon (tr). Brown quartz-alkali feldspar groundmass is in part micrographic and in part microspherulitic; plagioclase occurs as partly sericitized phenocrysts and probably some alkali feldspar is included in this total; slide contains one large fragment of rhyolite porphyry and a number of fragments of arkose containing round rhyolite sand grains. Grain size: groundmass, micrographic patches up to 0.2 mm; microspherulites up to 0.02 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

PECOS COUNTY

Anderson-Prichard #2 Boren core 4858 Humble Oil & Rfg. Co.

Albite-oligoclase (40%), microcline (36%), quartz (10%), biotite (10%), chlorite (4%), sphene (tr), apatite (tr), zircon (tr). Plagioclase is partly seriticized and locally myrmekitic; rock shows two distinct layers separated by grain size and mineral content—one layer, 1 to 2 mm grain size, is rich in quartz-microcline; the second layer, 0.5 mm grain size, is rich in plagioclase and biotite; biotite is reddish brown and occurs as oriented plates concentrated in the finer-grained layer. Grain size: 0.5 to 2 mm. Fabric: crystalloblastic—gneissic. Rock: *granodiorite gneiss.*

Anderson-Prichard #2 Masterson core 4570 Bureau of Economic Geology

Andesine-labradorite (50%), amphibole (25%), magnetite or ilmenite (10%), brownish chlorite? (7%), green chlorite (5%), apatite (2%), calcite (1%), sphalerite (tr). Plagioclase is transected by a network of veinlets of brownish mineral that is probably chlorite; amphibole, pale green to pale brown pleochroism, occurs in bent, frayed prisms and is partly altered to chlorite; apatite is in unusually large grains; the resinous opaque mineral is probably sphalerite (blackjack). Grain size: 2 to 10 mm. Fabric: hypidiomorphic granular. Rock: altered *diorite.*

Anderson-Prichard #1-A Masterson cuttings 4560-64 Bureau of Economic Geology

Quartz (40%), microcline (29%), hematite (20%), sericitized plagioclase (5%), finely crushed material (3%), biotite relicts (2%), chlorite (1%), calcite (tr), apatite (tr), zircon (tr), pyrite (tr), magnetite or ilmenite (tr). Quartz occurs in large fractured grains; hematite is in large masses; sericite almost completely replaces plagioclase. Mineral percentages above are not too significant; some fragments are microcline-quartz-sericite-plagioclase rock, others show the same rock fractured and altered and containing introduced hematite. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: altered *granite.*

Childress Royalty #1 Masterson cuttings 4600-05 Bureau of Economic Geology

Hornblende (45%), labradorite (40%), magnetite or ilmenite (6%), chlorite (3%), pyrite (2%), biotite (2%), red and yellow iron oxide (1%), calcite (1%), leucoxene (tr), apatite (tr). Plagioclase is variably altered to sericite or sericite and very fine granular epidote or clinozoisite; it includes fine needles of an unidentified mineral; hornblende, yellow-green to green pleochroism, locally is so altered as to be nearly opaque; commonly it shows grain centers altered to a fibrous brownish highly birefringent mineral and fringes of unaltered green or blue-green hornblende; commonly the hornblende includes fine grains of magnetite or ilmenite; magnetite or ilmenite is intergrown with pyrite; biotite pleochroism is pale brown to dark red-brown; chlorite is in veinlets. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: altered *hornblende gabbro.*

Gulf #1 Garvin cuttings 4525-30 Bureau of Economic Geology

Oligoclase (47%), quartz (40%), microcline (10%), chlorite (1%), calcite (1%), leucoxene (1%), ilmenite (tr), zircon (tr). Plagioclase is partly sericitized; chlorite is in granular masses; ilmenite is partly altered to leucoxene. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Gulf #1 Millar core ? Stanolind Oil & Gas Co.

Microcline microperthite (73%), quartz (20%), oligoclase (5%), biotite (1%), chlorite (1%), zircon (tr), magnetite or ilmenite (tr), sericite (tr). Quartz is in a mosaic with feldspar; biotite in part poikilitic, shows pale brown to red-brown pleochroism. Grain size: 0.1 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Gulf #1 Millar core 4536-38 Bureau of Economic Geology

(1) Microcline microperthite (67%), quartz (25%), albite (5%), biotite (1%), chlorite (1%), magnetite or ilmenite (1%), apatite (tr), myrmekite (tr), leucoxene (tr), pyrite (tr). Red-brown biotite is partly altered to chlorite. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

(2) Microcline microperthite (58%), quartz (35%), plagioclase (5%), leucoxene (1%), magnetite or ilmenite (1%), zircon (tr), biotite (tr). Quartz is strained and locally granulated; plagioclase shows incipient alteration to sericite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—cataclastic. Rock: cataclastically altered *granite.*

Gulf #2 Millar cuttings 4489-93 Bureau of Economic Geology

There appear to be several rock types represented in the fragments in this slide: (1) quartz-alkali feldspar mosaic ranging from 100% quartz to 100% feldspar, (2) quartz grains in a mass of chlorite, (3) quartz grains cemented with pyrite, (4) quartz grains in a microcrystalline matrix. Number 1 is probably representative of basement and is a *microgranite* (grain size: 0.2 to 0.4 mm; fabric: xenomorphic granular). Number 4 consists of angular quartz, apatite, magnetite or ilmenite, biotite relicts, zircon, red iron oxide, and a microcrystalline quartz-chlorite-sericite-chalcedony matrix. In one fragment the biotite plates are oriented. Grain size: 0.5 mm. Fabric: clastic—cataclastic? Rock: *metasandstone?.*

Gulf #3 Millar cuttings 4396-4404 Bureau of Economic Geology

Alkali feldspar and albite (55%), quartz (25%), chalcedonic silica (20%), calcite (tr), apatite (tr). Albite is partly sericitized, alkali feldspar is partly kaolinized; the chalcedonic silica is in small grains and masses of grains; quartz is embayed by chalcedonic material and locally shows a sutured fabric. Grain size: 1 to 2 mm (chalcedonic material less than 0.02 mm). Fabric: hypidiomorphic granular—metasomatic. Rock: altered *granite* or *granodiorite.*

Gulf #1 O'Sullivan cuttings 4630-35 Bureau of Economic Geology

Labradorite (72%), hypersthene (10%), quartz (5%), biotite (4%), magnetite or ilmenite (4%), hornblende (4%), pyrite (1%), apatite (tr), chlorite (tr), sphene (tr), epidote (tr), zircon (tr). Plagioclase is very calcic, near bytownite, with maximum extinction angle about 40 degrees; it commonly shows two directions of twinning and is variably sericitized; in hornblende-rich fragments it is almost completely sericitized; quartz may be largely secondary; hornblende is largely restricted to one fragment and shows yellow-green to green pleochroism; biotite is very deep red-brown; chlorite is derived from alteration of hornblende. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microgabbro.*

Humble #1 B. F. Smith cuttings 5167-68 Bureau of Economic Geology

Plagioclase (60%), hornblende (35%), magnetite or ilmenite (5%), sericite (included in feldspar), zoisite and epidote (included in feldspar), apatite (tr). Plagioclase, probably originally andesine or labradorite, is completely altered to fine masses of sericite and epidote; hornblende, yellow-green to green pleochroism, shows blue-green borders. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: altered *diorite* or *microdiorite.*

Humble #1-L University core 5630-40 Bureau of Economic Geology

Oligoclase (56%), microcline (20%), biotite (6%), chlorite (5%), quartz (5%), magnetite or ilmenite (4%), sphene (2%), apatite (1%), calcite (1%), myrmekite (tr), amphibole (tr), pyrite (tr), zircon (tr). Plagioclase shows incipient sericitization; three types of biotite are present—pleochroism pale brown to dark brown, pleochroism pale brown to reddish brown, and pleochroism yellow-brown to dark green; chlorite is an alteration product of biotite and amphibole; amphibole relicts are surrounded by chlorite and calcite; apatite and sphene occur in strings and roughly defined layers parallel to the foliation. Grain size: 0.5 mm. Fabric: crystalloblastic—gneissic. Rock: *quartz-biotite-microcline-oligoclase gneiss* or *granodiorite gneiss.*

Humble #1 Wilson core 5235 Bureau of Economic Geology

Quartz (55%), microcline (30%), albite (10%), muscovite (2%), magnetite or ilmenite (2%), leucoxene (1%), apatite (tr), chlorite (tr). Microcline shows only minor perthitic development; plagioclase shows incipient alteration to sericite; some magnetite grains are rimmed with red iron oxide. Grain size: very irregular with large microcline grains and elongated lenses of smaller quartz-microcline-albite grains, range 0.05 to 2 mm. Fabric: gneissic—poorly developed layering of coarser and finer material. Rock: *granite gneiss.*

Los Nietos #1-B University cuttings 5550-60 Bureau of Economic Geology

Microcline (67%), quartz (20%), oligoclase (7%), biotite (4%), chlorite (1%), pyrite (1%), sphene (tr), zircon (tr), calcite (tr), apatite (tr), magnetite or ilmenite (tr). Biotite is dark red-brown. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular—poikilitic. Rock: *microgranite.*

Los Nietos #1-B University cuttings 5615-20 Bureau of Economic Geology

Same as 5550-60.

McCandless #1-10 Atlantic cuttings ? Shell Oil Co.

Microcline (53%), quartz (30%), biotite (10%), albite (5%), sericite (2%), apatite (tr), magnetite or ilmenite (tr), red iron oxide (tr). Quartz occurs in large strained grains; albite is partly sericitized; biotite pleochroism is pale red-brown to very dark brown. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

McCandless #1 Turney cuttings 4980-86 Bureau of Economic Geology

Microcline (61%), quartz (25%), plagioclase (10%), magnetite or ilmenite (3%), red iron oxide (1%). Microcline is in part in lenses or incipient augen and in part crushed and drawn out between recrystallized quartz masses; quartz is recrystallized and concentrated in lenticular masses of interlocking mosaic; plagioclase is in fragments in advanced stages of sericitization but showing less cataclastic alteration than microcline; red iron oxide stain pervades crushed material. Grain size: feldspar and quartz: 0.2 to 1 mm; crush material less than 0.1 mm. Fabric: cataclastic: Rock: cataclastically altered *granite* partly converted to *granite gneiss.*

McCandless #1 University core 5513 Bureau of Economic Geology

Microcline (35%), albite (30%), quartz (20%), biotite (4%), epidote (4%), calcite (2%), magnetite or ilmenite (2%), myrmekite (2%), muscovite (1%), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite pleochroism is pale yellow-brown to very dark brown; calcite is in veinlets and scattered grains and partly replaces plagioclase and primary ferromagnesian mineral; magnetite or ilmenite is locally altered to red iron oxide; epidote occurs in small masses of grains and "rosettes" of radiating needles; it is commonly associated with calcite. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Magnolia #3 Fromme core 4667-82 Bureau of Economic Geology

Kaolinized feldspar (55%), red iron oxide (25%), fine crush zone (10%), magnetite or ilmenite (4%), biotite relicts (3%), quartz (3%), apatite (tr). Plagioclase and alkali feldspar are in advanced stages of kaolinization; red iron oxide replaces the ferromagnesian minerals. Grain size: 0.5 to 2 mm. Fabric: relict hypidiomorphic granular. Rock: altered *syenite.*

Magnolia #3 Fromme core 4682-97 Bureau of Economic Geology

Thoroughly altered rock. Chlorite (40%), semi-opaque brownish-white clay mineral (30%), feldspar (14%), magnetite or ilmenite (5%), quartz (5%), calcite (5%), apatite (1%), unaltered biotite (tr). Chlorite occurs in large granular masses; semi-opaque brownish-white clay replaces a large body of the rock, including biotite and feldspar. Grain size: 0.5 mm. Fabric: relict hypidiomorphic granular. Rock: thoroughly altered igneous rock (note prismatic apatite), probably a chloritized and kaolinized *microsyenite.*

Magnolia #2-96 Powell-State cuttings 4695-4700 Bureau of Economic Geology

Two small fragments composed of large grains of strained quartz.

Pan American #1-4 MacDer cuttings 5290-95 Bureau of Economic Geology

Microcline and oligoclase-andesine (72%), quartz (25%), red iron oxide (2%), chlorite (1%), sericite (tr), zircon (tr). Feldspar is mostly microcline, locally microperthitic, and occurs as broken augen and in crushed areas with quartz; locally twinned plagioclase grains show bending; quartz occurs in some coarser dimensionally oriented masses (recrystallized) and in fine crush areas with feldspar; red iron oxide occurs as veinlets. Grain size: from crushed material less than 0.02 mm to augen up to 0.5 mm. Fabric: cataclastic. Rock: *granite gneiss.*

Phillips #1 Pascoe cuttings 4630-40 Bureau of Economic Geology

Andesine (45%), hornblende (20%), calcite (15%), biotite (10%), chlorite (5%), magnetite or ilmenite (5%), pyroxene? (tr), pyrite (tr), apatite (tr). Plagioclase is partly sericitized; hornblende pleochroism is yellow-brown to very dark green-brown—it is an intensely colored variety that is locally oxidized and semi-opaque; biotite pleochroism is reddish brown to very dark brown; calcite and blue-green chlorite locally invade and replace masses of the rock. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microdiorite.*

Phillips #1-A Puckett "B" cuttings 16510-25 Bureau of Economic Geology

Microcline microperthite (65%), quartz (20%), calcite (10%), biotite (3%), pyrite (1%), sericite (1%), apatite (tr), zircon (tr). Microcline microperthite and quartz occur as crushed and broken grains; secondary calcite has invaded the crushed areas; biotite is altered; sericite occurs in veinlets; mineral percentages are not significant as slide is composed largely of mineral fragments rather than rock fragments. Grain size: 1 to 3 mm. Fabric: xenomorphic granular—cataclastic. Rock: cataclastically altered *granite.*

Phillips #1-C Puckett core 14923 Bureau of Economic Geology

Microcline microperthite (58%), quartz (18%), oligoclase (15%), chlorite (5%), biotite (3%), magnetite or ilmenite (1%), hornblende (tr), muscovite (tr), calcite (tr), sphene (tr), pyrite (tr), apatite (tr), zircon (tr). Plagioclase is locally myrmekitically intergrown with quartz and occurs as large individuals and as small grains in a matrix between large microclines; biotite is dark red-brown; chlorite is brown and nearly opaque and results from alteration of ferromagnesian mineral; hornblende was observed completely enveloped by biotite in one grain; pyrite occurs along grain boundaries; calcite is in a veinlet. Grain size: large quartz and feldspars 2 to 6 mm; smaller feldspar 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Phillips #1-D Puckett core 14309-20 Bureau of Economic Geology

Microcline microperthite (64%), quartz (20%), oligoclase (10%), chlorite (3%), biotite (2%), magnetite or ilmenite (1%), hornblende (tr), calcite (tr), sphene (tr), apatite (tr), zircon (tr). Oligoclase shows incipient sericitization, locally is myrmekitically intergrown with quartz and occurs mostly as smaller grains between large microclines; red-brown biotite is partly altered to chlorite; dark green hornblende relicts occur in chlorite masses; some zircons are large. Grain size: plagioclase 0.5 to 1 mm; microcline and quartz 2 to 8 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell (Humphreys) #1 University cuttings 5200-04 Bureau of Economic Geology

Very small fragments of microcline, albite, quartz, pyrite, red iron oxide, green hornblende, and biotite. Grain size: 0.1 to 0.2 mm. Rock: *microgranite.*

Standard of Texas #1-3 MacDer cuttings 5350-60 Bureau of Economic Geology

Microcline microperthite (50%), albite (25%), quartz (20%), magnetite or ilmenite (2%), sericite (2%), chlorite (1%), zircon (tr). Perthitic structure is very fine and obscures microcline twinning; albite is finely twinned; quartz occurs as smeared and strained lenses in some fragments, is crushed (with feldspar) in some fragments, is mutilated in some fragments, and is in clear unstrained grains in other fragments; sericite is in scattered flakes. Grain size: 0.5 to 1 mm with finer crush zones. Fabric: xenomorphic granular—cataclastic. Rock: *microgranite.*

Standard of Texas #1-4 MacDer cuttings 5280-5313 Bureau of Economic Geology

Microcline (47%), oligoclase (30%), quartz (10%), biotite (5%), hornblende (3%), magnetite or ilmenite (2%), muscovite and sericite (1%), chlorite (1%), calcite (1%), pyrite (tr), apatite (tr), maroon iron oxide (tr), sphene (tr), zircon (tr). Microcline is locally microperthitic, plagioclase is partly sericitized; biotite pleochroism is pale to deep brown; hornblende pleochroism is colorless to pale green; chlorite is from alteration of biotite; muscovite and sericite occur as scattered plates and flakes and are derived from alteration of plagioclase. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.* Note: Two fragments in this slide consist of microcrystalline quartz-alkali feldspar-sericite groundmass containing sericitized oligoclase phenocrysts and showing flow structure, apatite, biotite relicts, quartz phenocrysts. Plagioclase phenocrysts have sericitized rims; groundmass less than 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Stanolind #1 Conry-Davis cuttings 5745 Bureau of Economic Geology

Andesine (61%), quartz (15%), hornblende (15%), biotite (3%), ilmenite (3%), chlorite (2%), epidote (1%), sphene (tr), apatite (tr). Hornblende pleochroism is yellow to deep green; biotite is a brown variety; sphene rims ilmenite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Stanolind #1-A Hinyard core 6473-73½ Stanolind Oil & Gas Co.

Quartz (67%), albite (30%), muscovite and sericite (3%), apatite (tr), leucoxene (tr), calcite (tr), epidote (tr), zircon (tr), sphene (tr), magnetite or ilmenite (tr), chlorite (tr). Plagioclase is partly sericitized and partly replaced by calcite; quartz occurs in a mosaic with plagioclase. Grain size: 0.5 mm. Fabric: granoblastic (quartz and feldspar recrystallized). Rock: *metarkosite.*

Stanolind #1-A Hinyard core 6487-89 Stanolind Oil & Gas Co.

Quartz (50%), oligoclase (40%), biotite (7%), sericite (3%), sphene (tr), zircon (tr), apatite (tr), chlorite (tr). Biotite pleochroism is pale brown to deep red-brown. Grain size: 0.5 to 1 mm. Fabric: granoblastic (quartz and feldspar recrystallized). Rock: *metarkosite.*

Stanolind #1-A Hinyard core 6721-24 Stanolind Oil & Gas Co.

(1) Oligoclase (59%), hornblende (25%), biotite (15%), calcite (1%), pyrite (tr), magnetite or ilmenite (tr), sphene (tr), apatite (tr), zircon (tr), sericite (tr). Plagioclase is partly altered to sericite; hornblende, yellow-green to green pleochroism, is in rudely oriented grains; biotite, pale brown to dark brown pleochroism, commonly shows a rude orientation, although some grains have grown normal to the foliation; zircon forms halos in biotite. Grain size: 0.5 mm. Fabric: crystalloblastic. Rock: *biotite amphibolite.*

(2) Quartz (69%), oligoclase (25%), biotite (2%), sericite (2%), hornblende (1%), calcite (1%). Quartz is in a mosaic with feldspar; plagioclase is partly sericitized and occurs in twinned and untwinned grains; biotite pleochroism is pale brown to dark brown; hornblende pleochroism is yellow-green to green. Grain size: 2 mm. Fabric: granoblastic. Rock: *feldspathic metaquartzite.*

Superior #1 Cordova Union cuttings 4860-65 Bureau of Economic Geology

Feldspar (75%), quartz (20%), calcite (3%), muscovite (1%), pyrite (1%), amphibole (tr), epidote (tr), apatite (tr). Feldspar is probably mostly albite; it is altered to sericite and partly replaced by calcite; quartz is in massive strained grains; amphibole occurs as sheaves of needles in vicinity of a veinlet; epidote prisms are associated with the amphibole; muscovite is in scattered plates. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *albite granodiorite.*

Union of California #1-C Heiner cuttings 6145-50 Bureau of Economic Geology

(1) 60% of total fragments in slide: andesine? (54%), hornblende (25%), biotite (10%), magnetite or ilmenite (7%), apatite (3%), pyrite (1%). Hornblende is blue-green; biotite is red-brown. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microdiorite.*

(2) 40% of total fragments in slide: microcline (37%), quartz (30%), albite-oligoclase (25%), myrmekite (8%), zircon (tr). Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Union of California #1-C Heiner cuttings 6155-60 Bureau of Economic Geology

(1) 90% of total fragments in slide: andesine and labradorite (55%), hornblende (20%), magnetite or ilmenite (7%), biotite (6%), augite (8%), calcite (4%), apatite (tr).

Andesine occurs in fragments that do not contain augite, labradorite is in augite-bearing fragments; hornblende is in yellow-green masses surrounding augite and apparently derived from augite and in blue-green prisms in fragments without augite; augite is not present in all fragments; calcite is in veinlets. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: fragments of *microdiorite* and *microgabbro* about equal in number.

(2) 10% of slide: microcline, quartz, oligoclase, myrmekite, and magnetite or ilmenite. Grain size: 0.5 to 1 mm. Fabric: ? Rock: *microgranite.*

POTTER COUNTY

Amarillo Oil & Gas #3 Masterson core 2750 Bureau of Economic Geology

Groundmass (78%), albite (10%), chlorite (7%), quartz-chlorite-epidote veinlets (3%), magnetite or ilmenite (2%), zircon (tr). Groundmass is a cryptocrystalline to microgranular aggregate of alkali feldspar stained with iron oxide; local coarsenings as parallel oriented lenses and layers show that quartz, chlorite, and epidote are minor constituents of the groundmass; cryptocrystalline areas show relict crystallitic structures; albite forms twinned phenocrysts; chlorite is after biotite; quartz-chlorite-epidote veinlets cut the rock and one occupies a microfault that shows 2 mm of apparent displacement. Grain size: groundmass cryptocrystalline to 0.02 mm; coarsenings up to 0.1 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *trachyte porphyry.*

Amarillo Oil & Gas #3 Masterson core 2765 Bureau of Economic Geology

Plagioclase (66%), nontronite? (20%), magnetite or ilmenite (7%), alkali feldspar (3%), quartz (2%), hornblende (1%), augite (1%), pyrite (tr), chlorite (tr), rutile (tr), apatite (tr). Radial laths of plagioclase are andesine or labradorite; augite and green-brown hornblende occur as corroded relict pyrogenic minerals in a mass of brown moderately birefringent mineral that appears to be nontronite; quartz and alkali feldspar are in micrographic intergrowths between plagioclase laths; tiny grains in nontronite mass are probably rutile; apatite occurs in long needles. Grain size: 0.2 to 1 mm. Fabric: subophitic. Rock: altered *leuco-diabase.*

Amarillo Oil & Gas #5 Masterson cuttings 2200 Bureau of Economic Geology

Microcline microperthite (42%), albite-oligoclase (40%), quartz (15%), calcite (2%), biotite (1%), pyrite (tr), sphene (tr), leucoxene (tr), apatite (tr). Plagioclase shows sericitized cores mantled with clear albite; quartz occurs in fractured and broken grains between feldspar grains; calcite fills fractures; biotite is a green-brown variety that is partly bleached. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Canadian River #4-B Masterson core 1943-52 Stanolind Oil & Gas Co.

Groundmass (90%), albite (8%), magnetite or ilmenite (1%), calcite (1%), apatite (tr), zircon (tr), rutile? (tr). Groundmass can be divided into a low-index cryptocrystalline area (60%) and a coarser area of quartz and feldspar (0.05 to 0.1 mm) that may be a cavity filling (30%). Plagioclase phenocrysts are partly sericitized; calcite occurs in the coarser part of the groundmass; rutile? occurs as hair-like inclusions in quartz in the coarser part of the groundmass. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Canadian River #4-B Masterson core 1952 Humble Oil & Rfg. Co.

Groundmass (89%), albite (8%), magnetite or ilmenite (2%), red iron oxide (1%), calcite (tr), leucoxene (tr), apatite (tr). Cryptocrystalline to microcrystalline quartz-alkali feldspar groundmass shows what appears to be a relict sub-parallel shard or vitroclastic structure; albite forms phenocrysts whose long dimension is parallel to the groundmass structure. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts up to 2 mm. Fabric: relict vitroclastic? Rock: *rhyolite tuff.*

Colorado Interstate #25-A Bivins cuttings 2460-67 Bureau of Economic Geology

Groundmass, feldspar, calcite, chalcedony, quartz. Heavily stained quartz-alkali feldspar groundmass is mostly micrographic, locally microspherulitic; leucoxene forms tiny plates throughout the groundmass; deeply kaolinized phenocrysts of plagioclase and alkali feldspar are present in some fragments; calcite as masses and veinlets replaces parts of the groundmass; chalcedony lines a cavity in one fragment; quartz grains fill a cavity in one fragment; a biaxial positive moderately birefringent mineral in a cavity in one fragment was not identified; mineral percentages are highly variable in different fragments. Grain size: groundmass less than 0.01 to 0.05 **mm**; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Colorado Interstate #25-A Bivins | cuttings 2546-52 | Bureau of Economic Geology

Plagioclase—labradorite?, olivine, augite, hypersthene, magnetite or ilmenite, iddingsite. Zoned plagioclase is variably sericitized in different fragments; augite shows a very fine diallage structure; mineral percentages and degree of alteration vary widely in different fragments. Grain size: 1 to 2 mm. Fabric: ranges from hypidiomorphic granular to ophitic. Rock: *leuco-olivine gabbro.*

Colorado Interstate #25-A Bivins | cuttings 2610-60 | Bureau of Economic Geology

Labradorite (80%), augite (15%), olivine (3%), iddingsite (2%), magnetite or ilmenite (tr), serpentine? (tr), biotite (tr), apatite (tr). Zoned plagioclase is variably sericitized; augite occurs as large individuals including plagioclase laths and as smaller grains interstitial to plagioclase laths; locally it shows a very fine diallage structure and locally it is partly altered to a brown moderately to highly birefringent mineral that may be hornblende; iddingsite and serpentine? are the result of alteration of olivine; red-brown biotite rims magnetite-ilmenite; mineral percentages vary in different fragments. Grain size: 0.5 to 1 mm. Fabric: ranges from hypidiomorphic granular to ophitic. Rock: *leuco-olivine diabase.*

Colorado Interstate #25-A Bivins | cuttings 2767-76 | Bureau of Economic Geology

(1) Plagioclase—labradorite? (63%), augite (20%), magnetite or ilmenite (10%), chlorite? (5%), hornblende (1%), quartz (1%), apatite (tr). Zoned plagioclase occurs as tiny laths in a more or less triangular or radial pattern; magnetite or ilmenite and augite occur interstitial to plagioclase laths; augite commonly shows an altered core of brownish chlorite?; chlorite? is a brownish fibrous mineral with moderate birefringence that apparently replaces plagioclase and augite; hornblende is a brown variety. Grain size: 0.1 to 0.2 mm. Fabric: subophitic. Rock: *diabase.*

(2) Fragments of almost opaque rock composed mostly of fine granular magnetite-ilmenite, with subordinate plagioclase microlites, and brownish chlorite. Grain size: less than 0.02 mm. Fabric: microgranular. Rock: *iron ore.*

Colorado Interstate #25-A Bivins | cuttings 2875-83 | Bureau of Economic Geology

(1) Labradorite (54%), augite (35%), magnetite or ilmenite (10%), chlorite? (1%), apatite (tr). Plagioclase shows incipient alteration to sericite; augite is lavender-brown; magnetite or ilmenite occurs in scattered grains; chlorite? is a dirty brown variety. Grain size: 0.1 to 0.5 mm. Fabric: subophitic. Rock: *diabase.*

(2) Groundmass (93%), augite (5%), plagioclase (2%). Groundmass is mostly fine granular magnetite or ilmenite with subordinate feldspar microlites; augite and plagioclase occur as scattered or sporadic phenocrysts. Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.2 mm. Fabric: microgranular. Rock: *iron ore.*

Colorado Interstate #25-A Bivins | cuttings 2956-62 | Bureau of Economic Geology

Labradorite (63%), magnetite or ilmenite (20%), augite (10%), olivine (4%), chlorite? (3%), apatite (tr). Plagioclase is zoned; magnetite or ilmenite grains occur between plagioclase laths; augite is lavender-brown and shows a fine diallage structure; olivine? is heavily stained and partly altered to chlorite?; chlorite? is a green-brown fibrous moderately birefringent mineral that has developed at the expense of the ferromagnesian minerals—it occurs in the parallel or diallage structure in the pyroxene and within the olivine; apatite is in long needles. Grain size: 0.5 to 1 mm. Fabric: subophitic. Rock: *olivine diabase.*

Colorado Interstate #25-A Bivins | cuttings 3002-10 | Bureau of Economic Geology

Groundmass (95%), serpentine and nontronite? "phenocrysts" (5%). Groundmass is an aggregate of serpentine, magnetite or ilmenite, plagioclase laths, epidote?, and nontronite?; original phenocrysts of augite and plagioclase are altered to serpentine and nontronite. Grain size: groundmass less than 0.02 mm; phenocrysts 0.2 to 0.5 mm. Fabric: metasomatic—relict subophitic?. Rock: altered *basalt porphyry.*

Colorado Interstate #25-A Bivins — cuttings 3010-30 — Bureau of Economic Geology

Groundmass (95%), feldspar (5%), apatite (tr). Micrographic quartz-alkali feldspar-magnetite or ilmenite-leucoxene groundmass is heavily stained with red iron oxide and the feldspar is partly kaolinized; feldspar phenocrysts are heavily kaolinized. Grain size: groundmass 0.01 to 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Colorado Interstate #41-B Masterson — cuttings 2419-24 — Bureau of Economic Geology

Microcline microperthite (66%), quartz (18%), albite-oligoclase (15%), magnetite or ilmenite and leucoxene (1%), sphene (tr), apatite (tr), zircon (tr). Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Emerald #1 Masterson — cuttings 2065± — Bureau of Economic Geology

Groundmass (80%), alkali feldspar and albite (18%), magnetite or ilmenite (1%), biotite (1%). Microgranular to microspherulitic quartz-alkali feldspar groundmass shows a peculiar "ropy" flowage structure and in some fragments deformed shards characteristic of welded tuffs; grains of alkali feldspar and albite appear as "phenocrysts." Grain size: groundmass 0.01 to 0.02 mm: "phenocrysts" up to 1 mm. Fabric: relict vitroclastic—welded?. Rock: *rhyolite tuff* (possibly a welded tuff).

Emerald #1 Masterson — cuttings 2125-30 — Bureau of Economic Geology

Very small fragments appear to be rhyolite porphyry; slide very poor.

Greater Amarillo Oil #1 Masterson — cuttings 2777 — Bureau of Economic Geology

(1) Igneous rock fragments, mostly sheared quartz, quartz, and microcline.
(2) Volcanic rock fragments, mostly with a groundmass composed of alkali feldspar, chlorite, leucoxene, and minor quartz and containing sericitized albite phenocrysts in some fragments. Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.2 mm. Fabric: microgranular—relict vitroclastic. Rock: fragments of *trachyte tuff* and *trachyte porphyry.*

Prairie #1 Bivins — core 2585-95 — Bureau of Economic Geology

Labradorite (58%), augite (30%), olivine (7%), alkali feldspar (2%), magnetite or ilmenite (2%), iddingsite (1%), biotite (tr). chlorite (tr), apatite (tr), zeolite? (tr). There are two varieties of pyroxene present: (1) large optically continuous irregular individuals of augite, pinkish brown in color with weak pleochroism and showing a faint diallage structure; (2) large optically continuous individuals, more marked shagreen surface than the first variety, markedly pleochroic in the pinkish-brown to green hypersthene formula but with positive optic sign; indistinctly zoned plagioclase occurs in laths and tablets, commonly within augite grains: olivine is locally partly altered to iddingsite; alkali feldspar occurs between plagioclase subhedrons; zeolite? forms a narrow veinlet. Grain size: 0.5 to 2 mm. Fabric: ophitic. Rock: *olivine diabase.* (Photomicrographs, Pl. X, A and B).

Ranch Creek #1 Masterson — cuttings 2480 — Bureau of Economic Geology

Groundmass, feldspar grains, chlorite, iron oxide, leucoxene, apatite. Red-stained and kaolinized potassium feldspar and albite groundmass is crytocrystalline to microgranular; kaolinized feldspar grains occur as phenocrysts. Slide is very poor and fragments are few. Grain size: groundmass cryptocrystalline to 0.1 mm; phenocrysts up to 0.5 mm. Fabric: in some fragments relict vitroclastic, in some fragments porphyritic. Rock: *trachyte tuff* and *trachyte porphyry* fragments.

Sinclair-Prairie #1 Bush — cuttings 5300-5700 — Stanolind Oil & Gas Co.

Groundmass (58%), albite (15%), microperthite (15%), quartz (6%), calcite (4%), sericite (1%), magnetite or ilmenite (1%), leucoxene (tr), chlorite (tr), apatite (tr), zircon (tr). Groundmass can be divided into a red-stained micrographic area (40%) and a microgranular quartz and alkali feldspar area about 0.02 mm, the two being in contact along a sharp line; plagioclase and microperthite occur as phenocrysts: quartz phenocrysts are corroded and embayed: calcite replaces feldspar and groundmass. Grain size: groundmass 0.02 mm; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Sinclair-Prairie #1 Bush cuttings 5900-6161 Stanolind Oil & Gas Co.

Groundmass (61%), microperthite (15%), quartz (15%), albite (5%), calcite (2%), sericite (1%), chlorite (1%), magnetite or ilmenite (tr), leucoxene (tr), zircon (tr), apatite (tr). Groundmass is cryptocrystalline to micrographic with vague flowage structure; quartz phenocrysts are corroded and embayed for the most part, although some are angular grains; microperthite phenocrysts are partly altered to sericite and partly replaced by calcite. Grain size: groundmass less than 0.02 mm; phenocrysts up to 0.5 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Sinclair-Prairie #1 Bush core 6158-61 Humble Oil & Rfg. Co.

Groundmass (65%), quartz (12%), microcline microperthite (10%), albite-oligoclase (8%), bleached biotite (1%), chlorite (1%), magnetite or ilmenite (1%), calcite (1%), leucoxene (1%), fluorite (tr), sphene (tr), apatite (tr), zircon (tr). Micrographic quartz-alkali feldspar groundmass shows flowage structure; quartz also forms round and embayed phenocrysts; microcline microperthite and albite-oligoclase are phenocrysts; bleached biotite and chlorite occur together as alteration products of biotite phenocrysts; sphene is altered to leucoxene. Grain size: groundmass less than 0.01 to 0.04 mm; phenocrysts 1 to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Standard of Texas #1 Bush core 6843-48 Humble Oil & Rfg. Co.

Groundmass (71%), albite (21%), microperthite (4%), quartz (2%), calcite (1%), red iron oxide (1%), leucoxene (tr), apatite (tr), zircon (tr). Quartz-alkali feldspar is mostly cryptocrystalline but local areas are microgranular; flowage is pronounced; albite and microperthite are phenocrysts; calcite and quartz occur in veinlets. Grain size: groundmass cryptocrystalline to 0.05 mm; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

PRESIDIO COUNTY

Hunt #1 Presidio Trust core 8110 Gulf Oil Corp.

Quartz (50%), microcline and albite (37%), muscovite (6%), chlorite (2%), magnetite or ilmenite (2%), hematite (2%), epidote (1%), sphene (tr), leucoxene (tr), calcite (tr), apatite (tr), zircon (tr). Quartz is irregularly distributed and occurs in part in a mosaic with feldspar and in part as more or less pure quartz mosaic; microcline is the predominant feldspar and is present in large and small grains; albite is in part porphyroblastic-poikiloblastic; poikiloblastic muscovite occurs in local concentrations; scattered magnetite or ilmenite grains are locally subhedral; epidote and chlorite are associated in small patches; chlorite is in part after biotite; rock is essentially a recrystallized arkosic sediment but porphyroblastic feldspars indicate introduced feldspathic material—the rock is partly granitized. Grain size: average 0.1 to 0.3 mm with sporadic feldspar porphyroblasts up to 2 mm. Fabric: crystalloblastic. Rock: *metarkosite.*

Hunt #1 Presidio Trust core 8110 Bureau of Economic Geology

Same as Gulf Oil Corporation 8110. (Photomicrographs, Pl. VI, C and D.)

Presidio #1 Conring cuttings Stanolind Oil & Gas Co.

(1) 4020-30. Albite (74%), quartz (8%), chlorite (8%), aegirine-augite (8%), magnetite or ilmenite (2%). Grain size: 0.1 mm. Fabric: microlitic. Rock: *albite dacite*? [probably Tertiary].

(2) 4060-70. Alkali feldspar (71%), quartz (15%), amphibole (8%), aegirine-augite (3%), chlorite (3%), zircon (tr), magnetite or ilmenite (tr). Amphibole is an intensely colored variety—blue-green to deep brown. Grain size: 0.1 mm. Fabric: xenomorphic granular. Rock: *microgranite* [probably Tertiary].

(3) 4280-90. Alkali feldspar (73%), quartz (15%), amphibole (7%), chlorite (3%), aegirine-augite (2%), apatite (tr). There are two amphiboles present—a dark brown variety (arfvedsonite?) (5%) and a blue variety—riebeckite (2%). Fabric: xenomorphic granular. grain size: 0.05 mm. Rock: *microgranite* [probably Tertiary].

(4) 4400-10. Alkali feldspar (72%), quartz (20%), aegirine-augite (4%), amphibole (3%), chlorite (1%). Two amphiboles are present—a brown variety (3%), and a blue to blue-green variety (tr). The aegirine-augite is yellow-green in the centers of the grains and green on the peripheries. Grain size: 0.05 to 0.2 mm. Fabric: xenomorphic granular. Rock: *microgranite* [probably Tertiary].

Welch #1 Espy core 7830 Bureau of Economic Geology

Microcline microperthite (42%), quartz (35%), albite (12%), chlorite (4%), biotite (3%), myrmekite (1%), red iron oxide (1%), magnetite or ilmenite (1%), calcite (1%), zircon (tr), apatite (tr), sericite-muscovite (tr). Quartz is unequally distributed through the rock and occurs in clusters of grains; plagioclase shows incipient alteration to sericite; biotite, pale to very dark brown pleochroism, is partly altered to chlorite; calcite partly replaces plagioclase; red iron oxide occurs in veinlets and along grain boundaries; sericite-muscovite occurs in a veinlet and within plagioclase grains (sericite only) as a result of alteration. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular—poorly developed; larger grains are surrounded by clusters of small grains. Rock: *granite.*

RANDALL COUNTY

Placid #1 Greeley cuttings 8240-44 Bureau of Economic Geology

Groundmass (72%), quartz (10%), albite (8%), microperthite (8%), chlorite (2%), leucoxene (tr), apatite (tr). Brown micrographic groundmass contains local microspherulitic patches; quartz occurs as corroded, embayed phenocrysts; microperthite and plagioclase, probably albite, are phenocrysts; chlorite occurs as a replacement of biotite. Grain size: groundmass 0.05 to 0.1 mm; phenocrysts up to 0.2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

ROBERTS COUNTY

Phillips #1 Jenkie cuttings 11737 Humble Oil & Rfg. Co.

Albite-oligoclase (52%), quartz (22%), microperthite (20%), chlorite (3%), biotite (2%), leucoxene (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Plagioclase is in an advanced stage of sericitization; red-brown biotite is partly altered to chlorite; leucoxene is locally in diamond-shaped grains after sphene. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

RUNNELS COUNTY

Superior #1 McDowell cuttings 6283 Bureau of Economic Geology

Albite (86%), biotite (7%), quartz (4%), amphibole (1%), muscovite (1%), leucoxene (1%), piedmontite? (tr), apatite (tr), zircon (tr), pyrite (tr), ilmenite (tr), fluorite (tr), alkali feldspar (tr), rutile? (tr). Plagioclase occurs in a mosaic of twinned grains with a trace of alkali feldspar present between plagioclase grains and as anti-perthite; biotite, colorless to red-brown pleochroism, occurs in short equant plates, commonly showing tiny pleochroic halos; bundles of elongate colorless prisms occur in a crystalloblastic habit in one fragment and appear to be amphibole—anthophyllite?; one grain of a mineral pleochroic in pink occurs in this same fragment and may be piedmontite. Grain size: 0.2 to 0.5 mm average, 2 mm maximum. Fabric: predominantly hypidiomorphic granular but with elements of a sieve fabric evident in one fragment. Rock: *albite hornfels?.*

SAN SABA COUNTY

Cayce #1 Moore cuttings 1656-69 Bureau of Economic Geology

Microcline (46%), albite-oligoclase (30%), quartz (22%), biotite (2%), chlorite (tr), sericite-muscovite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase shows incipient sericitization; sericite-muscovite occurs in irregular plates and fibers; biotite pleochroism is yellow-brown to almost black. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular—poikilitic. Rock: *granite.*

SCHLEICHER COUNTY

Atlantic #1 Roberts core 7751 Bureau of Economic Geology

Microcline microperthite (72%), quartz (18%), oligoclase (5%), calcite (3%), chlorite (1%), magnetite or ilmenite and red iron oxide (1%), leucoxene (tr), zircon (tr). Quartz is locally micrographically intergrown with microcline microperthite and commonly quartz grains are connected by veinlets along feldspar boundaries; chlorite is after biotite; red iron oxide occurs in veinlets. Grain size: 0.5 to 4 mm. Fabric: xenomorphic granular—micrographic. Rock: *granite.*

Humble #1 Spencer core 6909-10 Bureau of Economic Geology

Microcline microperthite (70%), quartz (20%), albite (8%), calcite (2%), muscovite (tr), bleached biotite? (tr), pyrite (tr), zircon (tr). Microcline microperthite shows incipient kaolinization and abundant carlsbad twins; quartz is locally micrographically intergrown with feldspar and in some areas penetrates and embays feldspar in almost skeletal grains; plagioclase is murky with incipient sericite but locally has clear rims; bleached biotite? is associated with masses of calcite. Grain size: 2 mm to 1 cm. Fabric: xenomorphic granular. Rock: *granite.*

Humble #1 Stanford core 9020 Bureau of Economic Geology

Microcline microperthite (64%), quartz (18%), albite (15%), chlorite (2%), leucoxene (1%), bleached biotite (tr), zircon (tr). Microcline microperthite grains locally show micrographic borders; quartz occurs as individual grains and in micrographic intergrowths; zircon is in clusters of small grains. Grain size: fine granular quartz-feldspar veinlet 0.05 to 0.1 mm; rock 2 to 5 mm. Fabric: xenomorphic granular—micrographic. Rock: *granite.*

Phillips #1 Callan cuttings 6058-65 Bureau of Economic Geology

Chlorite (38%), sericite (25%), labradorite-bytownite (15%), magnetite or ilmenite and pyrite (10%), olivine (5%), augite (5%), serpentine (2%). Olivine relicts occur wthin masses of greenish-brown chlorite that shows a characteristic mesh structure; green chlorite is present in minor amounts; plagioclase is in part completely sericitized and in part shows sericitized cores with less altered rims, some plagioclase is partly replaced by calcite; sericite in the rock is from alteration of plagioclase; augite is present as partly altered relicts with olivine; one fragment shows a vug or cavity in chloritic material that is partly filled with serpentine; some fragments are brecciated with chlorite filling in between broken fragments. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—metasomatic. Rock: altered *olivine gabbro.*

SCURRY COUNTY

Humble #1 Nachlinger core 8266 Bureau of Economic Geology

Dolomite (92%), quartz and plagioclase (7%), talc? (1%), tourmaline (tr). Dolomite mosaic shows some zones with elongate dimensionally oriented grains imparting a rude foliation, coarser dolomite occurs in cross-cutting veinlets; plagioclase and subordinate quartz occur as scattered grains in the dolomite mosaic; highly birefringent parallel oriented fibers are probably talc but possibly are sericite or brucite; tourmaline is yellow-brown. Grain size: 0.02 to 0.1 mm. Fabric: cataclastic—granoblastic. Rock: *metadolomite.*

Humble #1 Nachlinger core 8266 Bureau of Economic Geology

Megascopic view of section shows a convoluted foliation. Dolomite (80%), quartz and plagioclase (10%), tourmaline (7%), talc? (2%), red iron oxide (1%), pyrite (tr). Dolomite occurs as (1) fine-grained sheared mosaic with grains showing severe strain and dimensional orientation, (2) a coarser mosaic showing strained grains but no orientation, and (3) coarser cross-cutting veinlets; quartz and subordinate plagioclase occur as scattered grains in the dolomite mosaic and locally show a dimensional orientation; yellow-brown prismatic tourmaline crystals occur in layers and lenses emphasizing the foliation—the long axis of the tourmaline crystals is parallel to the foliation but there is no lineation; a highly birefringent mineral occurring in oriented fibers is probably talc but possibly is sericite or brucite; red iron oxide occurs in spots from alteration of pyrite. Grain size: dolomite mosaic 0.02 to 0.05 mm; vein dolomite is up to 0.3 mm. Fabric: cataclastic—crystalloblastic. Rock: *metadolomite.* (Photomicrograph, Pl. VII, D.)

Stanolind (Superior and Intex) #1 Jordan cuttings 8920-21 Bureau of Economic Geology

Oligoclase (61%), quartz (20%), microcline (15%), biotite (2%), epidote (2%), chlorite (tr), magnetite or ilmenite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase shows incipient alteration to sericite; biotite, pale yellow to very dark brown pleochroism, is partly altered to chlorite; epidote is in masses of grains with biotite and along grain boundaries. Grain size: 0.5 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Stanolind (Superior and Intex) #1 Jordan cuttings 8920-25 Bureau of Economic Geology

Microcline (75%), albite (15%), quartz (5%), biotite (3%), epidote (1%), sphene (1%), apatite (tr), zircon (tr). Microcline occurs as large grains and as embayed, corroded remnants in plagioclase; biotite pleochroism is yellow-brown to very dark brown; epidote occurs in veinlets and scattered tiny grains. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Sun and Ohio #1 Helms core ? Bureau of Economic Geology

Oligoclase-andesine (53%), hornblende (15%), biotite (15%), quartz (10%), epidote (5%), sphene (2%), calcite (tr), apatite (tr), zircon (tr). Plagioclase shows indistinct zoning and incipient alteration to sericite; hornblende, yellow-green to blue-green pleochroism, is locally poikilitic; biotite is a green-brown variety; epidote occurs in fresh euhedral grains; zircon forms halos in biotite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

SHACKELFORD COUNTY

Honolulu #1 Pool core 5273-76 Humble Oil & Rfg. Co.

Microcline microperthite (50%), hornblende (20%), epidote (12%), albite (10%), biotite (8%), calcite (tr), magnetite or ilmenite (tr), sphene (tr), apatite (tr). Partly epidotized pale green hornblende occurs in large grains (primary) and in masses of sheaves (secondary); epidote is the result of alteration of plagioclase and other ferromagnesian minerals and replaces albite, hornblende, and biotite; green-brown biotite occurs in large plates (primary) partly altered to epidote and nests of small plates (secondary); sodic nature of the plagioclase is probably partly due to epidotization. The ferromagnesian minerals in this rock seem to have suffered extensive deuteric changes. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—metasomatic. Rock: altered *syenite.*

SHERMAN COUNTY

Humble #1 Morris core 6085-6100 Bureau of Economic Geology

Microcline microperthite (60%), quartz (39%), chlorite (1%), pyrite (tr), red iron oxide (tr), bleached biotite (tr), calcite (tr), zircon (tr). Microcline microperthite is micrographically intergrown with quartz—the intergrowth ranges from cuneiform to irregular to myrmekitic. Grain size: 0.5 to 2 mm for grains; 0.1 to 0.5 for intergrowth. Fabric: micrographic. Rock: *micrographic granite.*

I.T.I.O. #1 Bryan cuttings 5123-38 Stanolind Oil & Gas Co.

Albite (59%), fine-grained quartz-albite fracture filling (20%), chlorite (10%), quartz (5%), epidote (4%), magnetite or ilmenite (1%), leucoxene (1%), apatite (tr), zircon (tr). Grain size: 0.5 to 2 mm; fracture filling 0.05 mm. Fabric: hypidiomorphic granular. Rock: *leuco-albite-quartz diorite.*

Phillips #1 Kathryn core 7739 Humble Oil & Rfg. Co.

Groundmass (65%), albite (20%), microcline microperthite (10%), pyrite (2%), chlorite (1%), bleached biotite (1%), isotropic brown mineral (1%), red iron oxide (tr), apatite (tr), zircon (tr). Groundmass is a microgranular aggregate of quartz and alkali feldspar; microcline microperthite and albite are phenocrysts, albite is altered to a mixture of sericite and what appears to be a clay mineral; chlorite and bleached biotite are derived from biotite phenocrysts; a brown isotropic mineral associated with apatite and zircon was not identified. Grain size: groundmass 0.02 to 0.04; phenocrysts 0.5 to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Phillips #1 Virginia cuttings 7040-50 Humble Oil & Rfg. Co.

Microcline (58%), quartz (35%), sericite-muscovite (4%), biotite (1%), chlorite (1%), leucoxene (1%), rutile (tr). Microcline mode includes subordinate plagioclase; reddish-brown biotite is poikilitic. Grain size: 0.05 to 0.2 mm. Fabric: granoblastic with elements of sieve fabric. Rock: *metarkosite?.*

STONEWALL COUNTY

Honolulu #1 Baugh core ? Honolulu Oil Corp.

Quartz (53%), oligoclase (20%), microcline (15%), biotite (12%), sphene (tr), magnetite or ilmenite (tr), zircon (tr), apatite (tr). Feldspar and quartz occur in a mosaic; plagioclase shows incipient alteration to sericite; biotite, pale brown to very deep brown pleochroism, occurs in non-oriented equant grains; zircon forms halos in biotite. Grain size: 0.5 mm. Fabric: granoblastic (quartz and feldspar recrystallized). Rock: *metarkosite.*

SUTTON COUNTY

Phillips #1 Libb Wallis cuttings 5470-80 Bureau of Economic Geology

Microcline (45%), oligoclase (35%), quartz (20%), leucoxene (tr), red iron oxide (tr), sericite-muscovite (tr), zircon (tr). Only a few fragments present. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #3 Miers (Core Test #3) cuttings 4940-50 Shell Oil Co.

Albite (55%), chlorite (25%), calcite (10%), magnetite or ilmenite (5%), sericite (5%), pyrite (tr). Plagioclase is sericitized and replaced by calcite; chlorite replaces original ferromagnesian minerals. Grain size: 0.2 to 1 mm. Fabric: relict hypidiomorphic granular. Rock: altered *albite diorite.*

Shell #3 Miers (Core Test #3) cuttings 4950-5003 Bureau of Economic Geology

Microcline microperthite (40%), albite (33%), quartz (25%), calcite (1%), magnetite or ilmenite (1%), chlorite (tr), pyrite (tr). Some albite is early in subhedrons and shows incipient alteration to sericite; late clear albite occurs in veinlets. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

SWISHER COUNTY

Humble #1 Nanny cuttings 9590-9600 Shell Oil Co.

(1) 100% fine granular chlorite with scattered flecks of opaque mineral.
(2) Albite (70%), chlorite (30%). Albite is sericitized. Grain size: 0.5 mm. Fabric: relict hypidiomorphic granular. Rock: altered *albite microdiorite.*

Humble #1 Nanny cuttings 9630-40 Shell Oil Co.

Plagioclase (65%), amphibole (10%), chlorite (10%), sericite (10%), ilmenite (4%), calcite (1%), sphene (tr), biotite (tr). Plagioclase is in advanced stage of sericitization; chlorite occurs as a result of alteration of amphibole and in veinlets; sphene surrounds ilmenite; amphibole occurs in large subhedrons and as masses of fibers. Grain size: 1.0 to 2.0 mm. Fabric: hypidiomorphic granular. Rock: *altered diorite.*

Humble #1 Nanny cuttings 9630-40 Shell Oil Co.

Sericite (40%), albite? (29%), chlorite (15%), magnetite or ilmenite (10%), amphibole (5%), biotite (1%), pyrite (tr), apatite (tr). Feldspar (albite?) occurs in laths and is partly kaolinized; large areas of the slide are composed of masses of fine sericite fibers; amphibole occurs in ragged green to olive felty masses; apatite is in long needles; bright green chlorite occurs in masses and in veinlets; deep red-brown biotite surrounds opaque mineral. Grain size: 0.5 to 1.0 mm. Fabric: relict hypidiomorphic granular. Rock: altered *albite microdiorite.*

Humble #1 Nanny cuttings 9640-50 Shell Oil Co.

Same as preceding 9630-40 but contains a more calcic plagioclase. Hornblende, brown to green pleochroism, is partly altered to masses of small sheaves within the original large grains and sphene.

Standard of Texas #1 Johnson core 9193-9200 Bureau of Economic Geology

Andesine-labradorite (45%), augite (40%), olivine (10%), magnetite or ilmenite (5%), biotite (tr), chlorite (tr), apatite (tr). Plagioclase is in triangularly oriented laths within an optically continuous background of augite; plagioclase is vaguely zoned and shows variable alteration to sericite; red-brown biotite fringes opaque mineral. Grain size: augite forms one big optically continuous grain about 2 cm long and includes plagioclase and olivine grains up to 1 mm long. Fabric: ophitic. Rock: *olivine diabase.* (Photomicrograph, Pl. IX, A.)

TAYLOR COUNTY

Jamison #1 Webb cuttings 5845-50 Bureau of Economic Geology

Individual mineral grains indicate a biotite schist similar to 6081.

Jamison #1 Webb core 6081 Bureau of Economic Geology

Microcline and albite-oligoclase (48%), quartz (35%), biotite (15%), magnetite or ilmenite (1%), leucoxene (1%), chlorite (tr), sphene (tr), apatite (tr), zircon (tr). Feldspar and quartz form a mosaic, feldspar is predominantly microcline; green-brown biotite occurs in oriented plates; rock shows a layering expressed in grain size and varied concentration of quartz and feldspar. Grain size: 0.2 mm. Fabric: lepidoblastic. Rock: *feldspathic biotite schist.* (Photomicrographs, Pl. VII, A and B.)

Jamison #1 Webb core 6125-26 Bureau of Economic Geology

Quartz (50%), oligoclase (20%), microcline (15%), biotite (12%), hornblende (2%), pyrite (1%), sphene (tr), apatite (tr). Quartz and feldspar form a mosaic; biotite, red-brown, occurs in rudely oriented plates; hornblende pleochroism is yellow-green to green; plagioclase, microcline, and quartz show varied concentration in rude layers. Grain size: 0.1 to 0.5 mm. Fabric: lepidoblastic. Rock: *feldspathic biotite schist.*

Jamison #1 Webb *cuttings* 6234-44 Bureau of Economic Geology

Individual mineral grains indicate a biotite schist similar to 6081 and 6125-26.

TERRY COUNTY

Anderson-Prichard #1 Rich cuttings 13130-34 Bureau of Economic Geology

Albite and microcline (62%), quartz (30%), magnetite or ilmenite (4%), chlorite (2%), sericite-muscovite (1%), leucoxene (1%), red iron oxide (tr), apatite (tr). Quartz forms a granoblastic aggregate with feldspar; feldspar is mostly albite with porphyroblastic-poikiloblastic habit; chlorite and sericite-muscovite occur as intergranular fibers and plates. Minerals are unequally distributed in the rock—there are quartz-rich and quartz-poor areas. Grain size: aggregate 0.05 to 0.2 mm; porphyroblasts up to 2 mm. Fabric: crystalloblastic. Rock: *feldspathized arkosic sedimentary rock?, microgranite porphyry?.*

J. L. Hamon (Coroco) #1 Atlas Life cuttings 13250-60 Bureau of Economic Geology

Microcline microperthite (57%), quartz (30%), albite (10%), chlorite (2%), red iron oxide (1%), magnetite or ilmenite (tr), fluorite (tr), leucoxene (tr), biotite (tr), calcite (tr). Feldspar is partly kaolinized and it is difficult to separate plagioclase from microperthite; quartz is in part micrographically intergrown with feldspar; calcite occurs in masses from alteration of feldspar; magnetite or ilmenite is partly altered to red iron oxide; biotite laths are nearly opaque from partial oxidation. Grain size: 0.5 to 3 mm. Fabric: micrographic. Rock: *micrographic granite.*

TOM GREEN COUNTY

Honolulu #1 Nasworthy core 7688-89 Bureau of Economic Geology

Microcline microperthite (78%), quartz (12%), albite (5%), hornblende (3%), biotite (1%), chlorite (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Microcline microperthite is in large grains; hornblende is a deeply colored green-brown variety; biotite is red-brown and partly altered to chlorite. Grain size: microcline grains up to 2 cm; plagioclase-quartz-hornblende grains 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Richardson #1 Schwartz cuttings 7160-68 Bureau of Economic Geology

Microcline (40%), albite-oligoclase (26%), quartz (20%), hornblende (5%), chlorite (5%), biotite (2%), calcite (2%), ilmenite (tr), sphene (tr), apatite (tr), zircon (tr). Microcline is locally a patch perthite; hornblende is a deeply colored green-brown variety partly altered to chlorite and calcite; biotite is likewise a deeply colored brown variety. Grain size: 2 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

UPTON COUNTY

Slick-Urschel #1 Standefer cuttings 12490-500 Bureau of Economic Geology

Andesine (51%), hornblende (35%), biotite (7%), quartz (3%), calcite (2%), magnetite or ilmenite (2%), sphene (tr), apatite (tr), leucoxene (tr). Twinned plagioclase occurs in a mosaic with ferromagnesian minerals; hornblende pleochroism is yellow to dark green; biotite is red-brown. Grain size: 0.2 to 1 mm. Fabric: xenomorphic granular?, granoblastic?. Rock: *microdiorite?, amphibolite?.* (Also in slide is one fragment of severely strained and sutured mosaic of alkali feldspar and quartz with green-brown biotite, partly chloritized, and apatite.)

WHEELER COUNTY

Best #1 Tindall | cuttings 2252 | Bureau of Economic Geology

Microperthite, andesine?, quartz, chlorite, calcite, magnetite or ilmenite, biotite, apatite, zircon. Some microperthite grains show a cuneiform micrographic structure; indistinctly zoned plagioclase, probably andesine, is partly altered to sericite, chlorite, and calcite; biotite pleochroism is yellow-brown to very dark brown; chlorite is a finely fibrous green-brown variety. Mineral percentages are variable in different fragments. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Best #1 Tindall | cuttings 2267 | Bureau of Economic Geology

Similar to 2252 but with (1) traces of relict green hornblende and (2) one fragment of rhyolite (microgranular quartz-alkali feldspar groundmass 0.05 to 0.1 mm with one quartz phenocryst 1 mm in diameter).

Schenk et al. #1 George | cuttings 2492-2504 | Bureau of Economic Geology

Albite (58%), hornblende (35%), magnetite or ilmenite (4%), epidote (2%), sphene (1%), augite (tr), chlorite (tr), quartz (tr), calcite (tr). Albite is in partly sericitized laths; hornblende, green to yellow-green pleochroism, occurs in discrete grains and prisms and is associated with tiny epidote grains, possibly the hornblende is the result of alteration of augite; augite occurs in relicts surrounded by hornblende; epidote is in tiny grains in the body of the rock and in a cross-cutting veinlet; quartz and calcite occur together in a vug; magnetite or ilmenite is in scattered grains. Grain size: 0.2 to 1 mm. Fabric: subophitic. Rock: altered *albite diabase.*

Schenk et al. #1 George | cuttings 2492-2504 | Bureau of Economic Geology

Plagioclase (42%), chlorite (22%), hornblende (20%), magnetite or ilmenite and pyrite (12%), zeolite? (3%), unidentified needles (1%). Completely sericitized plagioclase occurs in radial laths in a mass of yellow green hornblende and its alteration product, chlorite; magnetite or ilmenite and pyrite grains are distributed throughout the slide; unsericitized low-birefringent mineral is probably zeolite but may be alkali feldspar; it is penetrated by an unidentified low birefringent acicular mineral. Grain size: 0.2 to 0.5 mm. Fabric: relict subophitic. Rock: altered *diabase.*

Schenk et al. #1 George | cuttings 2542-47 | Bureau of Economic Geology

Oligoclase-andesine, quartz, hornblende, biotite, epidote, sphene, magnetite or ilmenite, apatite, zircon. Plagioclase, locally anti-perthitic, is in an advanced stage of sericitization; hornblende pleochroism is yellow-green to green; biotite is green-brown; epidote is derived from alteration of hornblende and plagioclase. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Smith #2 Farren | cutting 2490-2500 | Stanolind Oil & Gas Co.

Microperthite (68%), calcite (15%), hornblende (5%), quartz (5%), albite (3%), chlorite (3%), magnetite or ilmenite (1%), apatite (tr), pyrite (tr), zircon (tr). Grains are fractured and cemented by calcite; calcite occurs in veinlets cementing breccia and also replaces feldspar and hornblende; hornblende pleochroism is green to deep brown-green, chlorite is in fine masses constituting part of the matrix of the breccia. Grain size: up to 3 mm. Fabric: cataclastic. Rock: brecciated *granite.*

Smith #2 Farren | cuttings 2961-69 | Stanolind Oil & Gas Co.

Albite (74%), microperthite (10%), biotite (9%), hornblende (6%), apatite (1%), zircon (tr). Microperthite is present as a single elongate phenocryst; biotite occurs in non-oriented laths and shows pale to deep brown pleochroism; hornblende, yellow-green to green pleochroism, occurs in needles and stubby prisms. Grain size: 0.02 to 0.1 mm with sporadic feldspar up to 2 mm. Fabric: xenomorphic granular. Rock: *porphyritic albite syenodiorite.*

Smith #2 Farren | cuttings 3056 | Stanolind Oil & Gas Co.

Microperthite (93%), quartz (6%), aegirine-augite (1%), apatite (tr). Grain size: up to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Smith #2 Farren cuttings 3065-70 Stanolind Oil & Gas Co.

Rock is breccia composed of fragments of quartz, microperthite, magnetite or ilmenite, biotite, zircon, and a fine intergranular matrix. Grain size: 0.5 mm. Fabric: cataclastic. Rock: brecciated *granite.*

Smith #2 Farren cuttings 3125 Stanolind Oil & Gas Co.

Microperthite (65%), quartz (30%), hornblende (3%), chlorite (1%), magnetite or ilmenite (1%), apatite (tr). Hornblende pleochroism is pale green-brown to deep green. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Smith #2 Farren cuttings 3125 Stanolind Oil & Gas Co.

(1) Microperthite (62%), quartz (30%), chlorite (5%), magnetite or ilmenite (2%), biotite (1%), leucoxene (tr), sphene (tr). Rock shows incipient brecciation. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*
(2) Microperthite (66%), quartz (25%), amphibole (7%), magnetite or ilmenite (1%), apatite (1%). Amphibole pleochroism is a brown to deep brown-green; apatite is abundant in needles. Grain size: 0.2 to 0.3 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Smith #2 Farren cuttings 3877-83 Stanolind Oil & Gas Co.

Fragment is apparently from a miarolitic cavity and consists of carbonate, radiating and convoluted masses of chlorite, biotite, and green pyroxene (probably aegirine-augite).

Smith #2 Farren cuttings 4286 Stanolind Oil & Gas Co.

Microperthite (55%), quartz (30%), albite (10%), amphibole (5%), biotite (1%), zircon (tr). Amphibole pleochroism is brown to deep brown with a border of riebeckite (blue). Grain size: 0.2 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Thomas & McFarland #1 Kachelhoffer cuttings 2280 Bureau of Economic Geology

Microcline microperthite, plagioclase, anhydrite, quartz, magnetite or ilmenite, red iron oxide. Microcline microperthite and sodic plagioclase occur as fractured grains veined with red iron oxide and anhydrite; masses of anhydrite are also present in the rock. Grain size: 0.5 to 4 mm. Fabric: ?. Rock: *granite.*

Thomas & McFarland #1 Kachelhoffer cuttings 2325 Bureau of Economic Geology

Microcline microperthite, albite-oligoclase, quartz, hornblende, biotite, magnetite or ilmenite, apatite, zircon. Plagioclase shows indistinct zoning; hornblende is green-brown; biotite is brown. Slide is composed mostly of individual mineral fragments. Grain size: 0.2 to 2 mm. Fabric: ?. Rock: *granite.*

WICHITA COUNTY

Continental and Magnolia #1 Beach cuttings 3180 Bureau of Economic Geology

Magnetite or ilmenite, quartz, sericite, epidote, calcite, sphene. Slide is poor and composed of very fine cuttings; sericite fibers appear to be oriented; magnetite or ilmenite content is very high. Grain size: less than 0.1 mm. Fabric: crystalloblastic?. Rock: *epidote-sericite phyllite?.*

Frabar-Hodges #1 George core 3318 Humble Oil & Rfg. Co.

Chlorite and epidote (83%), calcite (8%), mica? (4%), quartz (3%), pyrite and magnetite (2%), relict plagioclase? (tr). Tiny eidote and chlorite plates form the mass of the rock; epidote also occurs in large grains sporadically throughout the rock and in quartz-calcite veinlets; quartz in veinlets includes myriad tiny chlorite plates; the strongly birefringent platy mineral is probably a mica; pyrite and magnetite occurs as scattered grains and cubes; one grain apparently of relict twinned plagioclase almost entirely engulfed by chlorite and epidote was observed. Grain size: mostly less than 0.02 mm; mica? plates up to 0.2 mm long. Fabric: metasomatic. Rock: *chlorite-epidote rock.*

Gulf #1 Miller core 4231-35 Humble Oil & Rfg Co.

Microcline microperthite and albite-oligoclase (68%), quartz (15%), sericite (6%), rock fragments (5%), biotite (3%), calcite (2%), chlorite (1%), sphene (tr), epidote (tr), sphene and ilmenite (tr), apatite (tr), zircon (tr). Microcline microperthite and variably sericitized albite-oligoclase occur as angular grains; quartz is in angular grains; sericite occurs as intergranular fibers as a result of reconstitution and from alteration of plagioclase; green biotite occurs as small plates and fibers concentrated in nests with chlorite; rock fragments are chert, microgranite, and quartz mosaic; sphene-ilmenite occur together as single grains. Grain size: up to 0.5 mm. Fabric: relict clastic—incipient crystalloblastic (no recrystallization of quartz and feldspar but growth of biotite and sericite attests to reconstitution). Rock: *meta-arkose.*

Texas #44 Skinner core 2860 Bureau of Economic Geology

Albite and microcline (62%), quartz (15%), rock fragments (10%), quartz-feldspar-chlorite-sericite matrix (8%), chlorite (3%), calcite (1%), pyrite (1%), muscovite (tr), apatite (tr), zircon (tr). Feldspar and quartz occur in angular fractured and strained grains; microcline is microperthitic in some grains; rock fragments are chert, volcanic rocks, metasedimentary rocks, and granitic rocks; matrix may be a crush matrix or partly reconstituted intergranular sedimentary material; chlorite is in masses and veinlets; pyrite occurs with quartz and chlorite in veinlets and is partly altered to red iron oxide. Grain size: less than 0.02 to 0.5 mm. Fabric: cataclastic. Rock: *meta-arkose* or *metagraywacke.*

Texas #44 Skinner core 2860-65 Humble Oil & Rfg. Co.

Microcline microperthite and albite-oligoclase (73%), quartz (15%), rock fragments (4%), chlorite (3%), epidote (3%), magnetite or ilmenite (1%), sericite (1%), leucoxene (tr), calcite (tr), apatite (tr), zircon (tr). Feldspar occurs in both angular and round grains; quartz is in angular grains and in veinlets; epidote occurs with quartz in veinlets and as scattered grains in the rock: rock fragments are granitic and volcanic; chlorite forms intergranular plates and masses with sericite fibers. Grain size: up to 0.5 mm with sporadic rock and feldspar fragments up to 2 mm. Fabric: relict clastic—incipient crystalloblastic (no recrystallization of quartz and feldspar). Rock: *meta-arkose.*

WILBARGER COUNTY

Barkley-Meadows #14-A Stephens core 3007 Humble Oil & Rfg. Co.

Labradorite (63%), augite (25%), biotite (4%), magnetite or ilmenite (4%), hornblende (3%), hypersthene (1%), iddingsite? (tr), pyrite (tr), apatite (tr). Plagioclase is zoned; augite shows a parallel schiller structure and locally is fringed with hornblende showing pale brown to green pleochroism; biotite is red-brown and fringes the opaque mineral; hypersthene is partly altered to iddingsite?. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-microgabbro.*

Gulf #6-E Blackman core 3515-33 Bureau of Economic Geology

Quartz (51%), albite (25%), microcline (15%), biotite (7%), muscovite (1%), sericite (1%), apatite (tr), zircon (tr). Quartz and feldspar occur in a mosaic, plagioclase is partly sericitized; muscovite and biotite occur as equant non-oriented plates; biotite pleochroism is pale brown to almost black. Grain size: 0.2 to 0.4 mm. Fabric: granoblastic (thoroughly recrystallized rock). Rock: *metarkosite.* (Photomicrograph, Pl. V, B.)

Humble #6 Stevens cuttings 2810-15 Bureau of Economic Geology

Andesine (60%), hornblende (40%), magnetite or ilmenite (tr), apatite (tr). Plagioclase subhedrons are partly sericitized; green hornblende occurs in frayed and felty masses; locally it shows a brown fringe or interior patch. Grain size: up to 2 mm. Fabric: hypidiomorphic granular. Rock: *diorite.*

Texas #1 Main core 4725 Humble Oil & Rfg. Co.

Microcline (56%), quartz (25%), albite (8%), biotite (8%), muscovite (2%), magnetite or ilmenite and leucoxene (1%), apatite (tr), zircon (tr). Microcline and quartz form a mosaic showing a rude dimensional orientation; plagioclase is more or less concentrated in a layer that is also richer in muscovite; biotite and muscovite are in oriented plates. Grain size: 0.2 to 0.5 mm. Fabric: lepidoblastic. Rock: *biotite-quartz-microcline schist.*

WILLIAMSON COUNTY

Shell and Sinclair #1 Purcell core 9474-79 Bureau of Economic Geology

Microcline (40%), albite-oligoclase (35%), quartz (18%), biotite (4%), magnetite or ilmenite (2%), muscovite (1%), chlorite (tr), sphene (tr), calcite (tr), apatite (tr), zircon (tr).

Plagioclase is partly altered to sericite, locally it is replaced by muscovite; quartz is commonly welded and undulose; mahogany brown biotite, partly altered to chlorite, is locally crinkled and bent. The rock is cut by a number of fractures, one of which shows a 3-mm apparent displacement. There is an over-all dimensional orientation of grains. Grain size: 0.5 to 5 mm. Fabric: hypidiomorphic granular—gneissic. Rock: *granite gneiss.*

WINKLER COUNTY

Gulf #46-E Keystone cuttings 9995-10000 Bureau of Economic Geology

Microcline microperthite (54%), quartz (20%), albite-oligoclase (15%), chlorite (4%), hornblende (2%), calcite (2%), biotite (2%), pyrite (1%), zircon (tr), apatite (tr). Quartz is strained, granulated, and streaked out in incipient gneissic development; hornblende and biotite occur as faded relicts mostly altered to chlorite and calcite. Grain size: 0.05 mm (granulated quartz) to 5 mm (microcline). Fabric: hypidiomorphic granular—cataclastic. Rock: *granite* partly converted to *granite gneiss.*

Gulf #46-E Keystone cuttings 10000-05 Bureau of Economic Geology

Microcline microperthite and oligoclase (67%), quartz (25%), biotite (8%), apatite (tr), zircon (tr). Feldspar is mostly microcline microperthite, plagioclase is sericitized; biotite, very dark green-brown variety, is so oxidized as to be nearly opaque. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Gulf #50-E Keystone cuttings 10080-90 Bureau of Economic Geology

Microcline microperthite (37%), oligoclase (35%), quartz (15%), chlorite (7%), biotite (5%), calcite (1%), apatite (tr), sphene (tr), hornblende (tr), zircon (tr). Plagioclase is partly sericitized; biotite pleochroism is yellow-brown to very dark brown; chlorite is derived from alteration of hornblende. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #62-E Keystone cuttings 9650-60 Bureau of Economic Geology

Microcline microperthite (53%), albite-oligoclase (25%), quartz (15%), chlorite (3%), biotite (3%), hornblende (1%), apatite (tr). Plagioclase shows incipient sericitization; biotite, pale brown to brown pleochroism, is partly altered to a greenish-brown moderate to high-birefringent chlorite; blue-green hornblende shows alteration to the same type of chlorite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #69-E Keystone cuttings 9865-71 Bureau of Economic Geology

Microcline and microperthite and albite-oligoclase (77%), quartz (20%), biotite (2%), sericite-muscovite (1%), calcite (tr). Quartz is granulated; slide shows only a very few fragments. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite* or *granodiorite.*

Gulf #70-E Keystone cuttings 9744-48 Bureau of Economic Geology

Microcline (56%), quartz (20%), albite-oligoclase (15%), biotite (3%), chlorite (2%), hornblende (1%), sphene (1%), sericite-muscovite (1%), calcite (1%), zircon (tr), ilmenite (tr), leucoxene (tr), apatite (tr). Microcline is locally microperthitic; quartz shows incipient granulation; hornblende, green to dark green pleochroism, is partly altered to calcite and chlorite; biotite pleochroism is golden brown to very dark brown; ilmenite is enveloped by leucoxene. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #73-E Keystone cuttings 9830-40 Bureau of Economic Geology

Oligoclase (58%), microcline microperthite (15%), quartz (10%), biotite (10%), hornblende (4%), epidote (1%), chlorite (1%), sphene (1%), calcite (tr), leucoxene (tr), pyrite (tr), apatite (tr), zircon (tr). Biotite pleochroism is yellow-brown to brown; hornblende pleochroism is yellow-green to green. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Gulf #75-E Keystone cuttings 9800-10 Bureau of Economic Geology

Microcline, albite, quartz, sericite, biotite, chlorite, red iron oxide, apatite. Slide is composed mostly of mineral fragments; microcline is locally microperthitic; plagioclase is largely sericitized; biotite is bleached; sericite occurs in masses from alteration of plagioclase. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Phillips #2 Bashara core 9915 Stanolind Oil & Gas Co.

Oligoclase-andesine (68%), quartz (15%), biotite (10%) microperthite (5%), chlorite (1%), leucoxene (1%), apatite (tr), zircon (tr), pyrite (tr), calcite (tr). Plagioclase is partly sericitized; red-brown biotite occurs in oriented plates and is partly altered to chlorite; quartz is markedly strained; calcite is in veinlets. Grain size: 0.5 to 1 mm. Fabric: gneissic (biotite is oriented but there is also a tendency for orientation of long axes of quartz and feldspar grains; no separation of dark minerals, quartz, and feldspar has taken place; some evidence of relict hypidiomorphic fabric is present). Rock: *granodiorite gneiss.*

Phillips #4 Walton cuttings 9705-10 Bureau of Economic Geology

Microperthite (79%), albite-oligoclase (15%), quartz (5%), apatite (1%), muscovite (tr). Plagioclase is locally sericitized; slide is composed mostly of mineral fragments (largely feldspar) and estimated mode is not necessarily representative. Grain size: 1 to 4 mm. Fabric:?. Rock: probably a *granite.*

Phillips #5 Walton cuttings 9685-90 Bureau of Economic Geology

Quartz (48%), albite (25%), biotite (15%), amphibole (7%), chlorite (2%), magnetite or ilmenite (1%), calcite (1%), pyrite (1%), apatite (tr). Biotite, red-brown, occurs in oriented plates; hornblende, partly altered to chlorite, is in oriented prisms; calcite occurs as veinlets. Grain size: 0.5 mm. Fabric: crystalloblastic. Rock: *amphibole-biotite-albite-quartz schist.*

Richardson & Bass #10-E Walton core 9857 Stanolind Oil & Gas Co.

Oligoclase-andesine (40%), microperthite (27%), quartz (20%), biotite (10%), sericite (2%), calcite (1%), pyrite (tr), apatite (tr), zircon (tr). Biotite pleochroism is pale brown to red-brown; calcite is in veinlets. Grain size: 1 to 2 mm. Fabric: xenomorphic granular. Rock: *granodiorite.*

Richardson & Bass #10-E Walton core 9858 Stanolind Oil & Gas Co.

Oligoclase (74%), quartz (15%), biotite (8%), muscovite (1%), microcline (1%) pyrite (1%), leucoxene (tr), fluorite (tr), zircon (tr), apatite (tr), calcite (tr). Quartz is severely strained, locally crushed; biotite, pale to dark red-brown pleochroism, is in non-oriented laths and shows zircon halos; plagioclase is partly sericitized; microcline remnant is completely enveloped by plagioclase. Grain size: 5 mm. Fabric: hypidiomorphic granular. Rock: cataclastically altered *quartz diorite.*

Sinclair #6-A Walton cuttings 9955-65 Bureau of Economic Geology

Albite-oligoclase (62%), quartz (20%), microcline microperthite (15%), sericite-muscovite (2%), calcite (1%), zircon (tr), sphene (tr), magnetite or ilmenite (tr). Plagioclase shows incipient alteration to sericite; microcline is only locally microperthitic; quartz shows strain and incipient granulation; sericite-muscovite occurs as small fibers in plagioclase and small flakes scattered in the rock. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranodiorite.*

YOAKUM COUNTY

Continental #1 Rodgers core 13015 Bureau of Economic Geology

Groundmass (82%), oligoclase? and alkali feldspar (15%), leucoxene (3%), zircon (tr), apatite (tr), rock fragment-chert (tr), sphene (tr), pyrite (tr), calcite (tr). Groundmass is a microcrystalline mass of feldspar, sericite, and chlorite; chlorite also occurs as larger masses; sericite also occurs as an interlacing network of fibers; plagioclase and alkali feldspar occur as scattered grains; rock shows a parallel layering expressed in distribution of sericite and size of feldspar grains; there is a faint indication of vitroclastic structure. Grain size: groundmass less than 0.05 mm; feldspar fragments up to 1 mm. Fabric: pyroclastic. Rock: *trachyandesite tuff.* (Photomicrograph, Pl. VIII, C.)

Continental #1 Rodgers core 13015 Bureau of Economic Geology

Groundmass (97%), albite and alkali feldspar (3%), calcite (tr), leucoxene (tr), apatite (tr), zircon (tr). Groundmass is microcrystalline and composed of quartz-feldspar-chlorite-sericite; partly resorbed phenocryst consists of an albite core and an alkali feldspar rim. Grain size: groundmass less than 0.02 mm; phenocryst up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry* (possibly a fragment in the tuff).

Continental #1 Rodgers core 13016 Bureau of Economic Geology

Groundmass (90%), microperthite (8%), plagioclase (2%), chlorite (tr), leucoxene (tr), apatite (tr), zircon (tr). Microcrystalline groundmass is composed of quartz, feldspar, and sericite fibers and stained with iron oxide; angular fragments of microperthite and plagioclase are irregularly distributed in the groundmass. Grain size: groundmass less than 0.05 mm; feldspar grains up to 1 mm. Fabric: pyroclastic. Rock: *rhyolite tuff.*

Fikes & Murchison #17-C Elliott cuttings 11200-05 Bureau of Economic Geology

Microperthite (82%), quartz (18%), leucoxene (tr), sericite (tr), zircon (tr). Microperthite, possibly including some plagioclase, occurs in an irregular to cuneiform intergrowth with quartz. Grain size: 0.5 to 2 mm. Fabric: micrographic. Rock: *micrographic granite.*

Part 2 — Southeast New Mexico

CHAVES COUNTY

Amerada #1-RA State cuttings 11580-90 Shell Oil Co.

Groundmass (95%), tourmaline (5%). Microcrystalline quartz-alkali feldspar groundmass contains radial aggregates of gray to colorless tourmaline. Grain size: groundmass less than 0.02 mm; tourmaline aggregates up to 0.2 mm. Fabric: microgranular. Rock: *tourmalinized rhyolite.*

Amerada #1-RA State cuttings 11594 Bureau of Economic Geology

Groundmass (94%), albite (3%), alkali feldspar (1%), leucoxene (1%), calcite (1%), quartz (tr). Groundmass is composed of quartz and alkali feldspar and shows very fine flow structure; albite and alkali feldspar also occur as phenocrysts; quartz occurs mostly as a part of the groundmass but is also present in sporadic larger grains. Grain size: groundmass 0.01 to 0.02 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Amerada #1-RA State cuttings 11620-21 Shell Oil Co.

Slide contains two grains: one is similar to 11580-90 but without the tourmaline; the other is a breccia or conglomerate of angular rhyolite fragments 0.5 to 3 mm in diameter. Fragments for the most part have a microcrystalline groundmass but (a) one contains tourmaline, (b) one is micrographic, (c) one has small sporadic albite phenocrysts, and (d) one shows small scattered grains of opaque mineral that is probably ilmenite.

Amerada #1-RA State cuttings 11621 Bureau of Economic Geology

Microcrystalline to cryptocrystalline quartz-feldspar mass contains sporadic sericite fibers and thin quartz veinlets. Rock: *rhyolite.*

Barnsdall #1-A State core 12034-40 Bureau of Economic Geology

Labradorite (54%), semi-opaque mineral—partly devitrified glass? (30%), chlorite (10%), magnetite or ilmenite (5%), unidentified altered remnants (1%), carbonate (tr), biotite, (tr), pyrite (tr). Plagioclase is present as microlites; semi-opaque gray-brown mineral proves to be anisotropic on very thin edge under high illumination and may be a partly devitrified glass; chlorite? is an olive-green secondary mineral with moderate to high birefringence that shows a concentric banded structure; it commonly surrounds colorless, moderate to highly birefringent, one-cleavage, uniaxial-negative fragments that were not identified. Grain size: 0.1 to 0.2 mm. Fabric: hyalopilitic?. Rock: altered *basalt.*

Barnsdall #1-A State cuttings ? Shell Oil Co.

Labradorite (78%), chlorite (6%), biotite? (6%), augite (5%), magnetite or ilmenite (4%), amphibole (1%). Biotite?, pale green to pale brown pleochroism, is a highly birefringent micaceous mineral partly altered to an olive-drab chlorite; augite is brown and probably titaniferous; amphibole occurs in tiny needles. Grain size: 0.1 to 0.2 mm. Fabric: subophitic. Rock: *diabase.*

Black #1 Shildneck cuttings 6850-60 Shell Oil Co.

Microcline (58%), albite (15%), quartz (15%), chlorite (10%), leucoxene (2%), biotite (tr), zircon (tr). Biotite is almost completely altered to chlorite. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Black #1 Shildneck cuttings 6860-70 Shell Oil Co.

Quartz (35%), albite (30%), microcline (22%), amphibole (10%), chlorite (3%), apatite (tr). Amphibole is deeply colored with brown to green pleochroism but this deep color may be due in part to excess thickness of poor slide. Grain size: 0.5 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Black #1 Shildneck cuttings 6860-70 Shell Oil Co.

Labradorite (65%), chlorite (20%), augite (8%), magnetite or ilmenite (5%), epidote (1%), leucoxene (1%). Plagioclase is in non-oriented laths; augite is violet-brown in color and probably titaniferous; epidote occurs in small masses in plagioclase and chlorite; chlorite is derived from alteration of original ferromagnesian minerals. Grain size: 0.5 mm. Fabric: subophitic. Rock: altered *leuco-diabase.*

Continental #1 Lankford cuttings 8040-50 Shell Oil Co.

Quartz (74%), alkali feldspar (10%), muscovite and sericite (5%), pyrite (5%), biotite (4%), magnetite or ilmenite (2%), rutile (tr), apatite (tr), zircon (tr). Some large muscovite plates show bending, rucking; biotite, an olive-brown variety, is smeared out into streaks; feldspar is altered. Grain size: 0.1 to 0.2 mm. Fabric: ranges from granoblastic to lepidoblastic. Rock: *metaquartzite* (grading into a mica schist or phyllite).

Continental #1 Lankford cuttings 8075-95 Stanolind Oil & Gas Co.

Quartz (82%), feldspar (8%), biotite (6%), pyrite (3%), muscovite (1%), apatite (tr), rutile (tr), zircon (tr). Quartz occurs as round grains in a mosaic; feldspar, microcline and albite, occurs as large poikilitic grains and as smaller grains in the mosaic; one porphyroblast of muscovite is present; biotite, pale brown to very red-brown pleochroism, occurs in short equant plates. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Continental #1 Lankford cuttings 8090-95 Shell Oil Co.

Quartz (84%), alkali feldspar (10%), biotite (3%), pyrite (2%), muscovite (1%), calcite (tr), apatite (tr). Quartz is in an even-sized mosaic; biotite is in short stubby prisms. Grain size: 0.2 to 0.4 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Dekalb #1 Lewis core 5635-38 Bureau of Economic Geology

Plagioclase (45%), microcline microperthite (30%), quartz (15%), hornblende (3%), chlorite (3%), epidote (2%), magnetite or ilmenite (1%), sphene (1%), leucoxene (tr), calcite (tr), apatite (tr), zircon (tr). Zoned plagioclase shows cores altered to epidote and sericite and, locally, mantles of alkali feldspar—composition probably ranges from andesine through albite; quartz is interstitial to plagioclase subhedrons and locally is partly granulated; hornblende pleochroism is pale green to green; chlorite occurs with calcite and is derived from alteration of biotite and hornblende; sphene is in individual crystals and also mantles magnetite or ilmenite; locally it is partly altered to leucoxene. Grain size: feldspar 2 to 6 mm; quartz 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Dekalb and Magnolia #1 White core 7458-63 Bureau of Economic Geology

Microcline microperthite (39%), quartz (20%), albite (15%), fine granular quartz-alkali feldspar (15%), chlorite (8%), leucoxene (2%), pyrite (1%), apatite (tr), zircon (tr). Microcline microperthite occurs as large individuals which locally are fractured; albite is in advanced stage of sericitization; a fine granular mass of quartz and alkali feldspar containing chlorite and cut by pyrite veinlets occurs between larger quartz and feldspar grains in the area of fracturing and brecciation; some of the alkali feldspar shows rhombic cross sections characteristic of adularia; chlorite occurs in masses containing spots of pyrite and leucoxene; leucoxene occurs with chlorite and also as a replacement of sphene in diamond-shaped crystals. Grain size: 2 to 6 mm; fine granular quartz and feldspar 0.1 to 0.2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Franklin, Aston & Fair #1 Orchard Park cuttings 5350-60 Shell Oil Co.

Fragments of quartz, sericitized albite, and microcline, with a trace of chlorite. Grain size: 0.5 to 1 mm.

Franklin, Aston & Fair #1 Orchard Park cuttings 5360-70 Shell Oil Co.

Fragments of sericitized microcline microperthite and quartz up to 2 mm.

Franklin, Aston & Fair #1 Orchard Park cuttings 5400-10 Shell Oil Co.

Plagioclase (67%), quartz (30%), biotite (3%), sericite (included in feldspar), zircon (tr). Plagioclase has a completely sericitized center and an unaltered albite rim; biotite pleochroism is pale red-brown to very dark red-brown. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Franklin, Aston & Fair #1 Orchard Park cuttings 5440-50 Shell Oil Co.

Microcline microperthite (50%), quartz (50%), chlorite (tr), biotite (tr), apatite (tr). Biotite is altered to chlorite.

Franklin, Aston & Fair #1 Orchard Park cuttings 5480-90 Shell Oil Co.

One fragment only. Red-brown biotite, sericitized albite, microcline, magnetite or ilmenite, apatite.

Franklin, Aston & Fair #1 Orchard Park cuttings 5500-10 Shell Oil Co.

Albite (75%), biotite (15%), quartz (10%), pyrite (tr), zircon (tr), apatite (tr). Albite is partly sericitized; biotite is red-brown variety; pyrite occurs in biotite cleavages; apatite and zircon occur mostly in biotite with zircon making intense halos. Grain size: 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Franklin, Aston & Fair #1 Orchard Park cuttings 5650-60 Shell Oil Co.

Same as 5500-10 but with about 4% microcline and a trace of fluorite.

Franklin, Aston & Fair #1 Orchard Park cuttings 5800-10 Shell Oil Co.

Microcline microperthite (42%), albite (40%), quartz (15%), biotite (3%), muscovite (tr). Albite is partly sericitized. Grain size: 2 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Franklin, Aston & Fair #1 Orchard Park core 5814-27 Bureau of Economic Geology

Microcline microperthite (51%), quartz (25%), oligoclase (17%), chlorite (5%), leucoxene (1%), fluorite (1%), zircon (tr), apatite (tr), sphene (tr). Plagioclase is partly sericitized; leucoxene and sphene occur within masses of chlorite derived from alteration of biotite; fluorite is in a veinlet. Grain size: 2 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #1 Jennings core 8300 Bureau of Economic Geology

Microperthite (35%), oligoclase (33%), quartz (20%), chlorite (4%), calcite (3%), biotite (2%), leucoxene (2%), sphene (1%), apatite (tr), zircon (tr), fluorite (tr). Plagioclase is partly sericitized and microperthite shows incipient kaolinization; calcite replaces plagioclase; chlorite is derived from alteration of green-brown biotite and contains small scattered grains of leucoxene; sphene is altered in part to leucoxene. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #1 Jennings core 8319 Humble Oil & Rfg. Co.

Microperthite (34%), albite (25%), quartz (25%), chlorite (8%), fluorite (3%), sericite (3%), leucoxene (1%), calcite (1%), apatite (tr), zircon (tr). Chlorite is after biotite; leucoxene occurs as small grains in the chlorite; calcite replaces plagioclase; fluorite occurs in large masses; sericite is derived from alteration of plagioclase. Grain size: 1 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #1 Jennings core 8319 Bureau of Economic Geology

Microperthite (32%), albite (30%), quartz (30%), chlorite (5%), calcite (2%), leucoxene (1%), pyrite (tr), apatite (tr), zircon (tr). Plagioclase is in large twinned grains; chlorite apparently was derived from alteration of biotite; leucoxene occurs in masses and in small grains included in chlorite; calcite in part replaces feldspar; apatite and zircon show zonal growth. Grain size: 1 mm to 1 cm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #1 State-Chaves U core 3100± Bureau of Economic Geology

Groundmass (89%), calcite (7%), microcline and plagioclase (3%), zoisite (1%). Groundmass is composed of calcite-chlorite-zoisite-feldspar and a semi-opaque mineral that is greenish in reflected light; the groundmass shows a stratification or flowage structure; microcline and plagioclase occur as round grains; euhedral rhombic or prismatic zoisite crystals are dispersed through the slide. Grain size: groundmass less than 0.05 mm; feldspar and zoisite 0.1 to 0.2 mm. Fabric: pyroclastic?, porphyritic?. Rock: altered volcanic rock, *tuff* or *flow.*

Honolulu #1 Hinkle-Federal core 7310-15 Bureau of Economic Geology

Microcline microperthite (42%), albite (25%), quartz (25%), biotite (3%), chlorite (2%), magnetite and ilmenite (2%), epidote (1%), sphene (tr), apatite (tr), calcite (tr). Plagioclase is sericitized; quartz shows strain and granulation with development of some fine crushed areas; biotite occurs in partly bleached plates, pale brown to brown pleochroism, and is largely altered to chlorite; chlorite occurs in veinlets with epidote and as a result of alteration of biotite; magnetite and ilmenite are unevenly distributed in layers; ilmenite is surrounded by leucoxene or sphene. Grain size: irregular, 0.1 mm to 1 cm. Fabric: hypidiomorphic granular with cataclastic elements. Rock: *granite.*

Honolulu #1 Hinkle-Federal core 7310-15 (cut parallel to core) Humble Oil & Rfg. Co.

Albite (40%), quartz (30%), biotite (15%), epidote (7%), magnetite or ilmenite (4%), chlorite (3%), apatite (1%), sphene (tr). Plagioclase is zoned and shows incipient sericitization; epidote occurs in scattered grains, large masses, and tiny masses in plagioclase; biotite, pale to olive-drab pleochroism, is partly altered to chlorite; sphene occurs as very thin rims on opaque mineral. Grain size: wide range from 0.1 to 2 mm; average 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *albite-quartz microdiorite.*

Honolulu #1 Hinkle-Federal core 7310-15 (cut normal to core) Humble Oil & Rfg. Co.

Same as above.

Honolulu #1 Levick-State cuttings 7210-15 Bureau of Economic Geology

Albite (35%), microcline microperthite (30%), chlorite (12%), quartz (10%), epidote (8%), leucoxene (2%), calcite (2%), magnetite or ilmenite (1%), apatite (tr), sphene (tr). Plagioclase is altered to various combinations of sericite, epidote, and chlorite and probably originally was more calcic than albite; chlorite occurs as a result of alteration of plagioclase and in masses with epidote; quartz is sutured and partly granulated. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—cataclastic. Rock: cataclastically altered *albite granodiorite.*

Honolulu #1 McConkey Estate cuttings 5970-80 Shell Oil Co.

Groundmass (87%), albite (8%), leucoxene (2%), chlorite (1%), sphene (1%), calcite (1%), apatite (tr). Albite occurs in the quartz-alkali feldspar groundmass and as phenocrysts partly altered to sericite; apatite occurs in clusters of grains; sphene is partly altered to leucoxene. Grain size: groundmass less than 0.05 mm; phenocrysts up to 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Honolulu #1 McConkey Estate cuttings 6340-50 Shell Oil Co.

Alkali feldspar and albite-oligoclase (68%), quartz (20%), calcite (8%), leucoxene (2%), sericite and muscovite (2%), chlorite (tr). Quartz is strained; calcite is in veinlets and partly replaces feldspar. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Honolulu #1 McConkey Estate cuttings 6350-60 Shell Oil Co.

Alkali feldspar (83%), quartz (10%), chlorite (4%), sericite (3%), calcite (tr), zircon (tr). Feldspar is partly sericitized. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Honolulu #1 McConkey Estate core 6364-71 Bureau of Economic Geology

Groundmass (79%), quartz (10%), albite (5%), microperthite (5%), chlorite (1%), magnetite or ilmenite (tr), leucoxene (tr), pyrite (tr), sericite-muscovite (tr), apatite (tr), zircon (tr). Groundmass is a fine granular mosaic of quartz and alkali feldspar; albite, microperthite, and quartz occur as phenocrysts, locally poikilitic, containing inclusions of quartz and alkali feldspar and locally porphyroblastic (albite only); sericite and chlorite occur as fibers and plates in the groundmass. Grain size: groundmass 0.02 to 0.1 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Humble #1 Gorman-Federal core 5848-49 Bureau of Economic Geology

Microcline microperthite (58%), quartz (20%), albite (15%), chlorite (3%), magnetite or ilmenite (2%), leucoxene (1%), calcite (1%), pyrite (tr), biotite (tr), sphene (tr), scapolite? (tr), zircon (tr), apatite (tr). Quartz fills interstices between feldspar grains and shows a rude dimensional orientation; albite is partly sericitized; chlorite is the result of alteration of biotite and also occurs in masses around opaque mineral; sphene occurs in spongy masses of small subhedral grains around opaque mineral and is locally associated with scapolite?. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Humble #1-N State core 3476 *Stanolind Oil & Gas Co.*

Labradorite? (59%), sericite (15%), calcite (15%), augite (4%), magnetite or ilmenite (2%), chlorite (2%), glass (2%), pyrite (1%), apatite (tr). Most of plagioclase is in laths but one large phenocryst is present; sericite replaces a large part of the rock; calcite fills amygdules and replaces part of the mass of the rock; apatite occurs as needles. There is a local quartz-biotite-sericite-calcite-altered feldspar-chlorite area in the slide that is probably part of a vein or an area of deuteric alteration; it is separated from the diabase proper by calcite. Grain size: laths of feldspar 0.1 by 0.5 mm; phenocryst 1 cm. Fabric: subophitic. Rock: *diabase* [possibly Tertiary].

Humble #1-N State core 3500-03 Stanolind Oil & Gas Co.

Labradorite (73%), augite (8%), olivine (7%), magnetite or ilmenite (5%), chlorite (3%), biotite (1%), pyrite (1%), alkali feldspar (1%), sericite (1%), apatite (tr), analcite (tr). Plagioclase is zoned; augite is brownish violet and probably titaniferous; olivine is partly altered to a peculiar olive chlorite? that is highly birefringent; intensely red-brown biotite borders magnetite or ilmenite. Grain size: 0.5 to 1 mm. Fabric: subophitic. Rock: *analcitic olivine diabase* [possibly Tertiary].

Humble #1-N State core 3804-09 Bureau of Economic Geology

Labradorite (63%), sericite (10%,) calcite (8%), chlorite (5%), quartz (4%), augite (3%), alkali feldspar (2%), leucoxene (2%), biotite (1%), magnetite or ilmenite (1%), pyrite (1%), zeolite (tr). Plagioclase laths are partly sericitized; sericite in part replaces plagioclase and in part occurs in masses with calcite and chlorite surrounding augite remnants; biotite is in small flakes around magnetite or ilmenite; calcite fills amygdules; amygdules constitute about 10% of the slide and locally show a quartz center or contain pyrite; alkali feldspar occurs in interstices of plagioclase subhedrons. Grain size: plagioclase laths 0.1 by 0.5 mm; amygdules up to 1 cm. Fabric: subophitic. Rock: altered *diabase* [possibly Tertiary].

Humble #1-N State core 3835 Stanolind Oil & Gas Co.

Quartz (84%), calcite (7%), albite (4%), pyrite (3%), sericite (1%), chlorite (1%), leucoxene (tr), rutile (tr), zircon (tr). Quartz occurs in a well-sized equi-granular mosaic; calcite is dispersed through the slide. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Humble #1-N State core 3936 Stanolind Oil & Gas Co.

(1) 60% of slide: labradorite (52%), chlorite (30%), calcite (25%), magnetite or ilmenite (3%), pyrite (tr). Grain size: 0.1 to 0.4 mm. Fabric: subophitic. Rock: altered *diabase.*
(2) 40% of slide: albite (45%), quartz (30%), calcite (10%), biotite (10%), chlorite (5%). Grain size: 0.1 to 0.2 mm. Fabric: xenomorphic granular. Rock: *microgranodiorite* [possibly Tertiary].

Humble #1-N State core 3939 Stanolind Oil & Gas Co.

Labradorite? (70%), sericite (15%), amygdules (8%), augite (5%), magnetite or ilmenite (2%), chlorite (tr). Sericite with minor associated chlorite replaces large volumes of the rock; the rock is characterized by round amygdules composed for the most part of calcite but locally of pyrite and quartz; sericite commonly forms a rim around the outside of the amygdule. Grain size: feldspar laths 0.1 by 0.5 mm; amygdules up to 2 mm. Fabric: subophitic. Rock: *diabase* [possibly Tertiary].

Humble #1-U State cuttings 7847-51 Bureau of Economic Geology

Microperthite (56%), albite (20%), quartz (20%), chlorite (4%), apatite (tr), zircon (tr). Plagioclase is in an advanced stage of sericitization; microperthite is partly kaolinized; chlorite is derived from alteration of biotite. Grain size: 0.2 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Humble #1-Y State cuttings 7425-30 Bureau of Economic Geology

Microperthite (40%), oligoclase (38%), quartz (10%), biotite (6%), hornblende (3%), chlorite (1%), ilmenite (1%), sphene (1%), epidote (tr), apatite (tr). Plagioclase is partly sericitized; biotite pleochroism is pale brown to deep rich brown; hornblende pleochroism is yellow-green to green. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Magnolia #1 Black Hills Unit cuttings 5930-40 Shell Oil Co.

Groundmass (98%), quartz (1%), pyrite (1%), biotite (tr), apatite (tr), tourmaline (tr). Cryptocrystalline mass contains angular fragments of quartz (less than 0.05 mm) and biotite flakes; it is composed of sericite, chlorite, quartz, and feldspar where constituents are coarse enough to be recognized. Grain size: groundmass mostly cryptocrystalline; angular quartz fragments up to 0.05 mm. Fabric: ?. Rock: *argillite?*

Magnolia #1-B O'Brien core 7665-66 Bureau of Economic Geology

Albite-oligoclase and microcline microperthite (74%), quartz (10%), chlorite (10%), ilmenite (3%), calcite (3%), leucoxene (tr), sphene (tr), epidote (tr), apatite (tr), zircon (tr). Feldspar is mostly a partly sericitized albite-oligoclase which is commonly rimmed with microperthite; quartz is interstitial to feldspar and coarsely micrographic; chlorite, strongly pleochroic in yellow-brown to deep green, occurs in veinlets, masses, and plates; locally it contains biotite and hornblende relicts; calcite occurs with chlorite as result of alteration of ferromagnesian minerals; ilmenite grains include masses of small sphene crystals; epidote occurs with chlorite in the cores of some plagioclase grains; apatite is in part in long needles; zircon is in part in skeletal and needle-like crystals with serrate edges. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Magnolia #1 Shaw-Federal core 12070 Bureau of Economic Geology

Groundmass (64%), microcline microperthite (15%), andesine (10%), augite (4%), chlorite (3%), magnetite or ilmenite (2%), calcite (2%), amphibole (tr), apatite (tr), zircon (tr). Groundmass is a micrographic intergrowth of quartz and alkali feldspar; microcline microperthite occurs as phenocrysts; phenocrysts of zoned plagioclase show sericitized cores—mostly it is andesine; augite phenocrysts are fractured; chlorite is in fine fibrous masses; magnetite or ilmenite occurs as larger scattered grains and as finely disseminated grains in the groundmass; calcite is derived from alteration of ferromagnesian minerals; commonly it forms a core mass fringed with green amphibole. Grain size: groundmass 0.1 to 0.2 mm; phenocrysts 0.5 to 3 mm. Fabric: porphyritic. Rock: *augite-andesine-microgranite porphyry.*

Magnolia #1-Z State cuttings 8728 Bureau of Economic Geology

Albite-oligoclase (45%), microperthite (30%), quartz (20%), chlorite (4%), carbonate (1%), leucoxene (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; chlorite is after biotite; there are only a few mineral grains in each fragment in this slide and the percentages are not very significant. Grain size: 0.5 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Magnolia #1 Turney-Federal core 5321-24 Bureau of Economic Geology

Albite (70%), quartz (15%), alkali feldspar (8%), chlorite (3%), leucoxene (2%), epidote (1%), sphene (1%), apatite (tr). Plagioclase is partly sericitized; quartz appears to be late and fills voids between feldspar grains; a brown kaolinized alkali feldspar rims these voids and separates quartz from plagioclase; chlorite forms from alteration of biotite and is rudely oriented. Grain size: 0.5 mm. Fabric: hypidiomorphic granular—gneissic. Rock: *albite granodiorite gneiss.*

Magnolia #1 Turney-Federal core 5321-24 Bureau of Economic Geology

Oligoclase-andesine (42%), fine granular epidote-chlorite-magnetite material (25%), chlorite (8%), alkali feldspar (8%), epidote (7%), magnetite or ilmenite (5%), amphibole (5%), apatite (tr), pyrite (tr), sphene (tr). Partly kaolinized plagioclase is concentrated in layers; fine-grained epidote-chlorite-magnetite material occurs in layers, elongate lenses, and between plagioclase grains; some altered amphibole grains are included in this material; faded green hornblende occurs as oriented grains; alkali feldspar is almost completely kaolinized. Grain size: 0.2 to 0.5 mm. Fabric: crystalloblastic—cataclastic—gneissic. Rock: *epidote-chlorite-oligoclase gneiss.*

Olson #1 Noble Trust core 7630-60 Humble Oil & Rfg. Co.

Sericite (80%), quartz (15%), magnetite or ilmenite (3%), epidote (2%), leucoxene (tr), rutile (tr), calcite (tr), chlorite (tr). Sericite is in fine oriented fibers which in some layers are so closely packed as to appear a solid mass of sericite; quartz occurs in small angular to subangular grains with long axes aligned; quartz is irregularly distributed through the layers. Thin distinct layers (1 to 2 mm thick) are visible when the thin section is viewed megascopically. These layers under the microscope are expressed by variations in grain size and mica content. Grain size: mostly less than 0.02 mm. Fabric: lepidoblastic. Rock: *sericite phyllite.*

Olson #1 Noble Trust core 7630-60 Humble Oil & Rfg. Co.

Same as preceding slide but with a large feldspar pebble, more quartz and less well-defined layers.

Olson #1 Noble Trust core 8030 Bureau of Economic Geology

Sericite (82%), quartz (8%), feldspar (5%), magnetite or ilmenite and leucoxene (4%), calcite (1%), epidote (tr), apatite (tr), zircon (tr). Sericite occurs as oriented fibers which, locally, are so densely packed as to resemble a solid mass; quartz and feldspar occur as individual grains within the mass of sericite; quartz is mostly in angular grains and shows an orientation of long axes; the opaque minerals are in a large number of very small scattered grains. A megascopic examination of the thin section shows a very fine layering and cross-bedding with the layers on the order of several millimeters. Grain size: mostly less than 0.02 mm. Fabric: lepidoblastic. Rock: *sericite phyllite.*

Olson #1 Noble Trust core 8030? Bureau of Economic Geology

Sericite (64%), plagioclase and quartz (30%), chlorite (3%), epidote (2%), magnetite or ilmenite (1%), rock fragment (tr). Sericite in a network of anastomosing fibers flows around quartz and plagioclase grains; plagioclase occurs as augen and in smaller grains. Grain size: quartz and feldspar 0.1 to 1 mm. Fabric: lepidoblastic. Rock: *sericite phyllite.*

Richfield #1 Comanche Unit core 6128 Bureau of Economic Geology

Groundmass (78%), quartz (7%), microperthite (5%), albite (5%), chlorite (3%,), leucoxene (2%), apatite (tr), zircon (tr), calcite (tr). The alkali feldspar-quartz-sericite groundmass shows flowage structure; quartz grains and fragments of sutured mosaic occur as phenocrysts with plagioclase and microperthite; leucoxene and chlorite result from biotite alteration. Grain size: groundmass 0.01 to 0.02 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Richfield #1 Mullis core 12143-53 Stanolind Oil & Gas Co.

Albite (56%), alkali feldspar (10%), biotite (10%), chlorite (10%), quartz (10%), leucoxene (2%), magnetite or ilmenite (1%), calcite (1%), pyrite (tr), sericite (included in albite estimate), apatite (tr), zircon (tr), radioactive mineral (tr). Zoned plagioclase is partly replaced by sericite and calcite; biotite, brown to dark brown pleochroism, is partly altered to chlorite; radioactive mineral is opaque—nearly 1 mm in diameter—with a large halo. Grain size: 2 to 5 mm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.*

Richfield #1 Mullis core 12143-53 Bureau of Economic Geology

Oligoclase (34%), quartz (20%), microcline microperthite (15%), biotite (15%), chlorite (10%), amphibole (3%), leucoxene (2%), magnetite or ilmenite (1%), apatite (tr), zircon (tr), pyrite (tr), sphene (tr), calcite (tr). Plagioclase is partly sericitized; biotite, pale to dark brown pleochroism, is partly altered to chlorite; pale green to almost colorless amphibole relicts are altered to calcite and chlorite; calcite also replaces plagioclase and occurs in veinlets. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Richfield #1-A Trigg cuttings 9980-90 Shell Oil Co.

Albite (70%), chlorite (20%), sericite (7%), magnetite or ilmenite (1%), sphene (1%), calcite (1%), apatite (tr), zircon (tr). Albite is partly sericitized; chlorite is derived from biotite. Grain size: 1 mm. Fabric: hypidiomorphic granular. Rock: altered *albite diorite.*

Richfield #1-A Trigg cuttings 9980-90 Shell Oil Co.

Plagioclase (57%), microperthite (30%), chlorite (7%), biotite (5%), quartz (1%), zircon (tr), apatite (tr). Plagioclase is partly sericitized; biotite is almost completely altered to chlorite. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *syenodiorite.*

Richfield #1-A Trigg cuttings 9980-93 Stanolind Oil & Gas Co.

Plagioclase and microperthite (91%), quartz (5%), biotite (2%), hornblende (1%), chlorite (1%,) calcite (tr), sericite (tr), apatite (tr). Plagioclase is zoned with a core of andesine and an albite rim (estimated from relief); microperthite is partly kaolinized; hornblende pleochroism is brown to deep green; biotite pleochroism is brown to dark brown. Grain size: 1 to 2 mm average, with grains up to 4 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Richfield #1-3 White core 9046-47 Bureau of Economic Geology

Oligoclase? (62%), quartz (15%), chlorite (15%), calcite (3%), pyrite (3%), leucoxene (2%), apatite (tr). Plagioclase is sericitized; calcite and pyrite occur in veinlets and in scattered grains; chloritization is intense near veinlets. Grain size: 0.1 to 0.2 mm. Fabric: metasomatic. Rock: chloritized *quartz microdiorite.*

Sanders #1 Sanders cuttings 4940-50 Shell Oil Co.

Scattered fragments show leucoxene, chlorite, quartz, and alkali feldspar. Grain size: about 0.2 mm.

Sanders #1 Sanders cuttings 5240-50 Shell Oil Co.

Microcrystalline to cryptocrystalline mass contains oriented sericite flakes and is cut by thin quartz veinlets. It is partly replaced by masses of calcite. One angular quartz fragment 0.5 mm long is present. Fabric: cataclastic. Rock: *mylonite?* or a cataclastically altered *rhyolite?*

Sanders #1 Sanders cuttings 5260-70 Shell Oil Co.

Microcrystalline to cryptocrystalline mass contains streaks and veinlets of sericite showing rudely parallel orientation. Embayed and broken quartz fragments up to 1 mm long make up about 10% of the slide and are probably phenocrysts. Calcite replaces part of the groundmass. Rock: cataclastically altered *rhyolite.*

Sanders #1 Sanders cuttings 5270-80 Shell Oil Co.

Essentially same as 5260-70 but with altered feldspar phenocrysts (1%), and a trace of chlorite and leucoxene.

Sanders #1 Sanders cuttings 5280-90 Shell Oil Co.

Essentially same as 5270-80 but with (a) prismatic masses of leucoxene parallel to the general foliation; (b) some coarser masses of intergrown quartz and alkali feldspar; and (c) a trace of rutile and zircon.

Sanders #1 Sanders summary

Rock is a cataclastically altered *rhyolite porphyry* with a foliation developed through cataclasis.

Sun #1 Pinion core 1850 Bureau of Economic Geology

Albite (51%), epidote (20%), groundmass (15%), chlorite (10%), quartz (2%), calcite (1%), biotite (1%). Albite occurs as twinned subhedral phenocrysts, partly altered to epidote, and as microlites in the groundmass (original feldspar probably was more calcic); epidote occurs throughout the slide replacing feldspar and filling cavities; groundmass is composed of albite microlites, closely packed spherulites, and fine granular epidote; chlorite occurs with epidote as cavity fillings and shows remarkable interference colors; quartz is secondary and occurs with coarse epidote; green biotite fills cavities and is secondary. Grain size: from tiny microlites up to 2-mm phenocrysts; spherulites 0.1 to 0.2 mm. Fabric: microspherulitic—porphyritic. Rock: epidotized chloritized *albite andesite porphyry.*

Union and Dekalb #1 State cuttings 7575 Bureau of Economic Geology

Albite-oligoclase (34%), quartz (20%), hornblende (20%), microcline (15%), biotite (10%), magnetite or ilmenite (1%), epidote (tr), sphene (tr), calcite (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; hornblende shows yellow-green to green pleochroism and locally is poikilitic; biotite is green-brown. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *granodiorite.*

Union and Dekalb #1 State cuttings 7575-80 Bureau of Economic Geology

Microcline (66%), plagioclase (15%), quartz (15%), hornblende (1%), biotite (1%), calcite (1%), magnetite or ilmenite (1%), chlorite (tr), leucoxene (tr), apatite (tr), zircon (tr). Microcline is partly kaolinized; plagioclase is sericitized; biotite is green-brown; hornblende shows yellow-green to green pleochroism; calcite replaces feldspar locally. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Union and Dekalb #1 State cuttings 7575-80 Bureau of Economic Geology

Microcline (49%), oligoclase-andesine (20%), quartz (15%), hornblende (12%), biotite (2%), magnetite or ilmenite (1%), epidote (1%), chlorite (tr), leucoxene (tr), sphene (tr), apatite (tr). Microcline is sporadically microperthitic; zoned plagioclase grains in the oligoclase-andesine range commonly show sericitized cores; locally grains in advanced stage of sericitization appear to be more sodic; hornblende pleochroism is yellow-green to green. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Union and Dekalb #1 State cuttings 7580 Bureau of Economic Geology

Microcline microperthite and oligoclase (75%), quartz (10%), hornblende (8%), biotite (4%), ilmenite (2%), calcite (1%), leucoxene (tr), sphene (tr), epidote (tr). Feldspar is predominantly microcline microperthite; plagioclase is partly sericitized; hornblende pleochroism is yellow-green to green; biotite is green-brown; ilmenite is partly altered to leucoxene. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

DEBACA COUNTY

Cities Production #1 Hobson cuttings 6720-30 Bureau of Economic Geology

Microcline microperthite (52%), oligoclase (25%), quartz (15%), biotite (3%), magnetite or ilmenite (2%), muscovite and sericite (1%), chlorite (1%), calcite (1%), zircon (tr), apatite (tr). Plagioclase is partly sericitized; green-brown biotite shows rude orientation; calcite is from alteration of original ferromagnesian mineral. Grain size: rock contains fragments showing a grain size of 0.2 to 0.5 mm and fragments with a grain size of 0.5 to 3 mm (mostly just quartz and feldspar without accessory minerals). Fabric: xenomorphic granular. Rock: *microgranite* and *granite.*

Pure #1 Fee-Federal core 6467 Bureau of Economic Geology

Microcline (36%), oligoclase (35%), quartz (20%), muscovite (4%), biotite (3%), ilmenite (1%), chlorite (1%), sphene (tr), fluorite (tr), leucoxene (tr), apatite (tr). Microcline is locally microperthitic; plagioclase is in part sericitized; quartz is in large strained masses; biotite, pale brown to brown pleochroism, is in part altered to chlorite; leucoxene occurs within chlorite masses; sphene locally surrounds the opaque mineral. Grain size: 2 to 5 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

South Basin Oil Company #1 Good core 4774-79 Bureau of Economic Geology

Quartz (66%), hornblende (10%), biotite (9%), oligoclase (8%), epidote (5%), magnetite or ilmenite (2%). Quartz occurs in a mosaic and shows dimensional orientation; blue-green hornblende occurs as porphyroblasts with a planar orientation; biotite is in oriented plates (green-brown); oligoclase is partly sericitized and is unequally distributed in lenses and layers; epidote occurs as individual grains and strings of grains. Grain size: mosaic 0.05 to 0.1 mm; porphyroblasts up to 1 mm. Fabric: porphyroblastic. Rock: *epidote-biotite-hornblende schist.*

Woolworth & Hawkins #1 Myrick cuttings 6080-90 Bureau of Economic Geology

Albite-oligoclase (75%), hornblende (12%), magnetite or ilmenite (4%), quartz (3%), alkali feldspar (3%), biotite (2%), apatite (1%), pyrite (tr), epidote (tr). Zoned plagioclase is variably sericitized in different fragments and locally is rimmed with alkali feldspar; hornblende is considerably altered; biotite is a green-brown variety partly altered to chlorite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *leuco-diorite?*

Woolworth & Hawkins #1 Myrick cuttings 6080-90 Bureau of Economic Geology

Plagioclase, hornblende, pyroxene, quartz, biotite, chlorite, magnetite or ilmenite, apatite. Plagioclase is sericitized; hornblende and plagioclase are altered. Only a few fragments in the slide. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *quartz diorite.*

Woolworth & Hawkins #1 Myrick cuttings 6168-74 Bureau of Economic Geology

Oligoclase (61%), hornblende (15%), quartz (10%), pyroxene (5%), alkali feldspar (4%), magnetite or ilmenite (3%), biotite (2%), pyrite (tr), apatite (tr). Plagioclase is sericitized; hornblende, yellow-green to green pleochroism, occurs in prismatic grains and felty masses and locally is altered to a fine granular brownish mass of unidentified mineral which is rimmed with secondary green amphibole; larger hornblende prisms locally show a brown core; pyroxene is in faded partly oxidized grains; partly kaolinized alkali feldspar is commonly micrographic with quartz; biotite pleochroism is pale reddish brown to dark green; apatite is in part in needles. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *quartz diorite.*

Woolworth & Hawkins #1 Myrick cuttings 6173-74 Bureau of Economic Geology

Sericitized plagioclase, altered hornblende, pyroxene, quartz, biotite, chlorite, magnetite or ilmenite, apatite. Mineral percentages are not significant. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: altered *quartz diorite.*

EDDY COUNTY

Continental #1 Thurman-Federal cuttings 10760-65 Bureau of Economic Geology

Andesine to albite (57%), chlorite (20%), magnetite or ilmenite (10%), calcite (8%), leucoxene (3%), apatite (2%), pyrite (tr). Anorthite content of the plagioclase varies with degree of sericitization; where sericitization is minor the plagioclase is andesine; extensively sericitized plagioclase is albite; calcite occurs in masses replacing plagioclase; there are two varieties of chlorite present, a high-birefringent olive variety and a low-birefringent green variety; apatite is in large elongate prisms. Grain size: 0.5 to 2 mm. Fabric: relict hypidiomorphic granular with some local crushing. Rock: altered *diorite.*

Humble #1 Pearson core 8243-48 Bureau of Economic Geology

Quartz (81%), alkali feldspar (10%), biotite (8%), chlorite (1%), pyrite (tr), apatite (tr). Alkali feldspar is partly sericitized and occurs as large poikilitic host grains; some albite is probably included in the figure for alkali feldspar; biotite occurs in small equant scattered plates; quartz forms a mosaic that constitutes the mass of the rock. Grain size: 0.05 to 0.2 mm. Fabric: granoblastic. Rock: *metaquartzite.*

Humble #1 Pearson core 8243-48 (section cut parallel to core) Humble Oil & Rfg. Co.

Quartz (59%), alkali feldspar (20%), albite (10%), biotite (6%), chlorite (2%), sericite (1%), pyrite (1%), epidote (1%). Plagioclase is partly sericitized; chlorite developed from alteration of an intensely red-brown biotite; biotite plates are oriented; epidote occurs in very small scattered grains; quartz shows an orientation of long axes of grains and occurs in a mosaic with feldspar. Grain size: 0.05 to 0.1 mm. Fabric: ranges from granoblastic to lepidoblastic. Rock: schistose or phyllitic *metarkosite.*

Humble #1 Pearson core 8243-48 (section cut at right angles to core) Humble Oil & Rfg. Co.

Same as preceding but with more biotite (10%) and no visible foliation. Apparent increase in biotite is due to a cut more nearly parallel to the foliation. Also some through-going calcite-chlorite-quartz veinlets.

Humble #1 Pearson core 8245 Humble Oil & Rfg. Co.

Quartz and oligoclase-andesine (74%), biotite (20%), alkali feldspar (3%), pyrite (2%), chlorite (1%), sericite (tr), apatite (tr). Plagioclase is partly sericitized and some is twinned but it is difficult to arrive at an accurate estimation of the relative percentages of plagioclase and quartz in this very fine-grained rock; biotite, pale red-brown to almost black pleochroism, occurs in non-oriented equant plates and is locally altered to chlorite. A layering or bedding visible in a megascopic view of the thin section is not obvious under the microscope; it is expressed by zones of greater biotite content. Grain size: 0.1 mm. Fabric: granoblastic. Rock: *metaquartzite* or *metarkosite.*

Magnolia #1 State W cuttings 11290-11310 Stanolind Oil & Gas Co.

Quartz and albite (mostly quartz) (77%), epidote (15%), chlorite (5%), leucoxene (3%). Grain size: 0.02 to 0.2 mm. Fabric: crystalloblastic. Rock: *chlorite-epidote phyllite.*

Magnolia #1 State W cuttings 11300-10 Stanolind Oil & Gas Co.

Quartz and albite (71%), chlorite (15%), magnetite or ilmenite (10%), epidote (2%), sericite (2%). Micaceous minerals show a rude orientation. Grain size: 0.02 to 0.2 mm. Fabric: crystalloblastic. Rock: *chlorite phyllite* (may be a sheared diabasic rock).

Magnolia #1 State W core 11310-12½ Bureau of Economic Geology

Quartz (48%), epidote (30%), magnetite or ilmenite (12%), chlorite (10%), pyrite (tr), bornite (tr). Quartz occurs in veinlets, as cavity fillings, and with epidotized feldspar microlites in the mass of the rock; probably most of it is secondary; epidote is in veinlets and cavity fillings and has replaced and is pseudomorphous after feldspar microlites; chlorite is in veinlets, cavities, and in fibers in the body of the rock; cavities are filled with epidote and quartz, chlorite-quartz-pyrite-bornite, or combinations thereof. Grain size: 0.02 to 0.5 mm, irregular. Fabric: metasomatic. Rock: epidotized silicified *extrusive igneous rock=metabasalt?*

Richardson & Bass #1 Cobb-Federal core 16459 Bureau of Economic Geology

Microcline microperthite (40%), plagioclase (36%), quartz (12%), biotite (4%), chlorite (4%), magnetite or ilmenite (2%), epidote (1%), leucoxene (1%), sphene (tr), hornblende (tr), apatite (tr), zircon (tr). Microcline microperthite is locally in a coarse micrographic intergrowth with quartz; plagioclase occurs as large zoned individuals with andesine cores and albite-oligoclase rims and as smaller subhedrons—cores are commonly altered to sericite or sericite and epidote; biotite showing yellow-brown to very deep brown pleochroism is partly altered to chlorite; hornblende is mostly altered to chlorite. Estimation of the relative amounts of plagioclase and alkali feldspar is vulnerable. Grain size: 1 to 4 mm, variable. Fabric: hypidiomorphic granular. Rock: *granite.*

Southern Union and Magnolia #1 Elliott core 9886-87½ Bureau of Economic Geology

Microcline (40%), albite (35%), quartz (20%), chlorite (4%), bleached biotite (1%), muscovite (tr), epidote (tr), magnetite or ilmenite (tr), sphene (tr), calcite (tr), zircon (tr). Albite shows incipient sericitization and in part is in very long narrow tablets. Grain size: 0.2 to 1 mm average with sporadic plagioclase grains up to 4 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

LEA COUNTY

Amerada #5 Corrigan cuttings 7803 Bureau of Economic Geology

Oligoclase (60%), microcline microperthite (20%), quartz (10%), biotite (5%), hornblende (2%), ilmenite (2%), sphene (1%), pyrite (tr), calcite (tr), zircon (tr). Microcline microperthite accommodates itself to the quartz and plagioclase grains and commonly shows feathery projections into quartz and plagioclase grain boundaries; biotite pleochroism is pale olive-brown to very dark brown; hornblende pleochroism is yellow-green to green; zircon forms halos in biotite; ilmenite is commonly enveloped by leucoxene. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular with microcline showing a poikilitic tendency. Rock: *granodiorite.*

Amerada #6 Corrigan cuttings 7687 Bureau of Economic Geology

Microcline microperthite (66%), oligoclase (20%), quartz (10%), biotite (2%), magnetite or ilmenite (1%), calcite (1%), apatite (tr). Plagioclase is partly sericitized; quartz is in part myrmekitically intergrown with plagioclase; biotite occurs as bleached and altered remnants; calcite replaces plagioclase; microcline shows the same "late crystallizing features" as in #5 Corrigan, accommodates itself to plagioclase and quartz grains, and commonly occurs as a "spongy" host. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Amerada #7 Corrigan cuttings 7634 Bureau of Economic Geology

Microcline (40%), oligoclase (38%), quartz (10%), biotite (8%), leucoxene (2%), ilmenite (1%), calcite (1%), apatite (tr). Microcline is only locally perthitic and occurs in irregular grains which accommodate themselves to quartz and plagioclase grain boundaries; plagioclase shows a varied degree of alteration to sericite; biotite pleochroism is pale brown to very dark brown; locally quartz is myrmekitically intergrown with plagioclase. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Amerada #11 Corrigan cuttings 7410 Bureau of Economic Geology

Microcline (53%), oligoclase (25%), quartz (15%), biotite (5%), leucoxene (1%), epidote (1%), apatite (tr), calcite (tr). Microcline is locally microperthitic and occurs in large grains and as irregular projections into quartz and plagioclase grain boundaries; plagioclase is partly altered to sericite or sericite and epidote; quartz locally is myrmekitic with plagioclase; biotite pleochroism is pale brown to very dark brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Amerada #4 Hare cuttings 7928 Bureau of Economic Geology

Oligoclase (58%), quartz (15%), microcline (10%), biotite (8%), hornblende (5%), leucoxene (2%), calcite (1%), apatite (1%), magnetite or ilmenite (tr), zircon (tr). Plagioclase occurs as small clear twinned subhedrons and as large irregular twinned grains, porphyroblastic in habit, zoned, and including myriad small grains of the other mineral constituents of the rock; microcline occurs as grains and as irregular feathery bodies along quartz and plagioclase grain boundaries; amount of quartz varies widely in different fragments; hornblende, yellow-green to deep green pleochroism, occurs in poikilitic grains; biotite pleochroism is pale to deep brown. One fragment only shows feldspar, quartz, biotite, and apatite in a matrix of what appears to be chalcedonic silica and a fibrous pale brownish mineral that is probably sericite; apparently this is an altered phase (silicification-sericitization) of the normal igneous rock described above. From meager amount of material available for study it appears that the "phenocrysts" are actually porphyroblasts that have grown perhaps under the influence of late solutions. Rock appears to be meta-igneous to some degree. Grain size: 0.2 to 0.4 mm with large porphyroblastic feldspars up to 3 mm. Fabric: in most fragments xenomorphic to hypidiomorphic granular, in some fragments gneissic. Rock: *microgranodiorite porphyry.*

Amerada #5 Hare cuttings 7844 Bureau of Economic Geology

Oligoclase (52%), microcline (30%), quartz (12%), biotite (4%), magnetite or ilmenite (1%), leucoxene (1%), apatite (tr). Plagioclase is partly sericitized; microcline, locally microperthitic, corrodes and embays quartz and plagioclase; quartz is locally myrmekitic. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Amerada # 7 Phillips cuttings 10211 Bureau of Economic Geology

Microperthite (40%), oligoclase (35%), quartz (20%), leucoxene (2%), biotite (1%), pyrite (1%), sericite (1%), apatite (tr), zircon (tr). The potassium feldspar is very finely perthitic; sericite occurs as scattered flakes or fibers. Grain size: 0.1 to 1 mm. Fabric: poikilitic, round discrete quartz grains occur in a sponge of microperthite; plagioclase retains its integrity of grain. Rock: *microgranite.*

Amerada #7 Phillips cuttings 10214 Bureau of Economic Geology

Microcline (56%), quartz (30%), albite (10%), magnetite or ilmenite (3%), biotite (1%), leucoxene (tr), sphene (tr). Grain size: 0.05 to 0.2 mm. Fabric: xenomorphic granular—poikilitic. Rock: *microgranite.*

Amerada #3-A Phillips cuttings 11006 Bureau of Economic Geology

Albite (51%), microcline (30%), quartz (15%), biotite (2%), chlorite (1%), magnetite or ilmenite (1%), leucoxene (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase shows incipient alteration to sericite; ratio of plagioclase to microcline varies widely in different fragments. Grain size: 0.2 to 0.5 mm with sporadic grains up to 2 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *albite microgranodiorite.*

Amerada #1 State BTA core 11716 Bureau of Economic Geology

Groundmass (98%), quartz (2%), sericite (tr), calcite (tr), pyrite (tr), zircon (tr). Groundmass is micrographic with equi-extinguishing patches less than 0.1 mm in diameter; quartz and sericite occur in cross-cutting veinlets. Grain size: less than 0.1 mm. Fabric: micrographic. Rock: silicified *rhyolite.* (see 11754-55).

Amerada #1 State BTA core 11754-55 Bureau of Economic Geology

Microcrystalline micrographic mass contains sericite and quartz in veinlets and a trace of secondary calcite. Equi-extinguishing patches of the micrographic intergrowth are less than 0.1 mm and individual grains are less than 0.02 mm. Under high magnification the index of refraction of the microcrystalline mass proves to be about equal to the cement (1.54). Probably it is a fine quartz-feldspar intergrowth as the general relief of the material indicates it to be composed of at least two minerals of different indices of refraction. Rock: *silicified rhyolite* (hand specimen shows evidence of silicification, cf. *halleflinta*).

Amerada #1 State BTB core ? Bureau of Economic Geology

Micrographically intergrown quartz and alkali feldspar (71%), albite (15%), microperthite (10%), biotite relicts (1%), chlorite (1%), leucoxene (1%), pyrite (1%), apatite (tr), sphene (tr). The micrographically intergrown quartz and feldspar occur in grains up to 0.5 mm in diameter; microperthite and albite occur in large grains and the albite is commonly rimmed with alkali feldspar; sphene is almost completely altered to leucoxene. Grain size: micrographic groundmass up to 0.5 mm; albite and microperthite up to 6 mm. Fabric: microgranular—poikilitic. Rock: *microgranite.*

Amerada #5-F State-Graham cuttings 10250 ± Bureau of Economic Geology

Microcline (49%), oligoclase (30%), quartz (20%), magnetite or ilmenite (1%), pyrite (tr), leucoxene (tr), zircon (tr), apatite (tr). Grain size: 0.1 to 1 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *microgranite.*

Amerada #5-F State-Graham cuttings 10250 ± Bureau of Economic Geology

Microcline (49%), albite-oligoclase (25%), quartz (25%), leucoxene (1%), Microcline is locally microperthitic; plagioclase shows incipient alteration to sericite. Only two small fragments in slide. Grain size: 0.1 to 0.5 mm. Fabric: poikilitic. Rock: *microgranite.*

Amerada #5-F State-Graham cuttings ? Bureau of Economic Geology

Microcline (50%), albite (25%), quartz (25%), Only one small fragment of "basement" in slide. Grain size: 0.1 to 0.2 mm. Fabric: poikilitic. Rock: *microgranite.*

Amerada #1 Walden cuttings 7858 Bureau of Economic Geology

Albite and microcline (70%), quartz (25%), leucoxene (2%), biotite (1%), magnetite or ilmenite (1%), sericite (1%), zircon (tr), apatite (tr). It is difficult to estimate the percentages of plagioclase and microcline separately but plagioclase is probably dominant; biotite is in small scattered green-brown plates; sericite is in scattered fibers and fibrous plates. Grain size: 0.1 to 0.2 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *albite microgranodiorite.*

Amerada #3 Walden cuttings 7868 Bureau of Economic Geology

Same as #1 Walden except that microcline predominates; there is a more calcic plagioclase (albite-oligoclase) and a trace of pyrite.

Amerada #4 Walden cuttings 7906 Bureau of Economic Geology

Same as #1 Walden except that plagioclase is oligoclase.

Amerada #5 Wood cuttings 8113 Bureau of Economic Geology

Microcline (60%), quartz (25%), albite (10%), biotite (2%), magnetite or ilmenite (2%), sericite (1%), zircon (tr), calcite (tr). Biotite, pale brown to brown pleochroism, is in short prisms. Grain size: 0.1 to 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Amerada #6 Wood cuttings 7519 Bureau of Economic Geology

Same as #5 Wood except the slide contains a trace of apatite.

Amerada #9 Wood cuttings 8016 Bureau of Economic Geology

Microcline (54%), quartz (25%), albite (15%), muscovite (3%), magnetite or ilmenite (3%), zircon (tr), pyrite (tr), calcite (tr). Microcline and plagioclase are difficult to separate for modal estimation; plagioclase is in part in large porphyroblastic grains engulfing quartz and microcline (large porphyroblastic plagioclase may be late as result of solutions); muscovite occurs in scattered small plates; pyrite is concentrated along grain boundaries and may be largely secondary; magnetite or ilmenite is in fine scattered grains. Grain size: 0.1 to 0.3 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Amerada #10 Wood cuttings 7661 Bureau of Economic Geology

Same as #9 Wood but slide contains only 10% plagioclase and markedly elongated zircons.

Cities Service #3-S State cuttings 8030-34 Bureau of Economic Geology

Oligoclase (57%), microcline microperthite (25%), quartz (12%), biotite (4%), magnetite or ilmenite (1%), leucoxene (1%), epidote (tr), apatite (tr). Plagioclase is partly sericitized; quartz contains fine needles of rutile?; biotite is green-brown; leucoxene envelops ilmenite. Grain size: 0.3 to 1 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranodiorite.*

Continental #1 Burger B-28 core 9373 Bureau of Economic Geology

Feldspar (39%), biotite (20%), calcite (15%), chlorite (10%), sericite (10%), quartz (3%), leucoxene (2%), ilmenite (1%), epidote (tr), apatite (tr). Feldspar is almost completely sericitized and makes up the mass of the rock; green-brown biotite occurs in tiny flakes; quartz is in small "eyes"; ilmenite is partly altered to leucoxene. This rock consists of a mass of secondary minerals, chlorite-calcite-biotite-epidote-sericite, that completely obscure the original fabric. Parallel, anastomosing, calcite veinlets and concentrations of biotite-chlorite in layers and lenses give the rock a banded or layered character. Grain size: 0.1 to 0.2 mm. Fabric: metasomatic. Rock: probably an altered *microdiorite.*

Continental #1 Burger B-28 core 9376 Bureau of Economic Geology

Plagioclase (76%), chlorite (15%), pyrite, magnetite or ilmenite, and leucoxene (5%), calcite (3%), biotite (1%), apatite (tr). Original nature of plagioclase is obscured by sericitization, only the shape of grains and twinning remain; chlorite occurs in non-oriented fibers and plates; opaque minerals occur in veinlets and in scattered grains. Grain size: 0.1 to 2 mm. Fabric: relict hypidiomorphic granular. Rock: altered *microdiorite.*

Continental #1 Burger B-28 core 9379 Bureau of Economic Geology

Microcline microperthite (68%), quartz (20%), albite (10%), biotite (1%), calcite (1%), magnetite or ilmenite (tr), chlorite (tr), zircon (tr), sphene (tr), apatite (tr). Plagioclase has a sericitized core and a clear border; biotite pleochroism is pale green to deep brown; chlorite is a brown variety. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.* Hand specimen of core shows that this granite occurs in a narrow stringer intruding altered microdiorite.

Continental #1-E Lockhart A-27 core 7791 Bureau of Economic Geology

Albite (52%), quartz (30%), microcline (15%), biotite (2%), pyrite and magnetite or ilmenite (1%), leucoxene (tr), zircon (tr), apatite (tr), muscovite (tr). Green-brown biotite occurs in small scattered plates and is commonly surrounded by leucoxene. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *albite microgranodiorite.* (Photomicrograph, Pl. IV, C.)

Continental #6-E Lockhart B-11 cuttings 8058-65 Bureau of Economic Geology

Microcline microperthite (49%), oligoclase (35%), quartz (10%), sericite (3%), biotite (2%), calcite (1%), pyrite (tr), zircon (tr), leucoxene (tr), magnetite or ilmenite (tr). Plagioclase shows incipient alteration to sericite; sericite and muscovite occur as (a) fine fibers as a result of plagioclase alteration and (b) as flakes and masses distributed through the rock; biotite is a red-brown variety. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular—poikilitic. Rock: *microgranite.*

Continental #4 Lockhart B-12 cuttings 8202 Bureau of Economic Geology

Microcline (63%), quartz (20%), albite-oligoclase (15%), calcite (2%), magnetite or ilmenite (tr), muscovite (tr), leucoxene (tr). Calcite is in a cross-cutting veinlet. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *granite.*

Continental #4 Lockhart B-12 cuttings 8202 Bureau of Economic Geology

Andesine-labradorite (56%), hornblende (30%), biotite (5%), epidote (3%), chlorite (2%), calcite (2%), magnetite or ilmenite (2%), sphene (tr), apatite (tr). Hornblende showing yellow-green to dark green pleochroism is locally poikilitic; biotite is green-brown; calcite occurs in a veinlet. Grain size: 0.5 to 1 mm with sporadic grains up to 2 mm. Fabric: xenomorphic granular. Rock: *microdiorite.*

Continental #1-A Lockhart B-13 cuttings 7514-39 Bureau of Economic Geology

Microcline microperthite (71%), oligoclase (20%), magnetite or ilmenite (4%), chlorite (4%), calcite (1%), quartz (tr), apatite (tr). Brownish chlorite fills breccia zones; calcite in part replaces plagioclase; quartz occurs as veinlets in breccia zones. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular with local brecciation. Rock: *syenite.*

Continental #1-A Lockhart B-13 cuttings 7585-90 Bureau of Economic Geology

Microcline microperthite (62%), oligoclase (20%), augite (10%), magnetite or ilmenite (7%), red iron oxide (1%), pyrite (tr), sphene (tr), zircon (tr). Green pyroxene shows schiller structure. Grain size: 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *syenite.*

Continental #1 Warren A-29 core 9361-91 Bureau of Economic Geology

Oligoclase-andesine (34%), microcline microperthite (25%), quartz (15%), amphibole (10%), biotite (7%), magnetite or ilmenite (3%), epidote (3%), pyroxene remnants? (2%), calcite (1%), myrmekite (tr), zircon (tr), sphene (tr). Plagioclase is indistinctly zoned; rarely quartz and alkali feldspar show micrographic intergrowth; amphibole is composed about equally of hornblende with yellow-green to blue-green pleochroism and a pale, almost colorless, amphibole apparently derived from alteration of the blue-green hornblende; 5% of the biotite occurs as red-brown plates around opaque mineral, the remainder is green biotite fringing altered hornblende; pyroxene remnants? show schiller structure and are enveloped by amphibole and biotite; epidote is derived from alteration of hornblende; calcite occurs in veinlets. Most of the accessory minerals occur together in "nests." Grain size: 0.5 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Continental #1 Warren A-29 core 9371-72 Bureau of Economic Geology

Labradorite (58%), pyroxene (15%), olivine (10%), biotite (5%), magnetite or ilmenite (4%), amphibole (3%), chlorite? (3%), corona pyroxene? (2%), rutile? (tr), apatite (tr). Plagioclase is vaguely zoned, shows incipient sericitization, and contains tiny rod-like inclusions of ilmenite? (opaque) and rutile? (highly birefringent); pyroxene shows typical diallage structure but has a negative optic sign; olivine is partly altered to a moderate to highly birefringent olive-green mineral that may be a chlorite; magnetite or ilmenite occurs in large grains but locally shows a plumose structure; brown amphibole fringes pyroxene, biotite, and opaque mineral; olivine and other ferromagnesian minerals are locally fringed with a corona of high relief low-birefringent mineral that may be another pyroxene. Grain size: 1 to 6 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Continental #2 Warren B-29 core 9850-52 Bureau of Economic Geology

Oligoclase (48%), microcline microperthite (30%), quartz (10%), chlorite (5%), biotite (2%), ilmenite (2%), leucoxene (2%), calcite (1%), red iron oxide (tr), apatite (tr), zircon (tr). Plagioclase shows partly sericitized cores with clear borders; biotite, pale to green-brown pleochroism, is partly altered to chlorite; leucoxene commonly surrounds ilmenite. Grain size: 1 to 4 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Continental #2 Warren B-29 core 9851 Stanolind Oil & Gas Co.

Oligoclase (45%), microcline (35%), quartz (10%), chlorite (5%), biotite (3%), magnetite or ilmenite (2%), calcite (tr), zircon (tr), apatite (tr). Plagioclase is partly sericitized; biotite, pale brown to brown pleochroism, is partly altered to chlorite; opaque mineral is surrounded by leucoxene. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Gulf #1 Amanda cuttings 7332 Bureau of Economic Geology

Two kinds of rock in slide:

(1, 35%) Albite-oligoclase (59%), biotite (18%), quartz (15%), chlorite (5%), magnetite or ilmenite (3%), apatite (tr). Plagioclase occurs as small grains in a mosaic with quartz and as larger poikilitic grains, locally it is partly sericitized; biotite, yellow-brown to dark brown pleochroism, occurs as large poikilitic porphyroblasts and as partly oxidized (semi-opaque) laths in parallel orientation. Grain size: 0.1 to 0.2 mm with sporadic grains up to 1 mm. Fabric: ranges from granoblastic to lepidoblastic. Rock: *biotite-quartz-albite-oligoclase schist.*

(2, 65%) Microcline (59%), quartz (20%), albite-oligoclase (15%), ilmenite, leucoxene and red iron oxide (3%), chlorite (2%), sericite (1%), apatite (tr), zircon (tr). Grain size: variable, some fragments 0.1 to 0.2 mm; others 0.5 to 2 mm. Fabric: xenomorphic granular. Rock: *micrgranite.*

Gulf #5-A Carson core 7881 Bureau of Economic Geology

Microcline microperthite (59%), oligoclase-andesine (15%), quartz (8%), biotite (8%), hornblende (5%), magnetite or ilmenite (2%), sphene (2%), chlorite (1%), epidote (tr), apatite (tr), pyrite (tr), zircon (tr). Plagioclase shows a vague zoning; hornblende is yellow-green; biotite is green-brown and partly altered to chlorite; zircon forms halos in biotite. Grain size: 2 to 6 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Gulf #4-A Cole-State cuttings 7649 Bureau of Economic Geology

Microcline (55%), albite (20%), quartz (20%), leucoxene (3%), magnetite or ilmenite (1%), sericite-muscovite (1%), epidote (tr), calcite (tr), apatite (tr). Plagioclase occurs as grains in a mosaic with quartz and microcline and as larger poikilitic grains (percentages of plagioclase and microcline vary considerably in different fragments in this slide); leucoxene is in scattered grains and veinlets; grains of magnetite or ilmenite are commonly surrounded by epidote. Grain size: 0.1 to 0.2 with sporadic plagioclase porphyroblasts up to 1 mm. Fabric: xenomorphic granular—poikilitic. Rock: *microgranite.*

Gulf #5-F Graham-State core 9820 Bureau of Economic Geology

Albite (40%), microcline (30%), quartz (20%), muscovite (4%), biotite (2%), calcite (2%), leucoxene (1%), pyrite (1%), red iron oxide (tr), zircon (tr). Plagioclase is partly sericitized and for the most part occurs as discrete grains in a mosaic, although there are sporadic large poikiloblastic albite grains as well; biotite is green-brown; ilmenite is partly altered to leucoxene; pyrite occurs in grains and along grain boundaries. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular. Rock: *albite microgranodiorite.*

Gulf #7 King core 8051-60 Bureau of Economic Geology

Sericite and chlorite (37%), microcline (30%), quartz (10%), hematite (10%), biotite (5%), yellow isotropic cavity filling (4%), ilmenite (2%), leucoxene (2%), apatite (tr), zircon (tr). Sericite and chlorite occur as a fine fibrous intergranular mass probably in large part derived from alteration of plagioclase, chlorite is subordinate to sericite; microcline is locally microperthitic and, in part, occurs as corroded grains within the sericite-chlorite mass; quartz occurs in fractured grains; biotite is frayed, faded, bent, wavy, and locally so stained with hematite as to be opaque; cavities are filled with an unidentified isotropic yellow mineral. Grain size: broken quartz and feldspar grains 0.5 to 2 mm; intergranular mass, less than 0.05 mm. Fabric: cataclastic. Rock: brecciated *granite.*

Gulf #7 King core 8060 Bureau of Economic Geology

Microcline (58%), oligoclase (20%), quartz (15%), biotite (3%), magnetite or ilmenite (1%), epidote (1%), sericite (1%), tourmaline (1%), zircon (tr), leucoxene (tr), apatite (tr). Plagioclase is partly sericitized; biotite shows yellow-brown to brown pleochroism; epidote is commonly associated with magnetite or ilmenite. Grain size: 0.2 to 0.5 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranite.*

Gulf #7 King core 8063 Humble Oil & Rfg. Co.

Microcline (56%), quartz (20%), albite (15%), sericite (4%), biotite (3%), magnetite or ilmenite (2%), apatite (tr). Some of the microcline is microperthitic but this is only locally developed; plagioclase is partly sericitized; scattered flakes of biotite, pale green-brown to almost black pleochroism, show very dark halos. Grain size: 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Gulf #2 Stichter core 7980 Bureau of Economic Geology

Microcline (60%), oligoclase (15%), quartz (12%), biotite (10%), leucoxene (2%), calcite (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr), chlorite (tr), hornblende (tr). Microcline is locally microperthitic; plagioclase is partly sericitized; biotite shows yellow-green to dark green pleochroism; zircons form halos in biotite. Grain size: 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Humble #1 Keinath-Federal cuttings 9951-54 Shell Oil Co.

Microcline microperthite (57%), quartz (30%), biotite (6%), albite (5%), magnetite or ilmenite (2%), hornblende (tr), rutile (tr), sphene (tr), zircon (tr), apatite (tr). Biotite pleochroism is green-brown to almost black. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Humble #1 Keinath-Federal core 9951-54 Bureau of Economic Geology

Oligoclase (41%), microcline (30%), quartz (20%), biotite (5%), hornblende (2%), ilmenite (1%), sphene (1%), apatite (tr), zircon (tr). Plagioclase occurs in large grains and locally includes microcline; biotite is green-brown; hornblende pleochroism is yellow-green to green; sphene in part surrounds ilmenite. Grain size: 0.2 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Humble #10 Greenwood cuttings 7710 Bureau of Economic Geology

Microcline (56%), quartz (25%), albite (15%), muscovite and sericite (2%), magnetite or ilmenite (2%), zircon (tr), red iron oxide (tr), apatite (tr). Plagioclase shows incipient alteration to sericite; zircon crystals are markedly elongate. Grain size: 0.1 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Humble #11 Greenwood cuttings 7495-7500 Bureau of Economic Geology

Microcline and oligoclase (71%), quartz (25%), magnetite or ilmenite (2%), biotite (1%), muscovite and sericite (1%), calcite (tr), zircon (tr). The feldspar is probably more than half microcline but the two feldspars are difficult to estimate quantitatively; biotite is green-brown. Grain size: 0.1 to 0.2 mm. Fabric: xenomorphic granular (microcline is late and accommodates itself to the plagioclase and quartz). Rock: *microgranite.*

Humble #3-V State cuttings 7665-70 Bureau of Economic Geology

Microcline microperthite (75%), oligoclase (10%), quartz (10%), hornblende (2%), biotite (2%), ilmenite (1%), chlorite (tr), leucoxene (tr), apatite (tr), zircon (tr). Plagioclase is locally myrmekitic; quartz contains inclusions of fine needles; hornblende is deeply colored—pleochroism green-brown to dark green-brown; biotite, pale to dark brown pleochroism, is partly oxidized and partly altered to chlorite; ilmenite is enveloped by leucoxene. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Humble #5-V State cuttings 8395-99 Bureau of Economic Geology

Microcline microperthite (75%), quartz (15%), oligoclase (10%), biotite (tr), leucoxene (tr), red iron oxide (tr), pyrite (tr), apatite (tr). Plagioclase shows incipient sericite development; biotite is a semi-opaque partly oxidized relict. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *granite.*

Humble #6-V State core 7705 Bureau of Economic Geology

Microcline (39%), oligoclase (30%), quartz (20%), biotite (8%), leucoxene (2%), calcite (1%), magnetite or ilmenite (tr), red iron oxide (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite shows an almost colorless to reddish-brown pleochroism. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Humble #8-V State cuttings 7560-65 Bureau of Economic Geology

Microcline, quartz, oligoclase-andesine, biotite, chlorite, magnetite or ilmenite, leucoxene, calcite, apatite. Slide is composed mostly of mineral fragments and no valid mode estimate can be made; plagioclase is partly sericitized; biotite pleochroism is green-brown to almost black; calcite is in a cross-cutting veinlet. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite* or *granodiorite.*

Humble #9-V State cuttings 8235-40 Bureau of Economic Geology

Microcline (56%), albite (20%), quartz (20%), biotite (2%), chlorite (1%), ilmenite (1%), leucoxene (tr), apatite (tr). Plagioclase shows incipient sericite development; biotite pleochroism is pale brown to very dark brown; ilmenite is enveloped in leucoxene. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Magnolia #17 Carson core 8155± Bureau of Economic Geology

Albite (45%), microcline microperthite (34%), quartz (10%), biotite (5%), calcite (4%), magnetite or ilmenite (1%), leucoxene (1%), zircon (tr), apatite (tr), Plagioclase is partly altered to sericite; biotite pleochroism is pale yellow-brown to almost black; calcite occurs in veinlets and masses. Grain size: 2 mm to 1 cm. Fabric: hypidiomorphic granular. Rock: *albite granodiorite.* (Photomicrograph, Pl. IV, B.)

Olson and Atlantic #1 Langlie core 9584 Bureau of Economic Geology

Microcline (51%), oligoclase (20%), quartz (15%), muscovite (5%), biotite (5%), leucoxene and sphene (2%), chlorite (1%), calcite (1%), apatite (tr). Plagioclase is partly sericitized, locally it is porphyroblastic in habit; biotite pleochroism is almost colorless to brown; sphene and leucoxene occur together in clusters; chlorite is from alteration of biotite. Grain size: average 0.5 mm; porphyroblastic plagioclase up to 5 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Olson and Atlantic #1 Langlie core 9584-92 Bureau of Economic Geology

Microcline (51%), albite (20%), quartz (15%), biotite (5%), muscovite (4%), ilmenite and leucoxene (3%), chlorite (2%), apatite (tr), zircon (tr), sphene (tr), calcite (tr). Plagioclase is thoroughly sericitized; microcline is locally microperthitic; ilmenite is partly converted to leucoxene; biotite pleochroism is pale to dark green-brown. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Penrose #3 Hinton cuttings 7387 Shell Oil Co.

Microcline (50%), albite (32%), quartz (15%), biotite (2%), magnetite or ilmenite (1%), leucoxene (tr), sericite (tr). Biotite pleochroism is pale green-brown to very dark brown. Grain size: 0.1 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranite.*

Phillips #1 Shipp cuttings 12620-25 Bureau of Economic Geology

Microcline microperthite (68%), albite (15%), quartz (15%), biotite (1%), ilmenite (1%), leucoxene (1%), chlorite (tr), apatite (tr), zircon (tr). Plagioclase is partly sericitized; ilmenite is enveloped by leucoxene; biotite is partly altered to chlorite. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #5 Argo-Herring cuttings 7980-8089 Bureau of Economic Geology

Microcline microperthite (70%), quartz (15%), oligoclase (10%), calcite (3%), leucoxene (1%), biotite (1%), chlorite (tr), zircon (tr). Plagioclase is partly sericitized and partly replaced by calcite; microcline is only sparsely microperthitic; biotite is a green-brown variety partly altered to chlorite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #7 Argo-Herring cuttings 8185-90 Bureau of Economic Geology

Microcline microperthite (64%), oligoclase (15%), quartz (15%), calcite (3%), leucoxene (2%), biotite (1%), chlorite (tr), apatite (tr). Microcline is only sparsely microperthitic; plagioclase is partly sericitized; biotite is green-brown in general but some plates show a reddish tinge; apatite is in elongate prisms. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular with local fracturing and crushing. Rock: *granite.*

Shell #9 Argo-Herring cuttings 8185-89 Bureau of Economic Geology

Microcline microperthite (65%), quartz (20%), oligoclase (10%), biotite (4%), magnetite or ilmenite (1%), red iron oxide (tr), calcite (tr), chlorite (tr). Quartz contains inclusions of fine needles; biotite pleochroism is yellow-brown to almost black. Grain size: 0.1 to 2 mm. Fabric: xenomorphic granular—poikilitic. Rock: *granite.*

Shell #4-A Argo-Herring cuttings 7760-7800 Bureau of Economic Geology

Microcline microperthite (60%), oligoclase-andesine (15%), quartz (15%), myrmekite (4%), biotite (3%), hornblende (2%), magnetite or ilmenite (1%), sphene (tr), apatite (tr). Biotite is green-blown; hornblende pleochroism is yellow-green to green. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #6-A Argo-Herring cuttings 7885-7907 Bureau of Economic Geology

Microcline microperthite (48%), oligoclase (25%), quartz (15%), biotite (4%), calcite (4%), magnetite or ilmenite (2%), sericite (2%), apatite (tr), zircon (tr). Biotite is green-brown; calcite occurs in veinlets and masses locally replacing plagioclase; sericite is associated with biotite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #10-A Argo-Herring cuttings 8125-32 Bureau of Economic Geology

Microcline microperthite (56%), oligoclase (20%), quartz (20%), biotite (3%), calcite (1%), leucoxene (tr), zircon (tr). Plagioclase is partly sericitized and partly myrmekitically intergrown with quartz; locally it is replaced by calcite; biotite, pale to dark brown pleochroism, shows halos around included zircons. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #1 Carter cuttings 14020-40 Bureau of Economic Geology

Microcline microperthite and micro-anti-perthite (80%), quartz (10%), chlorite (3%), biotite (2%), augite (2%), magnetite or ilmenite (1%), hornblende (1%), brown amphibole (1%), pyrite (tr), apatite (tr), zircon (tr), rutile (tr). Microcline microperthite is locally very finely developed, micro-anti-perthite consists of albite hosts containing numerous oriented blebs and veinlets of potassium feldspar, albite also commonly contains many inclusions of ferromagnesian minerals; highly birefringent chlorite is present in a veinlet; biotite, pale red-brown to very dark brown pleochroism, is in part in reaction rims around pyroxene; augite, colorless to greenish, is in part rimmed with brown amphibole or biotite and in part shows included opaque mineral in a fine cross-hatched structure; hornblende pleochroism is yellow-green to green. Grain size: 1 to 3 mm. Fabric: xenomorphic granular. Rock: *granite.*

Shell #1 Chesher cuttings 7630-65 Bureau of Economic Geology

Oligoclase-andesine (46%), microcline microperthite (30%), quartz (12%), biotite (5%), calcite (4%), magnetite or ilmenite (2%), hornblende (1%), pyrite (tr), chlorite (tr), leucoxene (tr), apatite (tr), zircon (tr). Biotite pleochroism is tan to reddish brown; hornblende pleochroism is yellow-green to green—it is partly replaced by calcite and chlorite. Grain size: 0.5 to 3 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Shell #4 Livingston cuttings 8150-67 Bureau of Economic Geology

Microcline microperthite (80%), quartz (15%), calcite (5%). Only a few fragments in slide; plagioclase that is perthitically included in the microcline is partly sericitized; calcite is in a veinlet. Grain size: 0.5 to 3 mm. Fabric: ? Rock: *granite.*

Shell #3 State cuttings 7900-05 Bureau of Economic Geology

Oligoclase (46%), microcline microperthite (30%), quartz (18%), biotite (5%), leucoxene (1%), calcite (tr), ilmenite (tr), chlorite (tr), pyrite (tr), sphene (tr), apatite (tr), zircon (tr). Plagioclase shows incipient alteration to sericite; biotite is green-brown and partly altered to chlorite; ilmenite is enveloped by leucoxene. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Shell #4 State cuttings 7550-67 Bureau of Economic Geology

Microcline microperthite (51%), oligoclase (30%), quartz (15%), biotite (3%), magnetite or ilmenite (1%), chlorite (tr), zircon (tr), red iron oxide (tr), apatite (tr). Biotite pleochroism is yellow-brown to dark brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *granite.*

Shell #5 State core 7955-56 Bureau of Economic Geology

Oligoclase (33%), microcline (30%), quartz (20%), biotite (7%), calcite (5%), ilmenite and leucoxene (5%), sphene (tr), apatite (tr), zircon (tr). Biotite is a pale green-brown variety; calcite appears to be after hornblende although no hornblende was seen in the slide; ilmenite is rimmed with leucoxene. Grain size: 0.5 to 1 mm. Fabric: xenomorphic granular. Rock: *microgranodiorite.*

Shell #6 State cuttings 8205-09 Bureau of Economic Geology

Microcline microperthite (48%), oligoclase (35%), quartz (12%), biotite (3%), calcite (1%), leucoxene (1%), chlorite (tr), zircon (tr), apatite (tr). Biotite is a green-brown variety. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Shell #8 State cuttings 8132-50 Bureau of Economic Geology

Oligoclase (46%), microcline (35%), quartz (12%), biotite (3%), leucoxene (1%), calcite (1%), magnetite or ilmenite (1%), sericite-muscovite (1%), apatite (tr), pyrite (tr), zircon (tr). Biotite pleochroism is yellow-brown to dark brown. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granodiorite.*

Shell #1 Taylor Glenn cuttings 8575-90 Bureau of Economic Geology

Microcline (48%), oligoclase (25%), quartz (20%), biotite (5%), epidote (1%), ilmenite (1%), sphene (tr), zircon (tr), apatite (tr). Microcline is locally microperthitic; biotite pleochroism is pale brown to very dark brown; ilmenite is rimmed with sphene; epidote occurs in "nests" with slightly altered biotite. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Shell #3 Taylor Glenn cuttings 8225-28 Bureau of Economic Geology

Microcline microperthite (68%), oligoclase (15%), quartz (12%), biotite (4%), magnetite or ilmenite and leucoxene (1%), apatite (tr), zircon (tr). Plagioclase has a sericitized core and a clear border; biotite shows yellow-brown to dark brown pleochroism. Grain size: 0.5 to 1 mm. Fabric: poikilitic. Rock: *microgranite.*

Shell #4 Turner cuttings 7890-96 Bureau of Economic Geology

Microcline (54%), quartz (25%), oligoclase (15%), biotite (2%), magnetite or ilmenite (2%), muscovite and/or sericite (2%), leucoxene (tr), calcite (tr), apatite (tr). Microcline is locally microperthitic and in general accommodates itself to quartz and plagioclase; plagioclase shows incipient alteration to sericite; biotite pleochroism is pale brown to deep brown. Grain size: 0.1 to 1 mm. Fabric: hypidiomorphic granular—poorly developed. Rock: *microgranite.*

Shell #11 Turner cuttings 7770-83 Bureau of Economic Geology

Microcline (64%), quartz (10%), oligoclase (8%), chlorite (8%), myrmekite (3%), calcite (3%), biotite (2%), pyrite (1%), leucoxene (1%), zircon (tr), apatite (tr). Plagioclase occurs in only one fragment as a framework of rounded (corroded?) subhedrons with interstitial quartz and microcline and poikilitic biotite—other fragments show normal xenomorphic poikilitic relations; biotite shows pale brown to dark brown pleochroism; the rock is locally brecciated and breccia zones are filled with a microspherulitic chlorite; calcite veins the rock. Grain size: 0.5 to 4 mm. Fabric: poikilitic. Rock: *granite.*

Shell #14 Turner cuttings 7725-55 Bureau of Economic Geology

Microcline microperthite (68%), oligoclase (10%), quartz (10%), myrmekite (4%), biotite (4%), hornblende (2%), magnetite or ilmenite (2%), apatite (tr). Biotite pleochroism is pale brown to dark brown; hornblende pleochroism is yellow-green to dark green. Grain size: 0.5 to 3 mm. Fabric: xenomorphic granular with incipient cataclasis. Rock: *granite.*

Shell #15 Turner cuttings 7430-70 Bureau of Economic Geology

Microcline microperthite (65%), oligoclase (15%), quartz (12%), hornblende (3%), myrmekite (2%), magnetite or ilmenite (2%), biotite (1%), apatite (tr), zircon (tr). Hornblende pleochroism is yellow-green to green; biotite pleochroism is golden brown to dark brown. Grain size: 0.5 to 3 mm. Fabric: xenomorphic granular. Rock: *granite.*

Sinclair #1 Barton core 7786 Bureau of Economic Geology

Microcline microperthite (58%), oligoclase (20%), augite (10%), olivine (5%), hornblende (3%), magnetite or ilmenite (2%), biotite (2%), chlorite (tr), apatite (tr). Schiller structure is well developed in pyroxene; there are two kinds of hornblende, bluish-green hornblende forming thin discontinuous rims around augite and dark olive amphibole commonly enclosing the opaque iron mineral: biotite is a very intensely colored red-brown variety; all the dark minerals occur together in local concentrations. Grain size: 1 to 5 mm. Fabric: hypidiomorphic granular. Rock: *olivine-augite syenite.*

Sinclair #4 Brunson cuttings 7880-83 Bureau of Economic Geology

Oligoclase (64%), microcline microperthite (15%), quartz (12%), biotite (6%), calcite (1%), leucoxene (1%), magnetite or ilmenite (1%), pyrite (tr), zircon (tr), apatite (tr). Microcline is only locally microperthitic; plagioclase shows indistinct zoning and beginnings of alteration of sericite; biotite is green-brown. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Sinclair #5 Brunson cuttings 7840-45 Bureau of Economic Geology

Oligoclase (64%), microcline microperthite (15%), quartz (12%), biotite (6%), calcite (1%), leucoxene (1%), magnetite or ilmenite (1%), pyrite (tr), zircon (tr), apatite (tr).

Microcline is only locally microperthitic; plagioclase shows indistinct zoning and beginnings of alteration of sericite; biotite is green-brown. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Sinclair #2 State 367 core 7642-46 Bureau of Economic Geology

Microcline microperthite (52%), quartz (25%), oligoclase (10%), sericite (7%), chlorite (4%), leucoxene (2%), apatite (tr), red iron oxide (tr), zircon (tr). Plagioclase is partly sericitized; quartz is in patches of sutured strained mosaic; sericite is concentrated in swirls and braided lenses; chlorite is locally concentrated with leucoxene; large feldspar grains (porphyroclasts) are set in a crush quartz-feldspar matrix but show no particular orientation. Grain size: 0.1 to 0.5 mm with porphyroclasts up to 5 mm. Fabric: protoclastic—porphyroclastic. Rock: protoclastic *granite gneiss.*

Sinclair #2 State 367 cuttings 7680 Bureau of Economic Geology

Microcline microperthite (62%), plagioclase (20%), quartz (15%), magnetite or ilmenite (2%), calcite (1%). Microcline is only locally microperthitic; plagioclase is almost completely sericitized; magnetite or ilmenite is partly altered to red iron oxide. Grain size: 0.5 to 2 mm. Fabric: only a few rock fragments—hypidiomorphic where observed. Rock: *granite.*

Skelly #5-B Baker cuttings 7315-22 Bureau of Economic Geology

Albite-oligoclase (44%), quartz (30%), microcline (20%), muscovite (4%), magnetite or ilmenite (2%), biotite (tr), zircon (tr). Plagioclase is locally porphyroblastic; biotite is green-brown. Grain size: 0.2 to 0.5 mm. Fabric: xenomorphic granular—poikilitic. Rock: *microgranodiorite.*

Skelly #1 Stichter cuttings 8052-53 Bureau of Economic Geology

Oligoclase (48%), microcline (30%), quartz (15%), biotite (3%), sericite-muscovite (1%), magnetite or ilmenite (1%), calcite (1%), leucoxene (1%), zircon (tr). Biotite pleochroism is yellow-brown to dark brown; sericite-muscovite occurs as fibers within plagioclase grains (alteration) and as scattered plates. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranodiorite.*

Stanolind #1 W. H. Jones cuttings 10570-80 Shell Oil Co.

Microcline microperthite (55%), albite (30%), quartz (15%), calcite (tr), biotite (tr), magnetite or ilmenite (tr). Microcline is to a large extent replaced by albite to form a twinned perthitic intergrowth; biotite is a deep green variety; calcite is in a veinlet. Grain size: 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Stanolind #11-X State core 8150 Bureau of Economic Geology

Microcline microperthite (57%), quartz (25%), albite (10%), biotite (4%), leucoxene (2%), chlorite (1%), magnetite or ilmenite (1%), apatite (tr), zircon (tr). In part of the slide quartz is in a micrographic intergrowth with microcline microperthite; biotite, pale to dark brown pleochroism, is partly altered to chlorite; zoned zircons form halos in biotite. Grain size: 0.5 to 5 mm. Fabric: hypidiomorphic granular—micrographic. Rock: *granite.*

Texas #1 Blinebry cuttings 7510-15 Bureau of Economic Geology

Microcline microperthite (46%), oligoclase (35%), quartz (15%), biotite (2%), magnetite or ilmenite (2%), apatite (tr), zircon (tr). Plagioclase is partly sericitized; biotite is green-brown. Grain size: 0.2 to 1 mm. Fabric: hypidiomorphic granular. Rock: *microgranite.*

Texas #4 Blinebry cuttings 8370-75 Bureau of Economic Geology

Microcline microperthite (47%), andesine (30%), biotite (10%), quartz (5%), hornblende (3%), magnetite or ilmenite (2%), calcite (2%), red iron oxide (1%), zircon (tr). Plagioclase is indistinctly zoned; hornblende pleochroism is yellow-green to green; biotite is red-brown; minerals are unequally distributed in different fragments—some are mostly plagioclase and some are mostly microcline microperthite; some fragments are brecciated; one fragment of augite-apatite is in the slide and indicates presence of more basic rocks in the well. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *granite.*

Texas #2 Lockhart cuttings 7590-95 Bureau of Economic Geology

Microcline microperthite (63%), oligoclase (15%), quartz (15%), biotite (4%), magnetite or ilmenite (3%), zircon (tr), apatite (tr). Biotite pleochroism is pale brown to brown. Grain size: 0.2 to 2 mm. Fabric: xenomorphic granular—poikilitic. Rock: *granite.*

LINCOLN COUNTY

Standard of Texas #1 Heard-Federal cuttings 7800-70 Bureau of Economic Geology

Labradorite (51%), olivine (20%), augite (10%), chlorite (10%), magnetite or ilmenite (5%), biotite (3%), pyrite or pyrrhotite (1%), epidote (tr). Plagioclase is partly sericitized: olivine is heavily veined with a mesh of opaque veinlets and is partly altered to an olive-colored chlorite; there are two kinds of chlorite, an olive-colored highly birefringent variety principally derived from alteration of olivine and a common green low-birefringent type; augite is apparently late and accommodates itself to olivine and labradorite, occupying inter-feldspar areas and wrapping around olivine; locally it is almost vermicular; augite also includes closely spaced fine linear opaque inclusions that give the mineral a "diallage" look; biotite, a very red variety, occurs around the opaque minerals; epidote is in small scattered grains in plagioclase as a result of alteration of the plagioclase. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Standard of Texas #1 Heard-Federal core 8050 Bureau of Economic Geology

Labradorite (54%), olivine (18%), olivine alteration product (12%), augite (5%), chlorite (5%), magnetite or ilmenite (4%), biotite (2%). Plagioclase is partly sericitized and shows vague zoning; olivine is meshed with veins of opaque mineral and is partly altered to a highly birefringent pale olive-brown to olive-green mineral—chlorite?; augite rims olivine and accommodates itself to plagioclase laths; red-brown biotite fringes opaque mineral. Grain size: 2 to 8 mm. Fabric: hypidiomorphic granular. Rock: *olivine gabbro.*

Stanolind #1 Picacho Unit cuttings 2685-90 Shell Oil Co.

Quartz (67%), microcline microperthite (30%), albite (2%), calcite (1%), magnetite or ilmenite (tr), rutile (tr). Some of the microcline microperthite grains appear to be round. Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *metarkosite.*

Stanolind #1 Picacho Unit cuttings 2685-90 Shell Oil Co.

Albite (59%), quartz (30%), alkali feldspar—microperthite? (10%), magnetite or ilmenite (1%), leucoxene (tr), calcite (tr), rutile (tr), zircon (tr). Grain size: 0.1 to 0.2 mm. Fabric: granoblastic. Rock: *metarkosite.*

Stanolind #1 Picacho Unit cuttings 2740-45 Shell Oil Co.

Quartz (58%), microcline microperthite (35%), calcite (4%), magnetite or ilmenite (2%), leucoxene (1%). Microcline is only sparsely perthitic and shows incipient kaolinization; some round feldspar grains show overgrowths. Grain size: 0.2 mm. Fabric: granoblastic. Rock: *metarkosite.*

OTERO COUNTY

Flynn et al. #1 Donohue cuttings 1685-88 Stanolind Oil & Gas Co.

Alkali feldspar and zeolite (86%), analcite (6%), aegirine (5%), magnetite or ilmenite (2%), clinozoisite (1%), eudialite? (tr), pyrite (tr). Fibrous zeolite is replacing feldspar. Grain size: 0.1 to 0.5 mm. Fabric: microlitic. Rock: *analcite-aegirine microsyenite* [probably Tertiary].

Hunt & Turner #1 McMillan core 2175 Bureau of Economic Geology

Groundmass (80%), albite and alkali feldspar (8%), quartz (5%), magnetite or ilmenite (3%), calcite (3%), red iron oxide (1%), sphene (tr). Micrographic quartz-alkali feldspar groundmass shows poorly developed flowage structure; feldspar phenocrysts are almost completely kaolinized but albite can be distinguished by chessboard twins; quartz occurs as embayed and corroded phenocrysts and is locally intergrown with feldspar phenocrysts. Grain size: groundmass less than 0.05 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Hunt & Turner #1 McMillan core 2175 Bureau of Economic Geology

Alkali feldspar (62%), quartz (20%), calcite (7%), magnetite or ilmenite (6%), yellow iron oxide? (3%), chlorite (1%), leucoxene (1%), zircon (tr), apatite (tr). Alkali feldspar is partly kaolinized and is micrographically intergrown with quartz—the intergrowth is mostly irregular but locally is cuneiform; quartz is in part in angular irregular-edged grains and in part in a fine micrographic intergrowth; magnetite or ilmenite is partly altered to red iron oxide; calcite is in cross-cutting veinlets; a canary-yellow mineral forms a stain in vicinity of calcite veinlets and may be an iron oxide. Grain size: 0.5 to 1 mm. Fabric: micrographic. Rock: *micrographic microgranite.*

Standard of Texas #1 Scarp Unit cuttings 2592-97 Bureau of Economic Geology

Labradorite (40%), hornblende (15%), sericite (15%), augite (10%), magnetite (5%), epidote (5%), biotite (4%), chlorite (4%), quartz (2%), apatite (tr). Plagioclase is in advanced stage of sericitization and in some places has gone over completely to masses of sericite; augite is a titaniferous violet-brown variety; hornblende, almost colorless to green pleochroism, occurs in large frayed grains (primary) and in masses of needles or "felts" with chlorite (secondary amphibole); epidote occurs as large grains and as masses of fine grains in plagioclase; quartz is present as a secondary cavity filling. Grain size: 1 to 3 mm. Fabric: hypidiomorphic granular. Rock: altered *gabbro.*

Standard of Texas #1 Scarp Unit cuttings 2600-10 Stanolind Oil & Gas Co.

Labradorite? (53%), augite (15%), amphibole (10%), chlorite (10%), sericite (5%), epidote (3%), magnetite or ilmenite (2%), biotite (1%), pyrite (1%), apatite (tr), zircon (tr), carbonate (tr), leucoxene (tr). Plagioclase is zoned but most of it is probably andesine-labradorite; there are three varieties of amphibole present: (a) pleochroism deep green to pale green; (b) pleochroism colorless to pale green; (c) pleochroism in brown (rare); most of amphibole occurs as masses of non-oriented prisms and grains apparently as a result of alteration of pyroxene, but the deep green amphibole also occurs as fracture fillings; brown hornblende is probably pyrogenic; brown corroded augite grains are rimmed by a fibrous pale amphibole with relatively high birefringence; chlorite occurs in fine granular to fibrous masses; biotite pleochroism is pale to red-brown; pyrite is in veinlets; epidote and sericite are derived from alteration of feldspar; zircon causes intense halos in chlorite. Grain size: up to 3 mm. Fabric: hypidiomorphic granular. Rock: altered *gabbro.*

Standard of Texas #1 Scarp Unit cuttings 2630-40 Stanolind Oil & Gas Co.

Same as 2600-10.

Standard of Texas #1 Scarp Unit cuttings 2650-60 Stanolind Oil & Gas Co.

Same as 2600-10 but with two kinds of chlorite: (a) common green chlorite with deep blue-red interference colors—penninite and (b) a brownish chlorite with a radiating structure.

Standard of Texas #1 Scarp Unit core 2655-60 Bureau of Economic Geology

Plagioclase (45%), alkali feldspar (11%), sericite (10%), augite (8%), biotite (6%), hornblende (5%), chlorite (5%), analcite? (5%), magnetite or ilmenite (3%), calcite (2%), pyrite (tr), apatite (tr), zircon (tr). Plagioclase is zoned with labradorite interiors and albite rims; it is partly replaced by sericite and calcite; low-relief isotropic mass replacing feldspar is probably analcite; blue-green hornblende is altered to fibrous mats of amphibole, colorless amphibole, or chlorite; biotite is a red-brown variety. Grain size: 1 mm to 1 cm. Fabric: hypidiomorphic granular. Rock: *analcitic syenogabbro.*

Standard of Texas #1 Scarp Unit cuttings ? Shell Oil Co.

Augite (45%), labradorite? (20%), sericite (15%), amphibole (10%), chlorite (6%), magnetite or ilmenite (3%), biotite (1%), apatite (tr). Augite is a lavender-brown titaniferous variety; plagioclase is in advanced stage of sericitization and it is difficult to determine the anorthite content, probably it is calcic; chlorite occurs in veinlets and surrounding masses of green amphibole; amphibole shows three modes of occurrence: (1) in large continuous grains; (2) in masses of non-oriented prisms and equant grains surrounded by chlorite; and (3) in veinlets; the latter two occurrences are more intensely colored, commonly blue-green rather than green, and are probably secondary; biotite is a red-brown variety. Grain size: 0.5 to 2 mm. Fabric: hypidiomorphic granular. Rock: *gabbro.*

Standard of Texas #1 Scarp Unit   cuttings ?   Shell Oil Co.

Plagioclase (41%), titanaugite (25%), chlorite (15%), sericite (10%), amphibole (5%), zoisite (4%), epidote (tr), apatite (tr). Plagioclase is altered to sericite and zoisite; chlorite commonly encloses masses of amphibole which occurs as (a) flakes and prisms surrounded by chlorite and (b) continous grains, colorless to pale green, partly altered to chlorite and epidote. Grain size: 1 to 2 mm. Fabric: hypidiomorphic granular. Rock: *gabbro*.

QUAY COUNTY

Stanolind #1 Fuller   core 6746-47   Bureau of Economic Geology

Groundmass (74%), sericite-muscovite (15%), magnetite or ilmenite, leucoxene and quartz (6%), red iron oxide (5%). Groundmass is composed mostly of alkali feldspar showing very fine radial or spherulitic extinction phenomena with minor sericite and scattered magnetite or ilmenite grains; masses of sericite grading into poikiloblastic muscovite occur throughout the slide and locally have a shape suggesting they are after former feldspar grains; angular quartz grains are scattered through the rock. Grain size: 0.01 to 0.1 mm. Fabric: relict pyroclastic—incipient crystalloblastic (poikiloblastic). Rock: *rhyolite metatuff.*

ROOSEVELT COUNTY

Austral #1 Saddler   core 8130-56   Bureau of Economic Geology

Hornblende (58%), oligoclase (25%), quartz (8%), epidote (7%), sphene (1%), pyrite (1%), apatite (tr), red iron oxide (tr). Hornblende, blue-green, occurs in large prismatic grains, masses, and matted felts of small needles and prisms; plagioclase is indistinctly zoned and shows a varied degree of sericitization, the more sericitized grains apparently being more sodic—possibly the composition ranges from oligoclase into andesine; epidote occurs as grains throughout the slide and in a veinlet. Grain size: 0.1 to 2 mm. Fabric: crystalloblastic with a gneissic tendency. Slide shows a layering expressed in grain size, percentage of hornblende, and percentage of quartz, but this layering is not evident in the hand specimen. Rock: *amphibolite.*

Goldston #1-A Lambirth-State   core 8287   Bureau of Economic Geology

Andesine-labradorite (49%), hornblende (45%), magnetite or ilmenite (4%), pyrite (1%), epidote (1%), apatite (tr), sphene (tr). Plagioclase occurs in (a) small grains in a mosaic showing vague zoning and (b) large grains showing polysynthetic twinning; blue-green hornblende is in felty masses, masses of small prisms, and large grains with shredded edges; apatite occurs in broken needles. Grain size: 0.1 to 1 mm. Fabric: crystalloblastic with relict hypidiomorphic granular elements—meta-igneous. Rock: *amphibolite.*

Magnolia #1 Brown   core 7110   Bureau of Economic Geology

Albite (52%), quartz (25%), chlorite (10%), hornblende (5%), calcite (5%), sphene (2%), epidote (1%), magnetite or ilmenite (tr), apatite (tr), zircon (tr). Plagioclase is in part sericitized and in part altered to yellow-green chlorite; quartz shows strain and sutured contacts and is unequally distributed through the rock in quartz-rich layers; fine granular quartz also occurs with chlorite and calcite in veinlets, two kinds of chlorite are present: (1) common green chlorite and (2) a yellow-green chlorite which seems to be transitional between hornblende and common green chlorite; hornblende, yellow-green to green pleochroism, occurs as oriented prisms; sphene occurs in many small grains and sporadic large grains. Grain size: 0.5 to 1 mm. Fabric: crystalloblastic—gneissic; rock has ferromagnesian mineral-rich layers and quartz-rich layers, quartz and feldspar show rude dimensional orientation, hornblende prisms are oriented. Rock: altered *hornblende-quartz-albite gneiss.*

Magnolia #1 Brown   core 7200   Bureau of Economic Geology

Similar to 7110 but with a more pronounced mineral orientation and layering.

Magnolia #1 Brown   core 7215   Bureau of Economic Geology

Albite (45%), quartz (18%), chlorite (15%), hornblende (7%), biotite (5%), epidote (5%), sphene and leucoxene (3%), calcite (2%), apatite (tr), ilmenite (tr), zircon (tr). Albite is sericitized; quartz is strained and shows sutured contacts—it is concentrated in coarser layers; chlorite occurs as (1) yellow-green chlorite in masses resulting from alteration of biotite and hornblende and, in part, replacing plagioclase (11%) and (2) green chlorite from alteration of biotite (4%): hornblende is mostly altered to yellow-green chlorite: biotite is red-brown and occurs as masses of plates partly altered to chlorite; sphene occurs in large numbers of small grains partly altered to leucoxene; calcite forms veinlets. Grain size: 0.5 to 3 mm. Fabric: crystalloblastic—gneissic; rock is composed of coarser quartz-rich layers and layers containing concentrations of oriented ferromagnesian minerals, finer grained plagioclase, and accessory minerals; some plagioclase grains are subhedral and suggest an original hypidiomorphic granular fabric. Rock: altered *biotite-hornblende-quartz-albite gneiss*, possibly a *granodiorite gneiss.*

Magnolia #1 Brown — core 9067 — Bureau of Economic Geology

Albite (30%), microperthite (25%), fine crush matrix (21%), sericite (10%), quartz (5%), calcite (4%), leucoxene (4%), pyrite (1%), apatite (tr), zircon (tr). Plagioclase is variably sericitized; fine crush matrix is composed of sericite, quartz, and feldspar; sericite occurs as fibers in matrix and in fibrous masses as a feldspar alteration product; quartz occurs as patches of strained and sutured grains and secondarily in small patches and along grain boundaries; calcite occurs in crushed zones and in part replaces feldspar; leucoxene is in grains and veinlets; pyrite is locally associated with leucoxene. Grain size: mineral fragments 0.2 to 2 mm; crush matrix less than 0.05 mm but without a clear separation. Fabric: cataclastic. Rock: brecciated *leuco-albite syenodiorite.*

Magnolia #1 A. K. Smith — cuttings 10000-16 — Shell Oil Co

Groundmass (92%), microperthite (8%). Microcrystalline to cryptocrystalline quartz-alkali feldspar groundmass shows well-developed flowage structure; stringers of coarser quartz grains and finely dispersed opaque mineral are present; microperthite is present as a single phenocryst. Grain size: groundmass microcrystalline to cryptocrystalline; phenocryst 1 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Magnolia #1 A. K. Smith — cuttings 10000-16 — Shell Oil Co.

Groundmass (65%), microperthite (35%), leucoxene (tr), pyrite (tr). Micrographic to microspherulitic to cryptocrystalline groundmass shows well-developed flowage structure, particularly around phenocrysts. Two large phenocrysts are apparently alkali feldspar in advanced stage of perthitization and are largely composed of patches of twinned albite. Grain size: groundmass, mostly less than 0.02 mm; phenocrysts 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Mid-Continent #1 Strickland — core 7508-13 — Bureau of Economic Geology

Sericite (78%), chlorite (10%), magnetite or ilmenite (7%), calcite (5%). Rock is thoroughly stained and altered; sericite has replaced most of the original feldspar but outlines of laths up to 0.5 mm can be seen; calcite occurs as veinlets. Grain size: (original igneous rock) 0.1 to 0.5 mm. Fabric: relict subophitic?, microlitic?. Rock: altered *andesite?* or *diabase?*

Mid-Continent #1 Strickland — core 7513 — Bureau of Economic Geology

Plagioclase (53%), actinolite (35%), magnetite or ilmenite (6%), chlorite (3%), calcite (3%), quartz (tr), rutile? (tr), red iron oxide (tr). Plagioclase microlites and laths are almost completely sericitized but index of refraction indicates an intermediate to calcic type; green fibrous actinolite replaces the original ferromagnesian mineral—probably pyroxene—and occurs between plagioclase laths; magnetite or ilmenite is in scattered grains; calcite occurs in veinlets; quartz is secondary. Grain size: 0.1 to 0.2 mm. Fabric: relict subophitic. Rock: altered *diabase.*

Mid-Continent #1 Strickland — cuttings bottom hole — Shell Oil Co.

Albite (71%), biotite (10%), hornblende (10%), ilmenite (6%), leucoxene (2%), chlorite (1%), epidote (tr). Plagioclase is in non-oriented laths; biotite occurs as fibrous masses replacing original mafic minerals. Grain size: 0.2 mm. Fabric: ophitic. Rock: altered *albite diabase.*

Shell #1 Harwood — cuttings 7935-55 — Bureau of Economic Geology

Alkali feldspar (73%), quartz (25%), chlorite (1%), leucoxene (1%), magnetite or ilmenite (tr), red iron oxide (tr), amphibole (tr). Alkali feldspar and quartz occur as a fine granular mass with about 1% of the alkali feldspar present as phenocrysts. Grain size: 0.01 to 0.02 mm. Fabric: microgranular. Rock: *rhyolite.*

Shell #1 Harwood — cuttings 7950-55 — Shell Oil Co

Rock is a fine mass of quartz and alkali feldspar with shreds of chlorite and biotite and flecks of leucoxene. Grain size: less than 0.02 mm. Fabric: microgranular. Rock: *rhyolite.*

Shell #1 Saunders cuttings 8640-79 Bureau of Economic Geology

Alkali feldspar (72%), quartz (25%), chlorite (1%), leucoxene (1%), red iron oxide (1%), zircon (tr), magnetite or ilmenite (tr). Alkali feldspar and quartz occur as a fine granular mass, containing one alkali feldspar phenocryst; magnetite or ilmenite is almost completely converted to red iron oxide which forms a pervading stain. Grain size: 0.01 to 0.02 mm. Fabric: microgranular. Rock: *rhyolite.*

Shell #1 Saunders core 8650 Bureau of Economic Geology

Groundmass (81%), microperthite (8%), oligoclase (3%), chlorite (3%), hydromuscovite? (2%), fluorite (1%), magnetite or ilmenite (1%), red iron oxide (1%), zircon (tr), leucoxene (tr), apatite (tr), sphene (tr). Microcrystalline groundmass is composed of quartz and alkali feldspar; microperthite phenocrysts show incipient alteration to sericite, contain fluorite inclusions, and locally are partly converted to hydromuscovite; plagioclase phenocrysts are partly sericitized and are rimmed with alkali feldspar; chlorite occurs in fibrous masses around some feldspar phenocrysts. Grain size: groundmass 0.05 to 0.1 mm; phenocrysts up to 3 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Shell #1 Saunders cuttings ? Shell Oil Co.

Quartz and feldspar (92%), calcite (5%), chlorite (2%), epidote (1%), altered biotite (tr). Quartz and feldspar are in a very fine granular mass so it is difficult to determine the feldspar or estimate percentages. Grain size: 0.02 mm. Fabric: microgranular. Rock: *rhyolite.*

Shell #1 Saunders cuttings ? Shell Oil Co.

Groundmass (75%), microperthite (24%), chlorite (1%), hematite (tr), apatite (tr), calcite (tr). Groundmass is micrographic quartz-alkali feldspar intergrowth; microperthite occurs as phenocrysts. Grain size: groundmass less than 0.1 mm; phenocrysts up to 2 mm. Fabric: porphyritic. Rock: *rhyolite porphyry.*

Signal #1 Bell-Federal core 7990-96 Bureau of Economic Geology

Labradorite (61%), augite (15%), olivine (9%), magnetite or ilmenite (7%), alkali feldspar (3%), chlorite (2%), apatite (2%), biotite (1%), pyrite (tr), quartz (tr), amphibole (tr). Zoned plagioclase is spottedly sericitized and occurs in very long tablets; microperthite, associated with micrographically intergrown quartz, is interstitial to plagioclase subhedrons; magnetite or ilmenite is in large grains: biotite is pale reddish brown and forms a narrow fringe on the opaque mineral; a variety of chlorites are present and probably represent intermediate stages of alteration of ferromagnesian minerals—they are olive-green low-birefringent chlorite, brown low-birefringent chlorite, green low-birefringent chlorite, and green moderately birefringent chlorite; the amphibole, pale brown to green pleochroism, appears to be a reaction product. The association of olivine and quartz deserves note and indicates a disequilibrium assemblage caused by incomplete reaction of minerals with melt. The fact that the disequilibrium persists suggests that the rock might be Tertiary but its geographic association with Precambrian gabbros of the Swisher terrane is contradictory. Grain size: plagioclase 5 mm to 1 cm; ferromagnesian minerals 0.5 to 1 mm. Fabric: hypidiomorphic granular. Rock: *leuco-olivine gabbro.*

Southern Union #1 Lucas cuttings 7140-55 Bureau of Economic Geology

Plagioclase, calcite, magnetite or ilmenite, apatite. Only a few fragments; slide is mostly sericitized plagioclase laths and calcite derived from alteration of the primary ferromagnesian mineral. Grain size: 0.2 to 0.5 mm. Fabric: subophitic. Rock: altered *diabase.*

Spartan #1-36 State core 7140 Bureau of Economic Geology

Fine crush matrix (27%), quartz (20%), oligoclase (20%), microcline (20%), granitic rock fragments (10%), red iron oxide cement (3%), leucoxene (tr), calcite (tr), chlorite (tr). Broken and fractured grains of quartz and feldspar and granitic rock fragments occur in a crushed matrix that is in part cemented by red iron oxide; microcline is locally microperthitic; crush matrix is composed of fine fragments of feldspar and quartz in microcrystalline to cryptocrystalline material. Grain size: cryptocrystalline to 5 mm. Fabric: cataclastic. Rock: brecciated *granite.*

Spartan #1-36 State core 7204 Bureau of Economic Geology

Plagioclase (63%), hornblende (18%), quartz (10%), chlorite (4%), epidote (3%), ilmenite and sphene (2%), apatite (tr). Plagioclase is almost completely sericitized but outlines of twinned subhedrons are distinct; hornblende, yellow-green to blue-green pleochroism, occurs in poorly oriented prisms but is distributed unequally in layers; it is partly altered to a yellow mineral in the cleavages that may be an amphibole or a mica; sphene envelops ilmenite. Grain size: 0.5 to 2 mm. Fabric: gneissic. Rock: *quartz-hornblende-plagioclase gneiss* or *quartz diorite gneiss.*

Spartan #1-36 State core 7210 Bureau of Economic Geology

Andesine (68%), quartz (15%), hornblende (5%), chlorite (5%), biotite (3%), ilmenite (2%), sphene (2%), apatite (tr), epidote (tr). Plagioclase is partly sericitized and vaguely zoned: quartz shows sutured contacts with other grains: ilmenite is surrounded by sphene; hornblende occurs as faded yellow-green relicts partly altered to chlorite; biotite is partly altered to chlorite. Rock consists of larger plagioclase grains and groups of strained quartz grains surrounded by finer grained plagioclase, biotite laths, hornblende, chlorite, broken quartz, and other accessory minerals: hand specimen is gneissic. Grain size: plagioclase grains 0.5 to 2 mm; interstitial material 0.1 to 0.5 mm. Fabric: protoclastic? Rock: *quartz diorite gneiss.*

Spartan #1-36 State core 7240-42 Bureau of Economic Geology

Oligoclase-andesine (62%), hornblende (15%), quartz (15%), biotite (5%), magnetite or ilmenite (1%), sphene (1%), epidote (1%), chlorite (tr), apatite (tr), zircon (tr). Plagioclase is partly altered to sericite: hornblende pleochroism is yellow-green to green; biotite is reddish brown: magnetite or ilmenite occurs as clouds of fine dispersed grains associated with other ferromagnesian minerals. Ferromagnesian minerals show parallel orientation and are more or less concentrated in layers; quartz and feldspar show a rude dimensional orientation and are likewise concentrated in layers. Grain size: 0.05 to 1 mm. Fabric: gneissic. Rock: *quartz diorite gneiss.*

Tidewater #1 Grady Best core 7265-77 Bureau of Economic Geology

Groundmass (65%), oligoclase (12%), quartz (8%), sericite (3%), chlorite (3%), microcline (3%), magnetite or ilmenite (2%), rock fragment (2%), epidote (1%), sphene (1%), apatite (tr). Groundmass is composed of alkali feldspar, quartz, and sericite showing dimensionally oriented grains and sericite fibers—flowage structure is pronounced; plagioclase and microcline form augen; quartz occurs in strained lenticular masses elongated parallel to flowage structure; epidote and chlorite occur with sericite in smeared-out masses: a granitic rock fragment occurs as an auge. Grain size: groundmass less than 0.1 mm; augen up to 2 mm. Fabric: cataclastic. Rock: *mylonitized granite.* (Photomicrograph, Pl. IV, D.)

Tidewater #1 Boone cuttings 8450-65 Bureau of Economic Geology

Microcline and plagioclase (99%), calcite (1%), leucoxene (tr), chlorite (tr). Only four small fragments in the slide—mostly crushed and strained feldspar. Grain size: less than 0.02 to 1 mm. Fabric: cataclastic. Rock: partly *mylonitized syenite.*

Tidewater #1 Boone cuttings 8460-65 Bureau of Economic Geology

Albite-oligoclase (84%), microcline (10%), chlorite (3%), quartz (2%), calcite (1%), leucoxene (tr), apatite (tr). Feldspar occurs in strained, broken, crushed, and granulated grains and masses; chlorite fills crushed areas; calcite veinlet cuts a crushed area; quartz appears to be mostly secondary in crush zones. Grain size: less than 0.02 to 2 mm. Fabric: cataclastic. Rock: cataclastically altered *leuco-diorite.*

APPENDIX III

MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON WELL CORES AND CUTTINGS OF PRECAMBRIAN ROCKS IN WEST TEXAS AND SOUTHEAST NEW MEXICO

Abstract

Data are presented on magnetic susceptibility measurements on 96 samples of Precambrian rock encountered in deep wells in west Texas and southeast New Mexico. Susceptibilities of major rock types such as granite and gabbro show an extremely wide range with considerable overlap of maximum and minimum values. It is suggested that an "average susceptibility" for a particular rock type means little and that susceptibility of a particular rock mass cannot be determined by random sampling by wells. Comparison between observed magnetic susceptibilities and calculated susceptibilities is discussed.

Introduction

In 1951, The University of Texas Bureau of Economic Geology, with cooperation of a number of oil companies, began a study of subsurface Precambrian rocks in west Texas and southeast New Mexico. As a part of this project a large collection of cores and cuttings of wells that penetrated Precambrian rocks was assembled. Through the interest and cooperation of Frost Geophysical Corporation of Tulsa, Oklahoma, which permitted the loan of the Frost magnetic susceptibility bridge, magnetic susceptibility determinations were made on part of this collection. Contamination and insufficiency of sample made it impossible to measure susceptibility for the entire collection.

Acknowledgments.—The kindness and cooperation of Messrs. C. H. Frost and J. C. Rollins of Frost Geophysical Corporation and Frost Airborne Surveys, Inc., are gratefully acknowledged. The writer is indebted to Mr. W. B. Varnell who operated the magnetic susceptibility bridge and made a number of valuable suggestions. Messrs. L. L. Nettleton and H. S. Cobb were kind enough to criticize the manuscript. The many companies and individuals engaged in exploration in west Texas and southeast New Mexico generously contributed samples of basement rock (see pp. 13–14) and the writer would like to express his deep appreciation to them. H. W. Mooney graciously permitted the writer to read an advance copy of a very pertinent paper (Mooney and Bleifuss, 1953).

General remarks.—Published data on magnetic susceptibility of rocks are scanty. Birch (1942, pp. 294–298) gives some tabulated information and a list of references. Some references on experimental work on magnetic susceptibility not given by Birch are Grenet (1930), Nagata (1940), Kato (1941), Haalck (1942), and Werner (1945). Values for the average magnetite-ilmenite content of some rocks are given by Stearn (1929, pp. 330-331); these were used by Nettleton (1940, p. 201) and Dobrin (1952, p. 109) as a basis for calculating magnetic susceptibility of some igneous rocks. Nettleton and Elkins (1944) calculated the normative magnetite content and the probable magnetic intensity for a large number of chemically analyzed igneous rocks. Heiland (1940, pp. 312–314) and Collingwood (1930) give some magnetic susceptibility values for rocks. Steenland and Woollard (1952, p. 1087) have published magnetic susceptibility values measured on the same instrument used in this study—the Frost magnetic susceptibility bridge. Hawes (1952) has made magnetic susceptibility measurements in connection with a complete magnetic study of a granite mass. Mooney (1952) describes apparatus for measuring magnetic susceptibility on the outcrop. Mooney and Bleifuss (1953) present information on the relation of magnetite content to susceptibility and tabulate considerable magnetic and petrologic data. Kalashnikov and Kapitsa (1952) have experimented with changes in magnetic susceptibility in rocks under elastic stresses and report decreases of susceptibility up to 50 percent in rocks under compression. A summary of this paper including Tables 1 and 2 has appeared previously (Flawn, 1953).

Many geophysicists consider that most published information on *measured* magnetic susceptibility of rocks is unreliable because measurements were made in a magnetic field much stronger than the earth's and the measured values are too low (Slichter, 1929, pp. 242–246; Nettleton, 1940, p. 203; Dobrin, 1952, p. 108). The Frost magnetic susceptibility bridge used in this research was designed and built by the Frost Geophysical Corporation and operates at a field strength of about 1 oersted. This is about 40 percent more than the earth's field (0.6 gauss) but considerably less than field strengths of some instruments used previously. Measurements were commonly made in fields in excess of 50 oersteds. Slichter (1929, p. 247) has drawn a curve showing the effect of field strengths ranging from 0.6 gauss to 30 gauss on the susceptibility of crushed magnetite, and the change between 0.6 gauss and 1 gauss is very slight.

The Frost magnetic susceptibility bridge.—The instrument developed by Frost Geophysical Corporation for measurement of the magnetic susceptibility of rocks consists of a stable 400-cps oscillator of constant output and low harmonic content; a Maxwell bridge, in one arm of which is an inductor whose air core will receive a ½ by 3-inch glass tube which contains the rock sample; an amplifier; an electronic synchronous rectifier; and a zero center DC bridge balance indicator meter. Power is supplied by a regulating unit operating from 110-volt AC mains. Resistive and reactive components of the bridge are independently balanced in the absence of the sample. The sample is then inserted and the change in effective resistance of the inductor and change in inductance of the inductor due to the conductivity and susceptibility, respectively, of the sample are compensated by re-balance of the bridge. From the calibrated dial reading of the reactive compensator and the mass and density of the sample, the volume susceptibility of the rock sample is calculated. The accuracy of determination of the susceptibility when a full tube of sample is used is about 1 x 10^{-6} cgs units.

Core samples.—Specific gravity of core fragments was determined to plus or minus 0.01 using the suspension method in a standard magnetically damped analytical balance. The fragment was then crushed in a porcelain mortar to about -10 mesh and inserted in the bridge in a glass vial. Reproducibility of results was determined by experiment. These experiments proved that fineness of grinding had no appreciable effect on the measured magnetic susceptibility, although Slichter (1929), pp. 246–248), working with magnetite and iron, found that pulverizing substantially reduced the susceptibility. Results further indicated that use of a pyknometer for specific gravity determinations was unnecessary, and it was discarded for the more rapid fragment-suspension method.

Samples that showed abnormally high susceptibility were scanned with a hand magnet to determine if tramp iron was present, but all these high readings were found to be the result of a high magnetite-ilmenite content.

Cuttings.—At the outset of the project it was planned to run magnetic susceptibility determinations of cuttings as well as core chips. However, for a number of reasons, it was found practical to determine magnetic susceptibility of only a small number of the samples of cuttings. The principal deterrent is contamination; in a large number of the basement cuttings received, the basement rock fragments make up less than half of the total sample, and the sample is of such size that picking will not produce enough material for a satisfactory determination (about a teaspoonful of uncontaminated material is necessary for a first-class determination). An attempt was made to utilize the contaminated samples by considering the contaminating limestone and shale as inert and estimating the percentage of basement material in the sample. However, the error introduced was too large and the method proved unsatisfactory. A second factor is size of cuttings. In a number of samples the ratio of size of cuttings to grain size of original rock was such as to produce comminuted mineral fragments rather than rock fragments, and no true sample of the original rock could be obtained from these mineral fragments. Basement rock chips were picked from those few samples of cuttings that consisted of enough *rock fragments;* the susceptibility was measured, and the specific gravity was determined by a pyknometer. Commonly insufficient material was available for a first-class determination, and a maximum reading was taken while moving the sample up and down in the field, or the insufficient sample was combined with an inert substance such as sugar.

Those cuttings whose susceptibility was measured were carefully scanned with a hand magnet, and in the magnetically separated portion of the sample, magnetite-ilmenite and tramp iron were separated by hand picking. The magnetite-ilmenite was returned to the sample.

Accuracy and reproducibility of results.—Variations in the dial reading when balancing the bridge for a specific sample commonly ranged from a few tenths of a dial division to 1 division. Such a variation might result in a difference of 1 in the second figure of the susceptibility value. Sporadic variations ranging up to 10 or more dial units were observed for a small number of samples. To reduce the effects of these variations in dial reading, multiple readings were averaged. These variations in dial readings are due to the extremely sensitive balance of this bridge and, although much of the variation is eliminated by using an average value, the third figure of the susceptibility value cannot be regularly reproduced and is not significant. Susceptibility values tabulated in this paper are given to two significant figures. To facilitate tabulation, susceptibility values of magnitude less than 10^{-6} are reported as 10^{-6}, but the zeros following the first two numbers are not significant.

One sample, a granite with a susceptibility of 750 x 10^{-6}, showed anomalous behavior. Marked change in dial reading was caused by rotation of the sample in the field, probably because of a gross shift in part of the magnetic dipoles of the magnetite-ilmenite in the sample. Examination of the sample showed that magnetite-ilmenite was not evenly dispersed but occurred in part in large grains in or attached to quartz fragments. The shift of these large fragments caused by rotation of the sample unbalanced the bridge. Finer grinding of the sample and resulting random orientation of dipoles eliminated this behavior.

Measured Values of Magnetic Susceptibility

Resolution of data.—Results of magnetic susceptibility measurements on 96 samples are presented in Table 1 (p. 240). Of these 96 samples, 83 are core chips and 13 are cuttings.

Values given in Table 1 show a wide range for the common types of plutonic rocks. Granite ranges from 21 to 1,400[1]; granodiorite ranges from 40 to 4,800 with values generally higher than those for granite; diorite ranges from 51 to 2,200;

[1] All figures are volume susceptibility in x 10^{-6} cgs units

syenite varies from 37 to 4,600; gabbros are consistently high and range from 220 to 6,900 with the bulk of the values between 1,200 and 2,400; basalt and diabase vary from 80 to 3,900; rhyolite is consistently low with a range from 18 to 72. Values for metamorphic rocks are also extremely varied: phyllite, metaquartzite, and metarkosite as measured were low; amphibolite was high with the maximum reading recorded — 13,000; schist and gneiss are varied. Maximum values for granite, granodiorite, and syenite far overlap minimum values for the more basic rocks such as diorite and gabbro. Evidently no positive rock determination could be made from magnetic susceptibility alone, although in general it can be said that gabbro has a higher susceptibility than granite. Hawes (1952, p. 41) gives susceptibility measurements for 41 samples of Spavinaw granite as part of a complete magnetic study of the body. Using an instrument with a field strength of 2 gauss, he found a range from 280 x 10^{-6} to 1980 x 10^{-6} cgs units per cubic centimeter.

These results demonstrate the potential error in assigning an average value for magnetic susceptibility or magnetite-ilmenite content to a particular rock type, such as granite. Calculated values to four significant figures given by Nettleton (1940, p. 201) based on average magnetite-ilmenite content of rock types as given by Stearn (1929, pp. 330–331) do not appear to have any practical significance, although it should be noted that these calculated values are much higher than those obtained with the Frost bridge. Dobrin (1952, p. 109) summarizes data on susceptibility *measurements* given by Heiland (1940) and Birch (1942), and the range of measured susceptibility values of various rock types is more in agreement with that obtained in this study, although correspondence of maximum and minimum values is poor. Dobrin (1952, p. 109) also presents calculated susceptibilities based on Slichter's method (1929) and Stearn's figures (1929) which are much higher than the observed values on the Frost bridge. Nettleton (1940) and Dobrin (1952), following Slichter (1929) conclude that the calculated values are more reliable than measurements made in too-strong fields.

In the writer's opinion there is possibility of error in the use of the magnetite content of an average of a particular rock type (that is, "the average granite") as a basis for calculation of magnetic susceptibility. Stearn (1929, pp. 330–331) does not indicate how he constructed the tables of values of magnetite-ilmenite content of various rock types which have been used in calculation of magnetic susceptibility, but in the experience of petrographers concerned with modal analysis of rocks, there can be, and commonly is, a wide range in the amount of resolvable magnetite-ilmenite in a particular type of rock. It is reasonable to assume a similar variation in cryptocrystalline magnetite-ilmenite. The average value may not be significant for purposes of calculation.

Nettleton and Elkins (1944) calculated magnetite content and probable intensity of magnetization from published analyses of igneous rocks for which density and data to compute normative magnetite were available. These 1,450 normative magnetite and density values were analyzed statistically according to the C.I.P.W. and Iddings' classifications of igneous rocks (Nettleton and Elkins, 1944, pp. 68–71), and the median magnetite value for each class or division of igneous rocks in these two classifications was used to calculate intensity of magnetization. The major weakness in these calculations, as realized by Nettleton and Elkins and pointed out by Duane Reno in the discussion following the paper, is the use of normative values. Normative and modal magnetite may differ considerably. This study by Nettleton and Elkins is a worthy contribution because it presents for use approximate magnetic data for a large number of rocks before a large body of experimental data on directly measured values is available.

Considerable difference in magnetite-ilmenite content may exist between similar rock types from separated localities and between samples of similar rock from one body. In this research it was found that two samples of diorite separated by a 3-foot interval in one core yielded magnetic susceptibility values of 74 and 150; granite samples from within a 7-foot interval ranged from 950 to 1,200; two diabase samples from the same well, separated by an interval of 300 feet, showed values of 340 and 3,900; two samples of gabbro from 200 feet apart in the same well ranged from 1,200 to 1,900. Of course, such variations are not always present, and some determinations on samples from the same core are in close agreement. Large masses of igneous rock are considered to be in general more homogeneous than masses of metamorphic or sedimentary rocks, and considering the tremendous volumes of material, the homogeneity is truly remarkable; in detail the percentages of magnetite-ilmenite may show considerable variation from one sample to another. Chayes (1950) discusses the question of homogeneity of igneous masses and presents data from micrometric analyses. In the writer's opinion, reservations must be made in calculations when using figures purporting to be the "magnetite-ilmenite content of the average granite" or the "average magnetite-ilmenite content of gabbros." Geologically and mathematically these figures may be extremely vulnerable.

It was noted that the values derived from measurements on the Frost magnetic susceptibility bridge are in general lower than calculated values derived from Stearn's tables on magnetite-ilmenite content of rocks, notwithstanding that the Frost bridge operates at a field strength only about 40 percent greater than that of the earth. Possibly Stearn's figures are in general too high or possibly ilmenite makes up a higher proportion of the total magnetite-ilmenite content than Stearn allowed. In any case, the source of these geologic data should be reviewed.

Conclusions.—It appears that a rock sample in a random well core, or in fact any single random sample, will not give satisfactory information on magnetic susceptibility of the rock mass penetrated. This is not surprising because most scientists have learned the danger in relying on a single sample. The theory of sampling has long been applied to geologic problems, and the value of systematic sampling has been many times demonstrated. The mining geologist in investigation of the content of a particular mineral in a rock mass must depend on large numbers of systematic samples. Magnetic susceptibility is related for the most part to the magnetite-ilmenite content of a rock. A single core sample will not give reliable information on the magnetite-ilmenite content of a rock mass any more than a single assay will give reliable information on, for example, the copper content of an ore body. The magnetite-ilmenite content of a particular granite is probably less varied than the copper content of an ore body, but the analogy is valid.

The over-all magnetic susceptibility of a particular rock mass can be determined only by thorough and systematic sampling much as was done by Steenland and Woollard (1952, pp. 1075–1093) in their investigation of the Cortlandt Complex. Precambrian rock masses in subsurface cannot be so investigated. In areas that show little variation in rock type as determined from relatively closely spaced wells, such as in the Brunson area of Lea County, New Mexico, there is a significant variation in magnetic susceptibility. In the Brunson area 18 susceptibility determinations on granite and granodiorite that show little variation in general mineral composition in thin section, ranged from 25 to 1,300 for granite and 40 to 4,800 for granodiorite.

It is concluded that magnetic susceptibility as measured in this study will not be of direct value to exploration geophysicists concerned with evaluating the magnetic effects of the basement. These determinations are of value only in that they add to the store of knowledge on magnetic susceptibility of rocks. Kalashnikov and Kapitsa (1952) state that mechanical stresses applied to rocks cause a decrease in susceptibility and conclude that magnetic susceptibility as measured in the laboratory is not the same as it is *in situ* because of changes in the mechanical conditions of the surrounding medium. This is more reason for caution in attempting to assign susceptibility values for classes of rocks on the basis of laboratory research and calculations.

Mooney and Bleifuss (1953) measured susceptibility of a number of rock types on the outcrop and give a mean susceptibility and a coefficient of variation for various rock types. They state that the mean susceptibility of a rock formation will determine the general level of magnetic intensity and the variability will determine the relief of the magnetic contours over a particular rock type. It is their opinion that, notwithstanding the overlap of individual susceptibility values of different rock types, the mean susceptibility of the rock types studied differs significantly. On the basis of values given in Table 1 of this paper, a mean susceptibility for rhyolite porphyry (range 18 to 72) is significant but a mean susceptibility for granite (range 21 to 1,400) is of dubious significance because of the variation. Published data show that the mean susceptibility of rhyolite in west Texas cannot be applied to rhyolite from other areas. Evidently each rock unit is an individual problem in sampling and measurement, and values obtained in an area where susceptibility of a basement unit can be determined through adequate sampling and measurement cannot be carried over to a similar rock unit that is concealed.

It has been assumed in magnetic prospecting that sedimentary rocks have little or no effect on the magnetometer and that the anomalies are due entirely to trends within the basement or to intrusive igneous rocks. While there are exceptions to this assumption, it is in general valid. The problem of magnetic anomalies and their interpretation has been approached from two directions: (1) by making assumptions based on magnetic susceptibilities of rock types obtained by calculations and measurements and (2) by field work with the magnetometer. It is concluded herein that sampling control adequate for determination of the magnetic susceptibility of masses of concealed basement rocks does not exist and probably will not be practical. Basic research with the magnetometer in the field will probably produce data of more value in the study of magnetic anomalies.

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TABLE 1. *Measured magnetic susceptibility values.*[1]

All x 10^{-6} cgs units/unit volume.

GRANITE[2]	GRANODIORITE	QUARTZ SYENITE AND SYENITE	QUARTZ DIORITE AND DIORITE	GABBRO	BASALT AND DIABASE	RHYOLITE AND RHYOLITE PORPHYRY	MISCELLANEOUS ROCKS
(1) 21	(28) 40	(42) 37	(47) 51	(55) 220*	(63) 80	(69) 18	(82) andesite porphyry 68
(2) 25	(29) 49	(43) 58	(48) 74	(56) 1200*	(64) 110	(70) 20	(83) andesite porphyry 4500
(3) 27	(30) 69	(44) 1300	(49) 110	(57) 1600	(65) 340	(71) 26	(84) andesite tuff 9100
(4) 29	(31) 88	(45) 4600	(50) 130	(58) 1900	(66) 1700	(72) 33	(85) latite tuff 51
(5) 31	(32) 730*		(51) 150	(59) 2200	(67) 3300	(73) 40	(86) serpentinite 3200
(6) 32	(33) 750*	SYENOGABBRO	(52) 1400	(60) 2300	(68) 3900	(74) 51	(87) sericite phyllite 44
(7) 32	(34) 790	(46) 170	(53) 1700*	(61) 2400*		(75) 53*	(88) sericite phyllite 53
(8) 33*	(35) 960		(54) 2200	(62) 6900*		(76) 60	(89) sericite phyllite 57
(9) 34	(36) 1300					(77) 66	(90) metaquartzite 67
(10) 37	(37) 1300*					(78) 67	(91) metarkosite 72
(11) 43	(38) 3500*					(79) 69	(92) amphibolite 3200
(12) 67	(39) 4000					(80) 72	(93) amphibolite 13000*
(13) 180	(40) 4800						(94) biotite-microcline-plagioclase gneiss 6500
(14) 180						RHYOLITE TUFF	
(15) 250*	GRANODIORITE GNEISS					(81) 44	(95) quartz-hornblende-plagioclase gneiss 52
(16) 250*							
(17) 610	(41) 9000						(96) epidote-hornblende-biotite schist 430
(18) 670							
(19) 750							
(20) 870							
(21) 950							
(22) 1200							
(23) 1300							
(24) 1400							
GRANITE GNEISS							
(25) 30							
(26) 43							
MYLONITIZED GRANITE							
(27) 290							

[1] Parenthesized number preceding susceptibility value refers to well name in Table 2.
[2] Rock family names include fine-grained equivalents such as microgranite and microgranite porphyry, microgabbro, etc.
* Sample is cuttings; all others are core samples.

TABLE 2. *Key to sample numbers in Table 1.*[1]

	COUNTY AND STATE	OPERATOR AND FARM	DEPTH (in feet) AND NATURE OF SAMPLE
(1)	Roosevelt, N. M.	Spartan #1–36 State	core 7140
(2)	Lea, N. M.	Humble #6-V State	core 7705
(3)	Andrews, Texas	Phillips #58 University	core 7922–26
(4)	Chaves, N. M.	Franklin, Aston & Fair #1 Park	core 5814–27
(5)	Lea, N. M.	Amerada #1 State BTB	core ?
(6)	Chaves, N. M.	Gulf #1 Jennings	core 8300
(7)	Lea, N. M.	Olson & Atlantic #1 Langlie	core 9584
(8)	Sutton, Texas	Shell #3 Core Test (Miers)	cuttings 4950–5003
(9)	Chaves, N. M.	Gulf #1 Jennings	core 8319
(10)	Pecos, Texas	Humble #1 Wilson	core 5235
(11)	Lea, N. M.	Continental #1 Burger B-28	core 9379
(12)	Mitchell, Texas	Sun #2 Elwood	core 8520–24
(13)	Pecos, Texas	McCandless #1 University	core 5513
(14)	Lea, N. M.	Gulf #2 Stitcher	core 7980
(15)	Lea, N. M.	Amerada #6 Corrigan	cuttings 7687
(16)	Lea, N. M.	Amerada #7 Phillips	cuttings 10211
(17)	Debaca, N. M.	Pure #1 Federal-Fee	core 6467
(18)	Presidio, Texas	Welch #1 Espy	core 7830
(19)	Chaves, N. M.	Humble #1 Federal-Gorman	core 5848–49
(20)	Lea, N. M.	Gulf #7 King	core 8051–60
(21)	Lubbock, Texas	Magnolia #1 Johnson	core 10171–78
(22)	Lubbock, Texas	Magnolia #1 Johnson	core 10171–78
(23)	Lea, N. M.	Stanolind #11-X State	core 8150
(24)	Chaves, N. M.	Honolulu #1 Federal-Hinkle	core 7310–15
(25)	Lea, N. M.	Sinclair #2 State 367	core 7642–46
(26)	Mitchell, Texas	Sun #2 Elwood	core 8464–74
(27)	Roosevelt, N. M.	Tidewater #1 Best	core 7265–77
(28)	Lea, N. M.	Magnolia #17 E.O. Carson	core ?
(29)	Lea, N. M.	Continental #1-E Lockhart A-27	core 7791
(30)	Lea, N. M.	Gulf #5-F Graham-State	core 9820
(31)	Crane, Texas	Atlantic #2-A University	core 11642–45
(32)	Lea, N. M.	Amerada #3-A Phillips	cuttings 11006
(33)	Lea, N. M.	Cities Service #3-S State	cuttings 8030–34
(34)	Chaves, N. M.	Richfield #1 Mullis	core 12143–53
(35)	Gaines, Texas	Texas #1 Jenkins	core 11699
(36)	Lea, N. M.	Continental #2 Warren B-29	core 9850–52
(37)	Lea, N. M.	Shell #1 Chesher	cuttings 7630–65
(38)	Lea, N. M.	Amerada #5 Corrigan	cuttings 7803
(39)	Lea, N. M.	Humble #1 Federal-Keinath	core 9951–54
(40)	Lea, N. M.	Continental #1 Warren A-29	core 9361–91
(41)	Chaves, N. M.	Magnolia #1 Federal-Turney	core 5321–24
(42)	Pecos, Texas	Magnolia #3 Fromme	core 4667–82
(43)	Pecos, Texas	Magnolia #3 Fromme	core 4682–97
(44)	Lea, N. M.	Sinclair #1 Barton	core 7786
(45)	Lea, N. M.	Gulf #5-A J. N. Carson	core 7881
(46)	Otero, N. M.	Standard Texas #1 Scarp Unit	core 2655–60
(47)	Scurry, Texas	Sun & Ohio #1 Helms	core ?
(48)	Lea, N. M.	Continental #1 Burger B-28	core 9373
(49)	Andrews, Texas	Humble #1 Scarborough	core 10926–29
(50)	Roosevelt, N. M.	Spartan #1–36 State	core 7210
(51)	Lea, N. M.	Continental #1 Burger B-28	core 9376
(52)	Donley, Texas	Stanolind #1 Broome	core 6748–53
(53)	Eddy, N. M.	Continental #1 Federal-Thurman	cuttings 10760–65
(54)	Chaves, N. M.	Honolulu #1 Federal-Hinkle	core 7310–15
(55)	Otero, N. M.	Standard Texas #1 Scarp Unit	cuttings 2592–97
(56)	Lincoln, N. M.	Standard Texas #1 Federal-Heard	cuttings 7800–70
(57)	Bailey, Texas	El Paso Natural Gas #1 West Texas Mtge-Loan	core ?
(58)	Lincoln, N. M.	Standard Texas #1 Federal-Heard	core 8050
(59)	Hale, Texas	Amerada #1 Kurfees	core 10245–50
(60)	Lea, N. M.	Continental #1 Warren A-29	core 9371–72
(61)	Castro, Texas	Sun #1 Herring	core 10449–54
(62)	Pecos, Texas	Union California #1-C Heiner	cuttings 6155–60
(63)	Chaves, N. M.	Humble #1-N State*	core 3804–09
(64)	Roosevelt, N. M.	Mid-Continent #1 Strickland	core 7508–13

	COUNTY AND STATE	OPERATOR AND FARM	DEPTH (in feet) AND NATURE OF SAMPLE
(65)	Chaves, N. M.	Humble #1-N State*	core 3804–09
(66)	Chaves, N. M.	Barnsdall #1-A State	core 12034–40
(67)	Swisher, Texas	Standard Texas #1 Johnson	core 9193–9200
(68)	Chaves, N. M.	Humble #1-N State*	core 3500–03
(69)	Lea, N. M.	Amerada #1 State BTA	core 11754–55
(70)	Lea, N. M.	Amerada #1 State BTA	core 11716
(71)	Cochran, Texas	Humble #1 Westheimer	core 7393–94
(72)	Armstrong, Texas	Standard Texas #1-A Palm	core 6140–41
(73)	Yoakum, Texas	Continental #1 Rodgers	core 13015
(74)	Hockley, Texas	Humble #1 Hobgood	core 10174
(75)	Childress, Texas	Stanolind #1 Owens	cuttings 7381–84
(76)	Cochran, Texas	Humble #1 Masten	core 10788
(77)	Cochran, Texas	Stanolind #1 Reed	core 12678
(78)	Lubbock, Texas	Humble #1 Farris	core 11780
(79)	Otero, N. M.	Hunt & Turner #1 McMillan	core 2175
(80)	Hockley, Texas	Honolulu and Sunray #1 Moore	core 11304–05
(81)	Yoakum, Texas	Continental #1 Rodgers	core 13016
(82)	Chaves, N. M.	Sun #1 Pinion	core 1850
(83)	Lamb, Texas	Stanolind #1 Hopping	core 9606–14
(84)	Lamb, Texas	Stanolind #1 Hopping	core 9600–24
(85)	Yoakum, Texas	Continental #1 Rodgers	core 13015
(86)	Castro, Texas	Sun #1 Herring	core 10114–28
(87)	Motley, Texas	Humble #2-H Matador	core 7878–82
(88)	Chaves, N. M.	Olson #1 Noble Trust	core 7630–60
(89)	Chaves, N. M.	Olson #1 Noble Trust	core 8030 ?
(90)	Eddy, N. M.	Humble #1 Pearson	core 8243–48
(91)	Eddy, N. M.	Humble #1 Pearson	core 8243–48
(92)	Roosevelt, N. M.	Austral #1 Saddler	core 8130–56
(93)	Pecos, Texas	Stanolind #1-A Hinyard	cuttings 6700–05
(94)	Pecos, Texas	Humble #1-L University	core 5630–40
(95)	Roosevelt, N. M.	Spartan #1–36 State	core 7204
(96)	Debaca, N. M.	South Basin #1 Good	core 4774–79

[1] Samples are grouped by rock type in Table 1. Table 2 may list the same well and core interval more than once, but each listing represents a different susceptibility value in Table 1.

* May be younger than Precambrian.

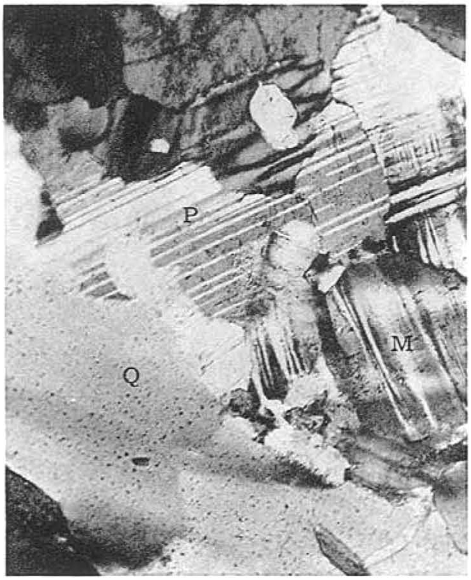
Plates IV–X

PLATE IV

Photomicrographs of rocks from the Texas craton

All x45

M, microcline; P, plagioclase; Q, quartz; B, biotite



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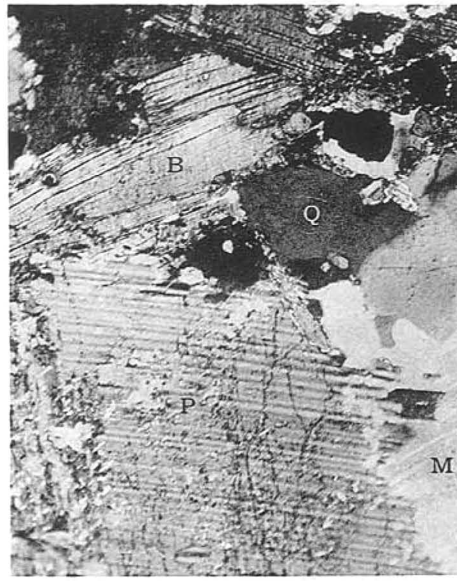

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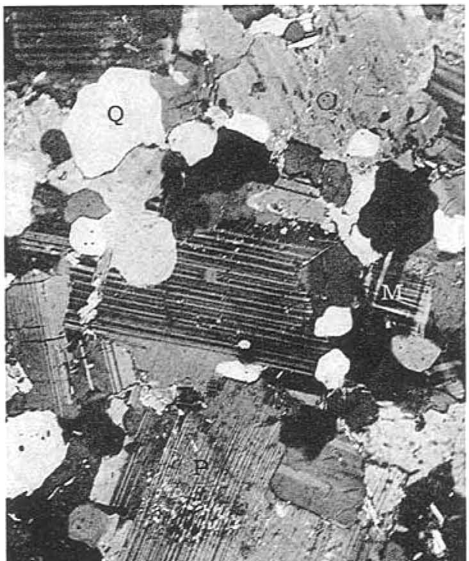

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D

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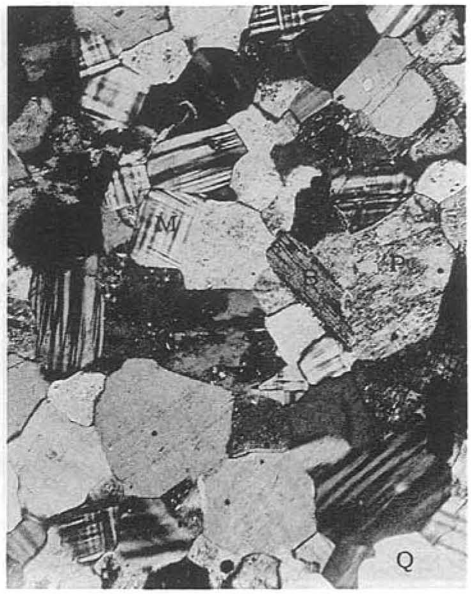

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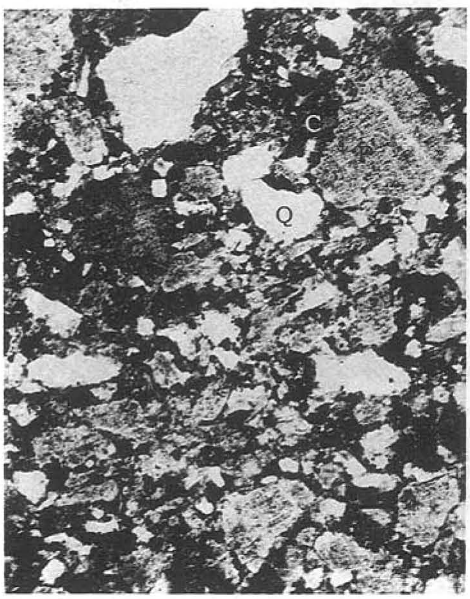


C

D

PLATE V

Photomicrographs of rocks from the Red River mobile belt

All x45

G, garnet; C, chlorite; Q, quartz; P, plagioclase; M, microcline; B, biotite; R_1, chlorite schist rock fragment; R_2, amphibolite rock fragment; MCP, mica-chlorite paste

PLATE VI

Photomicrographs of rocks from the Red River mobile belt

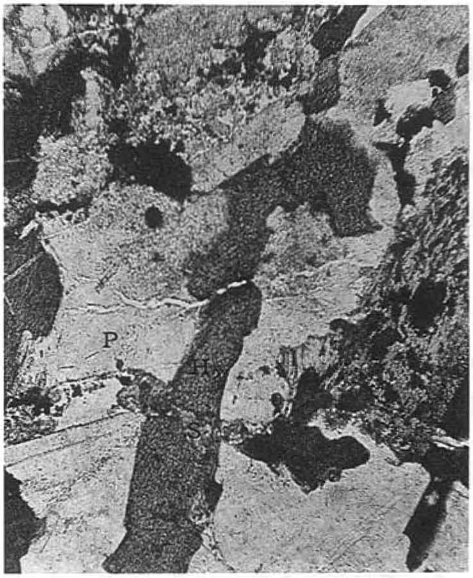
All x45

Photomicrographs of rocks from the Van Horn mobile belt

All x45

S, sillimanite; B, biotite; C, chlorite; Q, quartz; H, hornblende; P, plagioclase; M, microcline; E, epidote; MS, muscovite

A



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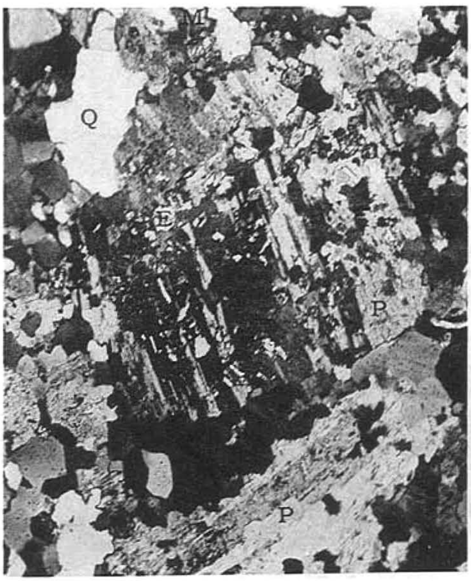

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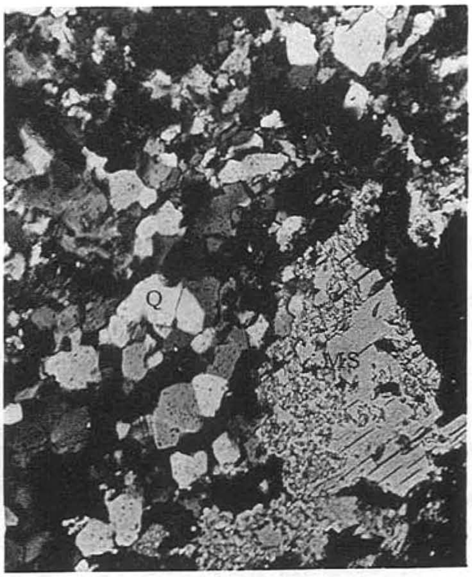

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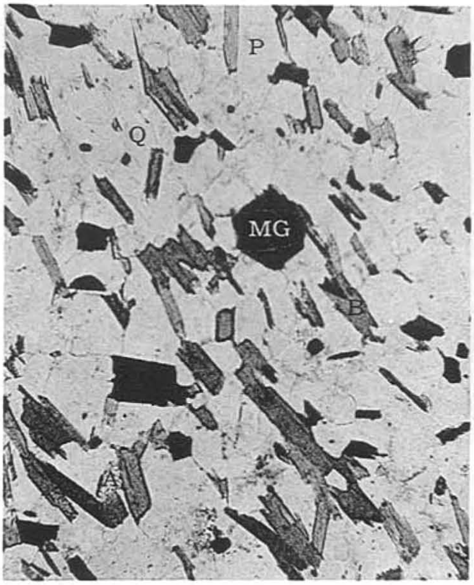

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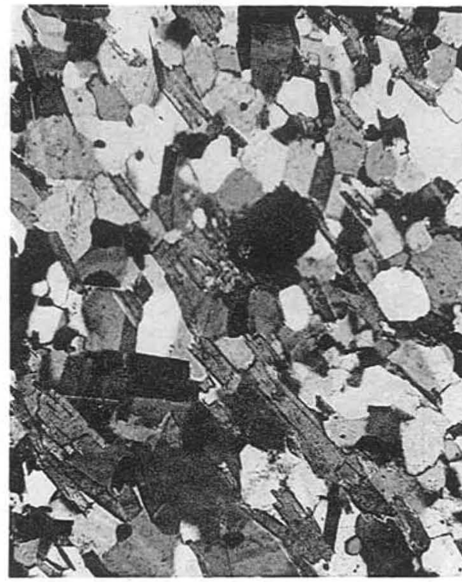


B

C

D

PLATE VII

Photomicrographs of rocks from the Fisher metasedimentary terrane

All x45

	APPENDIX II, PAGE
A. Biotite schist (Jamison No. 1 Webb, Taylor County, Texas, 6081 feet)	199
B. Same as (A) but with crossed nicols	199
C. Biotite schist (General Crude No. 12 Flanagan, Fisher County, Texas, 6743 to 6746 feet, cuttings)	155
D. Metadolomite (Humble No. 1 Nachlinger, Scurry County, Texas, 8266 feet)	196

B, biotite; Q, quartz; A, apatite; MG, magnetite; P, plagioclase; GP, gypsum cement (plaster-of-paris); D, sheared dolomite; T, talc

PLATE VIII

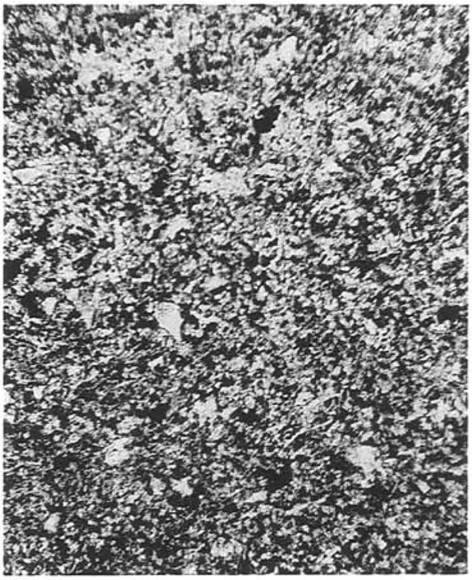
Photomicrographs of rocks from the Panhandle volcanic terrane

All x45

Q, quartz; P, plagioclase

A

B



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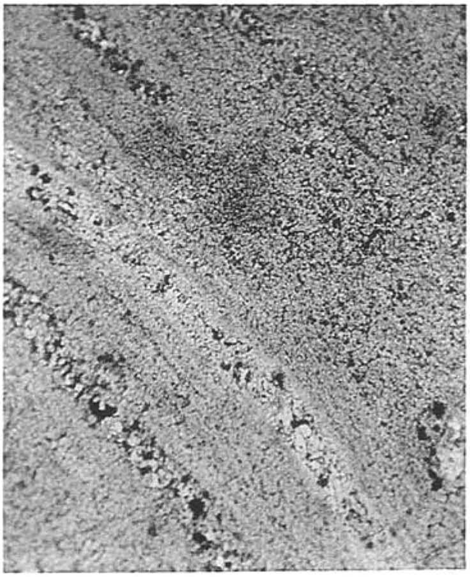

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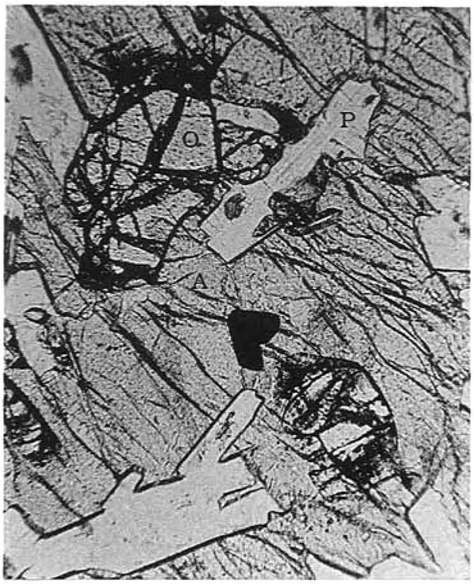

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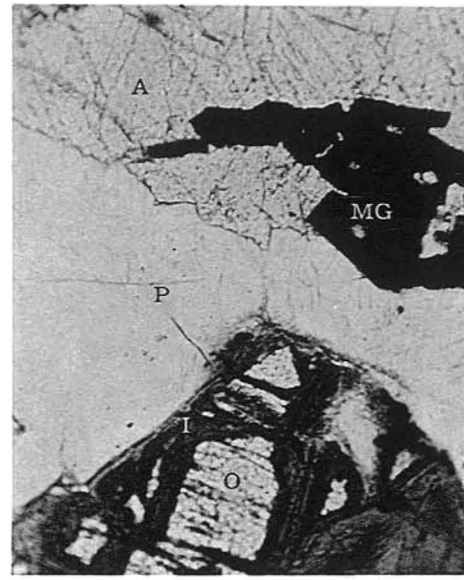


B

C

D

PLATE IX

Photomicrographs of rocks from the Swisher gabbroic terrane

All x45

	Appendix II, Page
A. Olivine diabase (Standard of Texas No. 1 Johnson, Swisher County, Texas, 9193 to 9200 feet)	198
B. Olivine gabbro (Gulf No. 1-A Keliehor, Parmer County, Texas, 9627 to 9628 feet)	185
C. Serpentinized dolomite (Hunt No. 2 Ritchie, Briscoe County, Texas, 7590 to 7710 feet)[1]	130
D. Hornfels (Sun No. 1 Herring, Castro County, Texas, 10,065 to 10,135 feet, cuttings)	135

O, olivine; A, augite, P, plagioclase; I, iddingsite; MG, magnetite; S, serpentine;
D, dolomite: F, albite and alkali feldspar; Q, quartz; MS, muscovite

[1]This well bottomed in volcanic rocks and therefore is considered with the Panhandle volcanic terrane (Table 1); however, the sequence of gabbro and contact metamorphosed sedimentary rocks encountered higher in the basement section is typical of the Swisher gabbroic terrane proper.

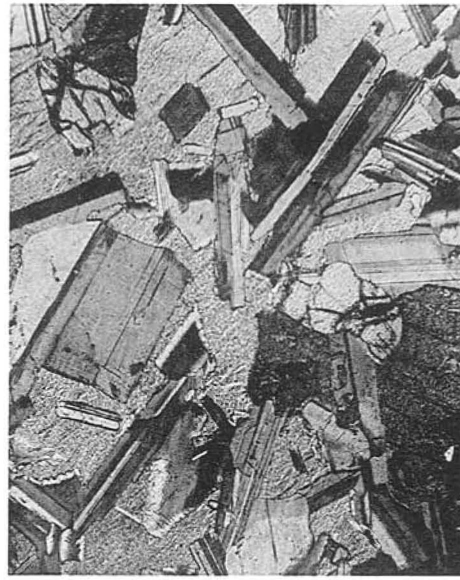
PLATE X

Photomicrographs of rocks from the Wichita igneous province

All x45

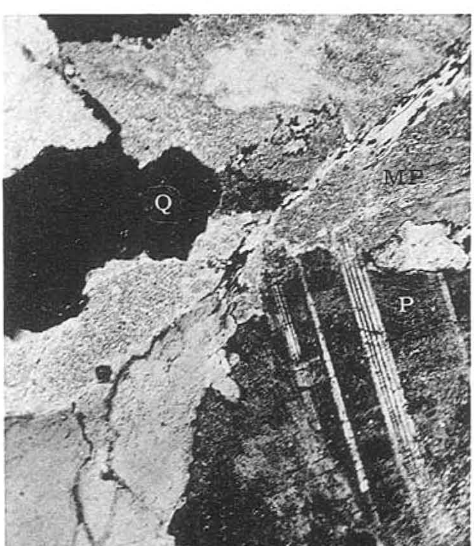
	Appendix II, Page
A. Olivine diabase (Prairie No. 1 Bivins, Potter County, Texas, 2585 to 2595 feet)	193
B. Same as (A) but with crossed nicols	193
C. Granite (Kerr-McGee No. 3 Berneta, Hartley County, Texas, 5878 to 5881 feet)	166
D. Cuneiform quartz-potassium feldspar intergrowth in micrographic granite (Superior No. 4 Matador, Oldham County, Texas, 7074 feet)	185

O, olivine; A, augite; P, plagioclase; Mp, microperthite; Q, quartz



A

B



C

D

Index