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Report of Investigations—No. 5

Iron Ore in the Llano Region Central Texas

By

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IRON ORE IN THE LLANO REGION, CENTRAL TEXAS[1]

Virgil E. Barnes,[2] Samuel S. Goldich,[3] and Frederick Romberg[4]

ABSTRACT

The magnetic iron-ore prospects of the Llano region of central Texas were investigated in a program which combined dip-needle and gravity-meter surveys by the Bureau of Economic Geology of The University of Texas and the U. S. Geological Survey with exploration by the U. S. Bureau of Mines. Magnetic observations were made on the Iron Mountain, the Bader, the Gamble, and the Olive mine prospects. Gravity observations were made over the first three areas, which subsequently were drilled. Approximately 65,000 long tons of ore is indicated for the Iron Mountain deposit. The investigations indicate the applicability of combined dip-needle and gravity-meter surveys in search of magnetic iron-ore deposits.

INTRODUCTION

Detailed investigations of the magnetic iron ores of the Llano region of central Texas were made during World War II in the period February 1942 to May 1944. In this report a summary is given of the more important results of these investigations which were carried on co-operatively by the Bureau of Economic Geology of The University of Texas and the U. S. Geological Survey and U. S. Bureau of Mines. Results of the geophysical studies of Iron Mountain have already been published (Barnes and Romberg, 1943), and a summary of the exploratory work on three of the prospects has been issued by the U. S. Bureau of Mines (1944) in War Minerals Report 318 and in Report of Investigations 4045 (Evans, 1947). The exploration program conducted by the Bureau of Mines contributed much useful information concerning the iron ore, rocks, and structure of this region.

[1]Prepared under co-operative arrangement between the Bureau of Economic Geology of The University of Texas and the U. S. Geological Survey. Published with the permission of the Director, U. S. Geological Survey.

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[4]LaCoste and Romberg, Austin, Texas.

LOCATION

The iron-ore district includes Llano County and the eastern part of Mason County (fig. 1). Llano, the county seat of Llano County, is the most important town and is the terminus of the Texas and New Orleans Railroad, a branch line of the Southern Pacific Railroad. Llano River conveniently divides the district into northern and southern sections. Most of the iron-ore prospects are in the northern section.

PREVIOUS WORK

The iron-ore deposits of the Llano region were first discussed by T. B. Comstock (1890, 1891). In the period from 1890 to 1910 mining operations were started on several deposits, and core drilling was done on at least three properties. Only small reserves were developed as a result of these operations, and little, if any, ore was shipped from the district. In 1908 and 1909 A. C. Spencer and Sidney Paige (1911) of the U. S. Geological Survey examined the known prospects and outcrops with showings of magnetite. They concluded that three deposits might have possible commercial value but stated that exploration would be needed to prove reserves of ore adequate for profitable mining. Magnetic observations were not within the scope of the field studies conducted by Spencer and Paige, but they recommended preliminary surveys with compass and dip needle, to be followed, if necessary, by more refined methods. Thus, some forty years later under the impetus of the war demand for high-grade iron ore that could be used in the steel industry in Texas, the suggestions of Spencer and Paige were finally acted upon.

FIELD WORK

Magnetic and gravity studies of Iron Mountain were made in 1942 by Barnes normal fault (fig. 2). This fault does not affect the ore body which pinches out to the southeast before the fault is reached.

Magnetic observations.—A dip-needle survey of the Iron Mountain deposit by Barnes (Barnes and Romberg, 1943) showed four magnetic poles indicating two distinct magnetic bodies (Pl. II). The poles related to the outcropping body are of minor intensity, whereas the poles to the southeast reflect a larger mass below the surface. It was concluded that the ore body was divided into separate parts by a cross-cutting dike such as the aplite exposed in the test pit on the surface.

Gravity observations.—The gravity-meter survey of the Iron Mountain prospect completed in March 1942 by Romberg showed a clearly defined anomaly (Pl. II). From the gravitational data together with the information available about the mine workings, an estimate of the tonnage in the ore bodies was made. The smaller body was estimated to contain about 5,000 metric tons (2,204.6 pounds) and the larger body about 40,000 tons, placing the reserves at approximately 50,000 metric tons. This first estimate is too low and resulted from an error in the calculations. It was estimated that the dimensions of a mass with a specific gravity of 4.7 that would produce the observed anomaly would be approximately 200 feet long, 23 feet wide, and 115 feet thick. A mass with these dimensions and with an average specific gravity of 4.7 would be equivalent to approximately 70,000 long tons (2,240 pounds) instead of the 40,000 tons stated by Barnes and Romberg (1943, p. 42). For details of the gravity observations over the Iron Mountain deposit, the reader is referred to the papers by Barnes and Romberg (1943 and 1949).

Exploration.—Thorough exploration of the Iron Mountain prospect by the Bureau of Mines showed that the deposit is an attenuated lens or "whale-shaped" mass approximately 600 feet long, 28 feet thick, and 60 feet wide (Pls. II, III, IV). The lens dips steeply to the southwest and strikes and plunges to the southeast. The pitch of 17 degrees to the southeast is in accordance with the pitch of the mineral alinement noted in the outcrop which was about 22 degrees to the southeast. The exploration included drilling to delimit the deposit and to provide samples for chemical analysis, reopening of the 50-foot level which was surveyed by Barnes and sampled by the U. S. Bureau of Mines, and sampling of the surface outcrop. Chemical analyses of the surface samples by the Bureau of Mines (1944; Evans, 1947) follow:

Sample location	Sample length in feet	Weight percent Fe	P	SiO_2	S (less than)
(A) Northwest end of outcrop	8	61.66	0.99	3.50	0.05
(B) 15 feet southeast of (A)	10	66.88	0.14	2.32	0.05
(C) 25 feet southeast of (A)	22	68.42	0.26	2.06	0.05
(D) 30 feet southeast of (A)					
(1)	10	66.30	0.15	2.54	0.05
(2)	12	64.90	0.46	3.24	0.05
(E) Test pit on southeast side	4	66.78	0.37	4.90	0.05

EXPLANATION FOR FIGURE 2—(on opposite page)

Covering deposits are indicated in one pattern bearing two symbols, as follows: Qal, alluvium; and Qc, colluvium.

The Cambrian is represented by 2 formations and 8 members, as follows: Wilberns formation: ꞓwp, Pedernales dolomite; ꞓws, San Saba limestone; ꞓwpp, Point Peak shale; ꞓwm, Morgan Creek limestone; and ꞓww, Welge sandstone members. Riley formation: ꞓrl, Lion Mountain sandstone; ꞓrc, Cap Mountain limestone; ꞓrh, Hickory sandstone members.

Pre-Cambrian rocks are shown by the following symbols: ap, aplite; cgr, coarse-grained granite; vs, Valley Spring gneiss with some schist, ps, under same ruled symbol.

Gravity stations are marked by circles. Dip and strike symbols denote attitude of foliation in pre-Cambrian rocks. U, upthrown side of fault; D, downthrown side of fault. +7-5A, location of fossil, rock, or mineral collection.

Base from U. S. Department of Agriculture, Soil Conservation Service, aerial photographs flown by Park Aerial Surveys, Inc., 1939–1940. Geology by Virgil E. Barnes and Lincoln E. Warren, 1943.

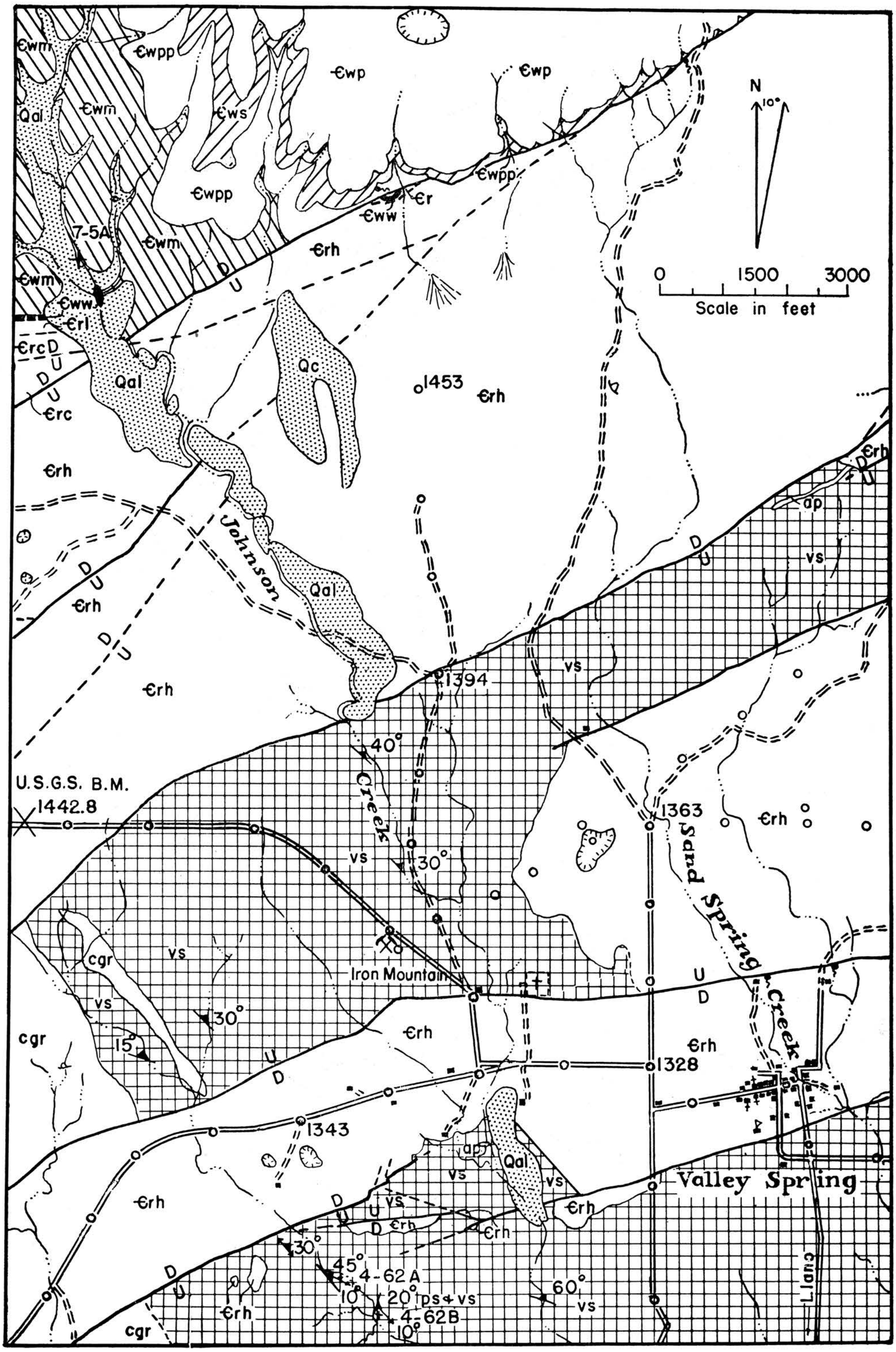


Figure 2. Geologic map of Iron Mountain and vicinity, Llano County, Texas.

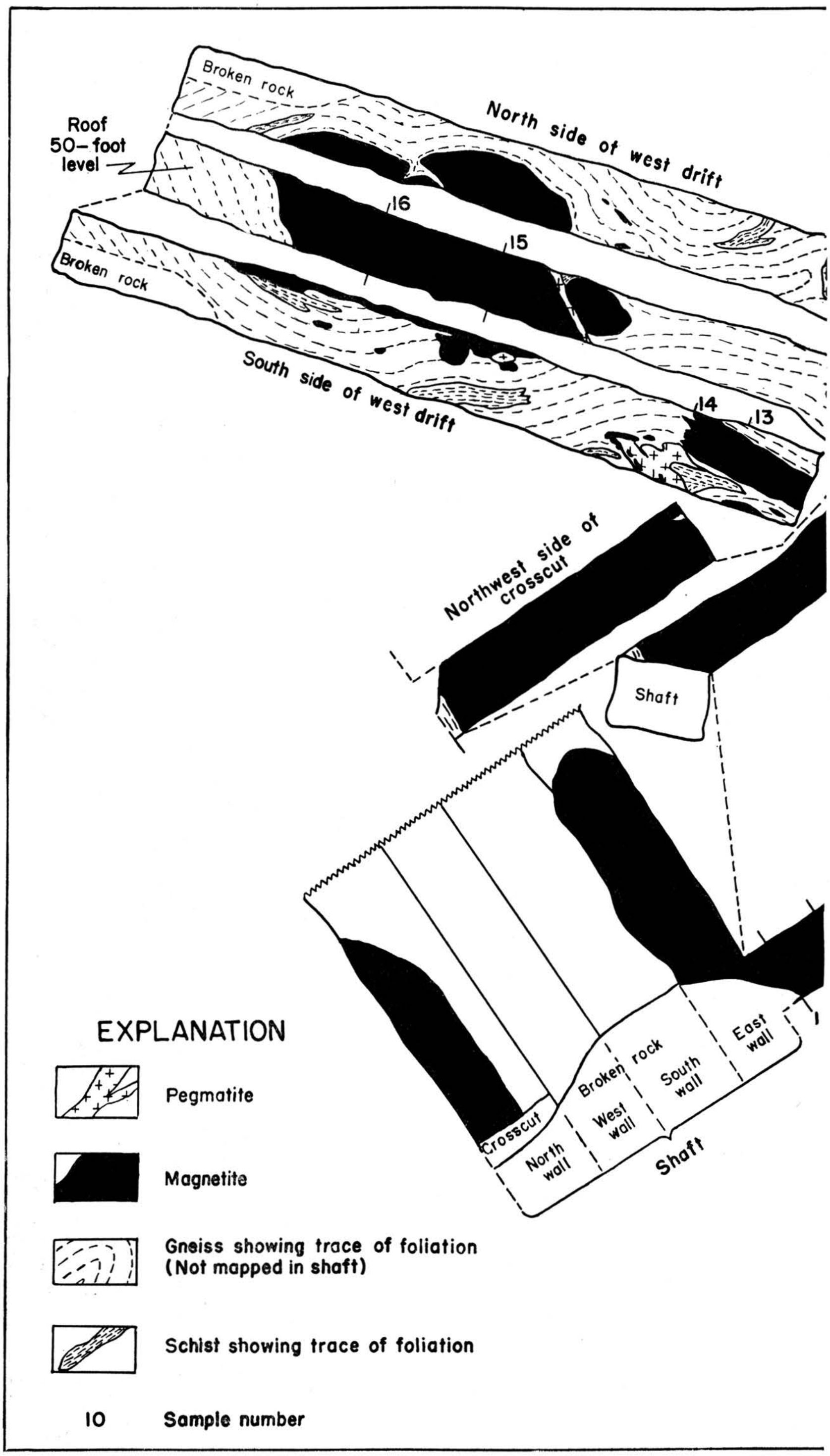
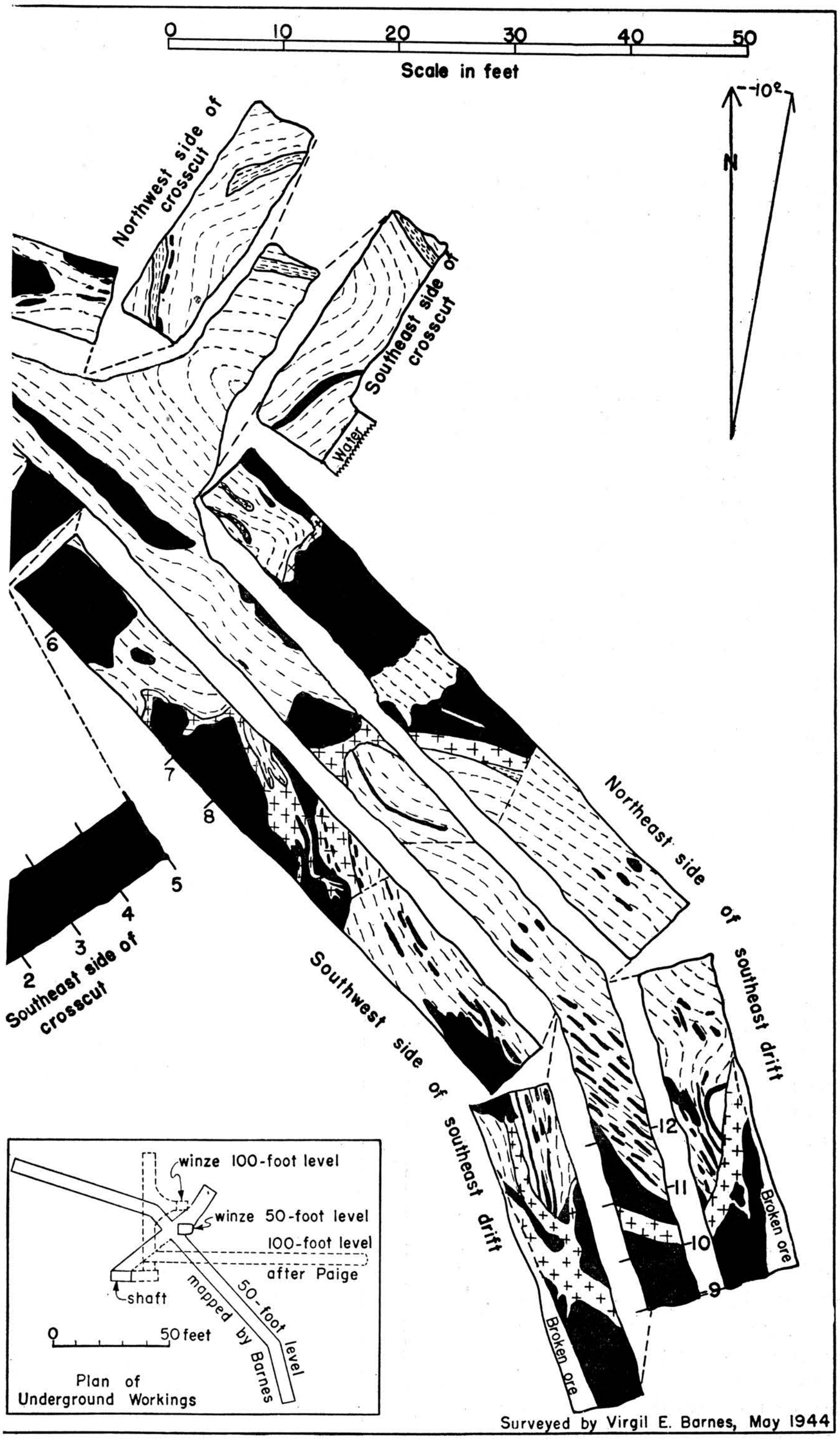


Figure 3. Sketch showing geology of the 50-foot level, Iron Mountain, Llano County, Texas.



0 10 20 30 40 50
Scale in feet
N
10°
Northwest side of crosscut
Southeast side of crosscut
Water
6
7
8
2
3
4
5
Southeast side of crosscut
Northeast side of southeast drift
Southwest side of southeast drift
12
11
10
9
Broken ore
Broken ore
winze 100-foot level
winze 50-foot level
100-foot level
after Paige
shaft
mapped by Barnes
50-foot level
0 50 feet
Plan of Underground Workings
Surveyed by Virgil E. Barnes, May 1944

A surface sample submitted by Mrs. T. B. Moss was analysed in the chemical laboratory of the U. S. Geological Survey and was found to contain 64.59 percent of iron; 0.007 percent of sulphur; and 0.022 percent of phosphorus.

Sixteen channel samples were taken in 2-inch and 4-inch grooves cut in the walls of the 50-foot level. The locations of these samples are shown in figure 3, and the analyses by the Bureau of Mines (1944) follow:

Sample No.	Percent Fe	Sample No.	Percent Fe
1	65.29	9	68.20
2	67.55	10	67.23
3	67.63	11	(lost)
4	66.34	12	67.55
5	67.23	13	51.76
6	65.61	14	43.74
7	60.40	15	65.77
8	67.88	16	67.07

The analysis of a composite sample which includes samples 1 through 5 above follows:

Constituent	*Percent*
Fe	66.89
Mn	0.10
P	0.061
S	0.039
SiO_2	5.27
Al_2O_3	0.84
CaO	0.23
MgO	0.16

The locations of 12 diamond-drill holes are shown in Plate II. The first hole missed the narrow ore body. but holes 2 to 9 inclusive were in the deposit. Hole 7 was aimed primarily to determine the nature of the cross-cutting body which separates the ore into two parts, and in this hole 25 feet of aplite was penetrated. Drill holes 10 and 11 showed no commercial ore but were useful in delimiting the deposit. Hole 12 penetrated a small amount of magnetite, delimiting the deposit at the southeastern end. The detailed logs of the diamond-drill holes are given in the appendix (table 1) and are shown graphically in Plate I. Cross sections of the deposit (fig. 4) were constructed from data from the drill holes and from information about the mine workings. Analytical data obtained by the Bureau of Mines (Evans, 1947) for the ore encountered in the drill holes are given in the appendix (table 4).

Reserves.—About 65,000 tons of iron ore is present in the Iron Mountain deposit. This estimate, made by Barnes, is based on an average ore specific gravity of 4.2, the dimensions of the ore deposit as interpreted from the drilling data, and

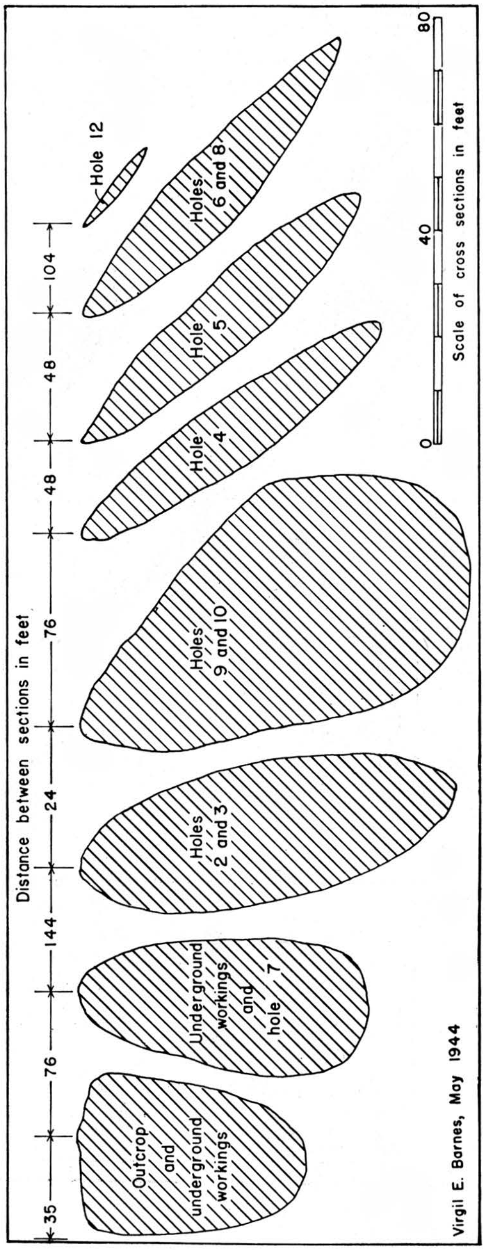


Figure 4. Cross sections of the Iron Mountain deposit from drilling and mine workings data.

observations in the mine and at the surface.

Correlation of geophysical and drilling data.—The Iron Mountain deposit affords an example of a gravity study of a metallic ore deposit which has been checked fully by exploration, and three illustrations have been prepared to show the size and shape of the ore body and its relationship to the gravity anomaly. In these diagrams the parts pertaining to the gravity anomaly have been reproduced from the figures previously published (Barnes and Romberg, 1943). Plate II is a plan of the ore body with the gravitational map superimposed; Plate III is a longitudinal sectional view of the ore body with a corresponding section of the gravitational map above it; and Plate IV is a projection of the Iron Mountain deposit with the anomalous mass assumed from the gravity data included for comparison. The aplite dike in Plate III is generalized, because the data are insufficient to determine its actual size and shape. The presence of a cross-cutting body was revealed by two magnetic anomalies over the deposit, and 25 feet of the aplite was cored in drill hole 7. The following conclusions are drawn from a comparison of the geophysical and the drilling data:

(1) The geophysical (gravitational and magnetic) studies accurately located the magnetite ore body and permitted the selection of drill-hole sites so that maximum benefit was derived from the coring. The average depth to the ore is about the same as predicted from the gravitational data.

(2) The actual ore body is longer than is indicated by the gravity data, but it does not extend to as great a depth. The plunge of the body was accurately indicated by the shape of the gravitational anomaly.

(3) A cross-cutting body indicated by the magnetic survey was found to be aplite which was penetrated in a hole directed for this purpose.

(4) The magnitude of the mass of the ore body was indicated by the gravitational study.

BADER PROSPECT

Location and access.—The Bader prospect is situated 8 miles west of Llano (fig. 1). The main prospects lie north of the Llano River, but there are some smaller showings on the south side of the river and along the tributary Hickory Creek. The area is accessible from Llano by the highway to Castell. Property owners are indicated on the sketch map (fig. 5).

History.—The Bader iron-ore prospect was explored in several surface openings and by core drilling by G. M. Wakefield apparently in the 1890's. An incline was opened in the northwest corner of what is now the Stribling tract. The incline was dug down the dip of the gneiss at an angle of about 32 degrees with the horizontal and in a northeast direction. The incline measures about 50 feet in length and was carried on in a drift for an additional 50 feet. A winze was sunk at the northeast end of the drift, but this part of the workings is flooded and further observations could not be made. Northwest of the incline in the southwest corner of the Kothmann tract (formerly the Otto tract) a vertical shaft was sunk. This shaft is filled with debris to within 20 feet of the surface, and its original extent is unknown. In the vicinity of the Bader incline and south of the Otto shaft are a number of shallow trenches and pits which were dug at different times. Some of them are fairly recent and date to a Federal Work Projects Administration project in this area. Approximately 4,600 feet southeast of the Bader incline is an old working now caved and overgrown.

Spencer (*in* Paige, 1911) indicated the location of two diamond-drill holes on a sketch map of the prospect. In the present field work three pipes which appear to be the surface casings of diamond-drill holes were located and are shown on the detailed map (Pl. V).

Geology.—The Valley Spring gneiss is the predominate rock type in the Bader tract. The fine-grained, felsic gneiss locally contains beds or lenses of massive magnetite or granular magnetite segregated in thin layers and bands. The thick-

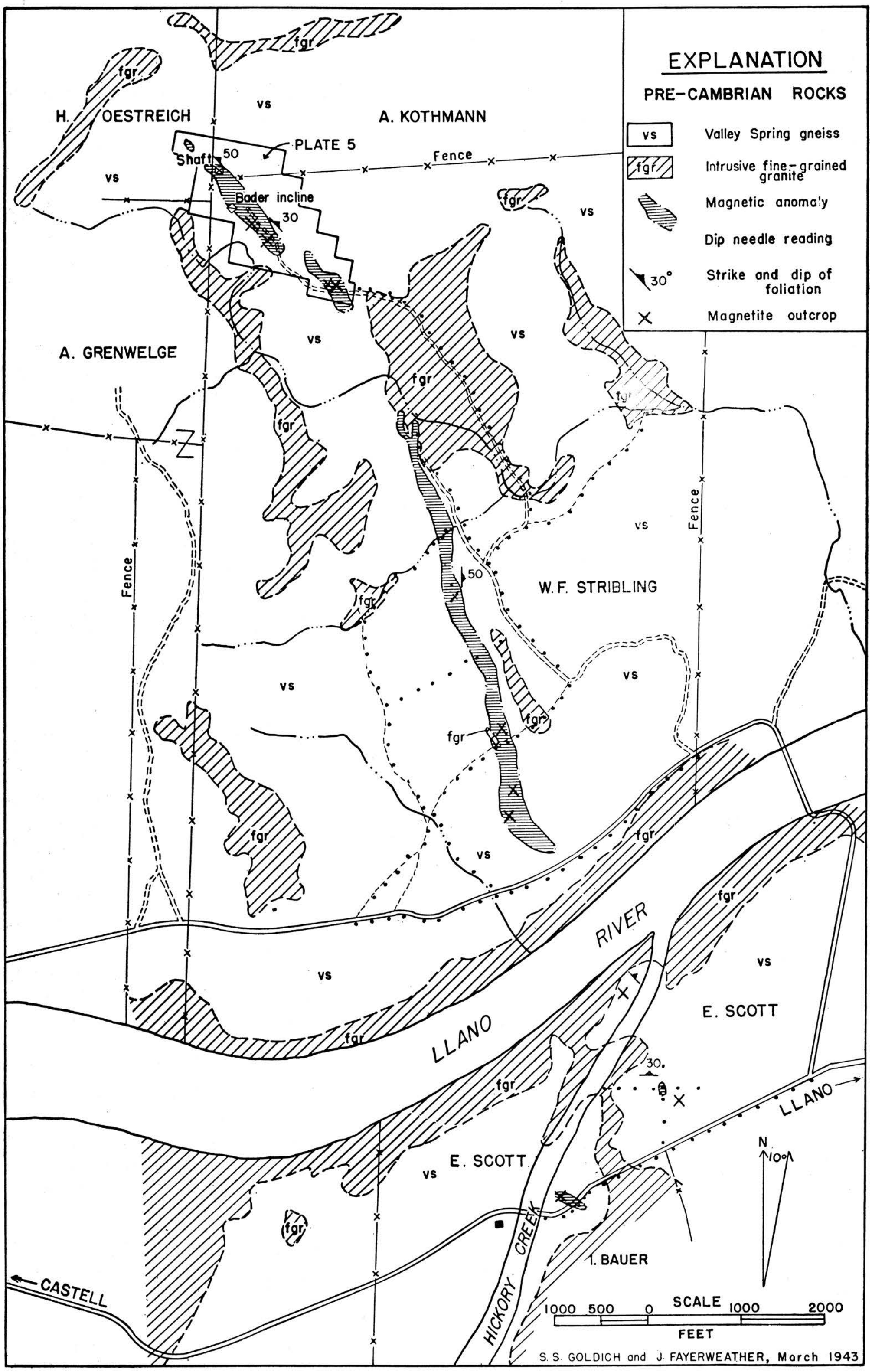


Figure 5. Index map of the Bader prospect, Llano County, Texas.

est layer of magnetite observed measures 1 foot. According to Spencer (*in* Paige, 1911, p. 32) two ore layers were found in the Bader incline. These were estimated to lie between 10 and 15 feet apart. The lower ore is described as gneiss carrying thin and discontinuous layers of magnetite. This zone, about 16 inches thick, is termed "lean material." The upper ore bed is described as massive with a maximum thickness of 20 inches. In shallow pits adjacent to the incline, bands of magnetite alternate with magnetite gneiss. The magnetite bands pinch out, and there are augen-like masses of magnetite with a maximum thickness of 1 foot in the gneiss. Study with a hand lens reveals that even the massive-appearing magnetite is not pure but contains some fine-grained silicates and quartz. The gneiss between the magnetite layers contains appreciable magnetite. Rough tests in the field indicate that in some of the pits there are zones measuring 7 feet in thickness with a magnetite content averaging about 25 percent by weight. A log of one of the old diamond-drill holes, quoted by Spencer from a private report by E. V. D'Invilliers, reports 40 feet of "magnetite ore mixed" and 7 feet of ore.

The magnetite layers and magnetite gneiss are parallel to the regional structure of the Valley Spring gneiss which in this area trends northwest. The dip to the northeast ranges from 30 to 60 degrees. The fresh gneiss is gray but weathers to a pink or light-brown color. Except for the indistinct banding the gneiss is not much different in appearance from the fine-grained, sugary-textured red granite which intruded it. This granite possibly was intruded at the time of the folding. It appears to have been intruded in thin sill-like sheets, although locally the magma broke through and across the regional strike forming dike-like masses with their elongation normal to the regional strike. The course of Llano River south of the Bader tract follows such a granite mass. The intimate interfingering of the granite and the gneiss and the lack of suitable exposures make detailed mapping in the area difficult. The few outcrops commonly are of granite either in small ridges or in the creek beds. So far as possible the areas of granite and of gneiss have been differentiated on the basis of outcrops, soils, vegetation, and topographic expression (fig. 5). The relations of granite and gneiss are well exposed on the south bank of Llano River near the mouth of Hickory Creek. In this area the magnetite, although limited in amount, occurs in massive form. Possibly proximity to the granite is in some way responsible. Locally pegmatite and aplite cut both the granite and the gneiss.

Magnetic observations.—Magnetic anomalies were traced in a narrow band from Llano River northward for a distance of over 8,000 feet (fig. 5). The anomalous strip corresponds roughly to the line of outcrop of the Valley Spring gneiss and is consistent with the regional strike. The magnetite-bearing gneiss dips about 30 degrees to the northeast, and the magnetically disturbed area is about 250 feet wide, so that the thickness of the magnetite gneiss zone is about 125 feet. In the reconnaissance work, traverses were made along roads, trails, creeks, and between landmarks which can be identified on aerial photographs. Readings were made at 50-foot intervals determined by chaining and pacing. Wherever greater than normal magnetic variations were found, additional detailed work was done. Principal lines of traverses are shown on the map, but only every fourth station has been plotted (fig. 5). The northwestern end of the magnetic range in the vicinity of the old Bader incline was selected for detailed study, and a 50-foot grid marked by stakes was laid out with a steel tape and plane table (Pl. V). The dip-needle observations reflect the presence of more than a single bed of magnetite, the discontinuous nature of these beds, and the fact that the magnetite is more concentrated in some places than in others. A break in the anomaly along the north-south line 014 (Pl. V) near the southeastern end of the detailed area is caused by the presence of a granitic intrusion. Near the northwestern end of the area the anomalies are weak, and farther north beyond the mapped area they disappear, and the Valley Spring gneiss is displaced by a granite mass.

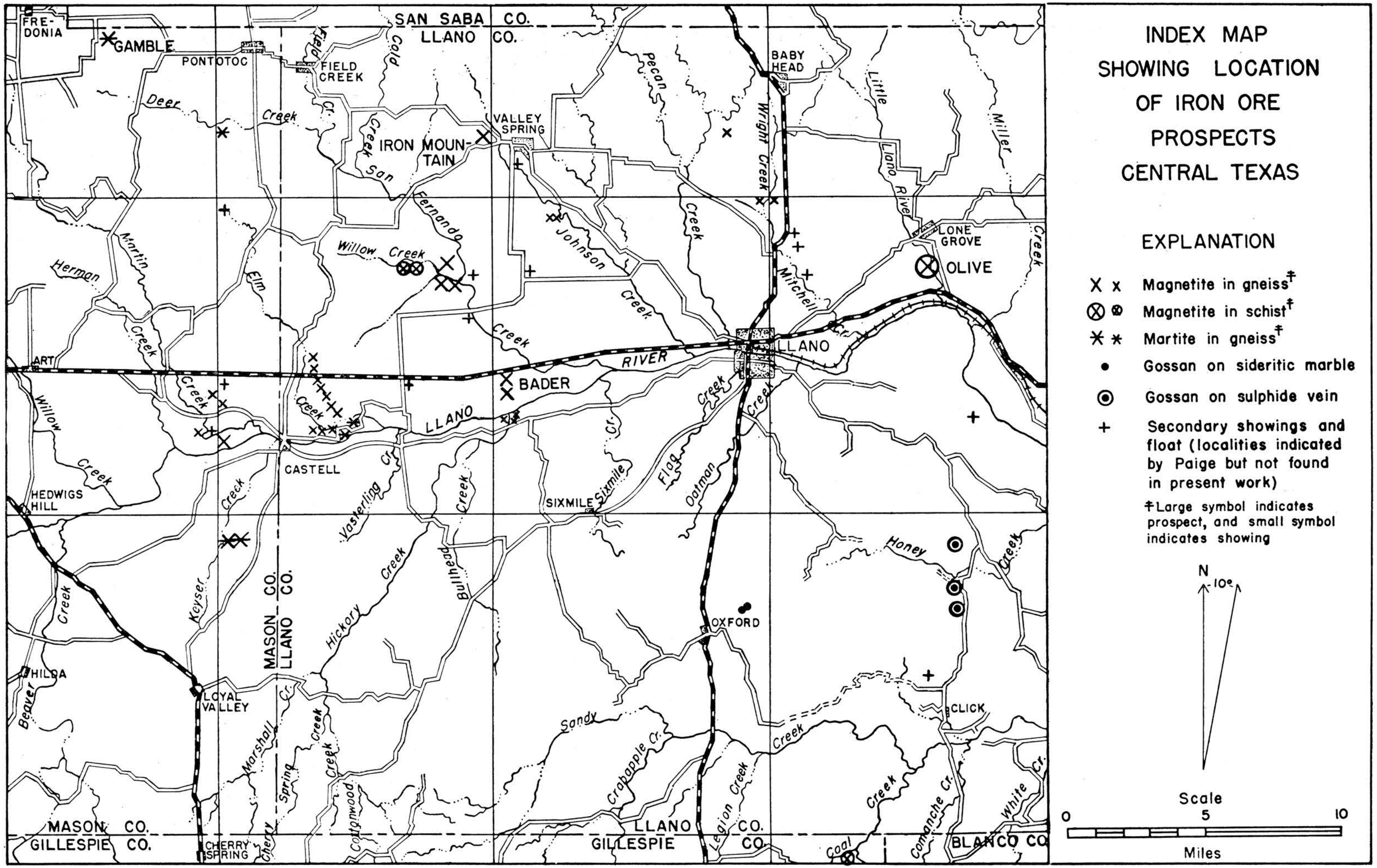


Figure 1. Index map showing location of iron-ore prospects in central Texas.

and Romberg (1943). Dip-needle surveys of the Olive mine, the Bader and the Gamble prospects, as well as examinations of most of the known outcrops, were made by Goldich and Fayerweather (1943) between January 1 and March 31, 1943. During this period Barnes visited many of the localities with Goldich, and Romberg ran three preliminary gravity profiles across the Bader prospect. The dip-needle surveys outlined the areas favorable for drilling, and three prospects were selected for exploration by the Bureau of Mines. This work consisted of core drilling, trenching, and sampling of the old workings. The program was directed by Mr. A. B. Needham, district engineer, and Mr. A. M. Evans, project engineer, of the Bureau of Mines and was completed in May 1944. Barnes, assisted by Mr. Lincoln E. Warren of the Bureau of Economic Geology, did the geological work in connection with the drilling. Romberg in the capacity of consultant to the Bureau of Economic Geology, completed the gravity survey of the Bader and the Gamble prospects.

METHODS

Magnetic Observations

The magnetic observations were made with Gurley dip needles which together with a field repair kit were generously loaned by the Wisconsin Geological Survey. The principles, construction, and operation of the dip needle are discussed by Stearn (1929). Observations were made at stations marked by a grid of stakes with 50-foot spacing. Additional readings were made at intermediate positions wherever it appeared advantageous. The dip needle was adjusted to give a normal reading of about plus 20 degrees. This reading varies as much as 3 or 4 degrees with the kind of country rock which in the Llano region may be granite, schist, gneiss, pegmatite, or various sedimentary rocks. Marked variations, however, are assumed to be caused by the presence of bodies of magnetite. The dip-needle readings were plotted on a map and contoured. The observed values over the Olive mine prospect are shown in figure 9, but the readings have been omitted in the maps of the Bader (Pl. V) and the Gamble (fig. 7) prospects to simplify these diagrams.

Gravimetric Data

A LaCoste-Romberg portable gravity meter was used in obtaining the gravimetric data. The methods used have been described by Barnes and Romberg (1943), and only a brief description is given here. The force measurements have an apparent probable error of between 0.01 and 0.02 milligal. After being corrected for errors of drift, latitude, elevation, and, where necessary, topography, the values are plotted on a map, and lines of equal force drawn from which a regional gradient is estimated. The values are then corrected for the regional gradient, and new maps are constructed which are the basis for gravimetric interpretation (Pls. II, VII). The Gamble prospect (fig. 8) was not corrected, because the observed anomaly was too poorly defined to warrant quantitative study.

Estimates of the mass of ore bodies are made from the corrected maps by measuring the "volume" of the anomalous figure. The anomalous mass is given by the expression

$$(1)\quad M = \frac{\Sigma F \Delta A}{2\pi K} \quad \text{or} \quad (2)\quad \frac{\Sigma A \Delta F}{2\pi K}$$

where M is the mass in grams; F, the force (properly the acceleration) in gals (dynes per gram); A, the area in square centimeters; and K, the gravitational constant. This method of measuring the anomalous mass is practical only if the mass is close to the surface and if the gravitational anomaly is well defined. It gives results which are smaller than the correct value, especially if the ore body is deep or scattered, because in these cases it is difficult to measure the "volume" of the anomalous figure.

GEOLOGY

General Features

The Llano region is a topographic basin encircled by scarps of Paleozoic and Cretaceous strata. The basin is underlain chiefly by metamorphic and igneous rock of pre-Cambrian age with minor areas of Paleozoic sedimentary rocks. The iron-ore district is one of moderate relief, approximately 1,200 feet above sea level. The major drainage is the eastward-flowing Llano River.

Pre-Cambrian Rocks

The pre-Cambrian metamorphic rocks have been assigned by Paige (1911, pp. 15–21) to two main groups on the basis of their structural and mineralogical characters. The Valley Spring gneiss generally is massive with indistinct banding and is felsic in composition. The Packsaddle schist is dominantly basic, generally darker in color than the Valley Spring gneiss, and is composed of mica, amphibole, and graphite schist with some marble beds. The structure of these rocks is complex and consists of a number of anticlines and synclines with the major axis of folding trending northwest-southeast and plunging to the southeast. Paige (1912) and his co-workers mapped the distribution of the rock types in the Llano and Burnet quadrangles which cover a large part of the Llano region. In the northern part of Llano County the predominant type is the Valley Spring gneiss, and the majority of the iron-ore prospects are related to this rock.

The metamorphic rocks are intruded by a variety of igneous rocks all of which are assigned to the pre-Cambrian, but several periods of igneous activity are represented. Only the granitic rocks intruded into the metamorphic rocks in the vicinity of iron-ore prospects are of interest to this report. Intimately related to the Valley Spring gneiss is a fine-grained, leucocratic granite which was intruded in thin, sill-like sheets as well as in cross-cutting, dike-like masses. So intricate is this intrusion of granite in gneiss that in many places it is difficult to distinguish between them, particularly where a flow structure has been developed in the granite. These relations suggest that the granite may have been intruded simultaneously with the folding. The metamorphic rocks appear to have been sediments, the alteration of which undoubtedly was affected materially by magmatic heat and magmatic additions. Related to the granites are aplites and pegmatite which cut both the granite and the gneiss in the form of numerous dikes, dikelets, and more irregular bodies. Both aplite and pegmatite are closely associated with the magnetite deposit at Iron Mountain. Magnetite commonly is a characteristic mineral in pegmatites of the Llano region.

Paleozoic Rocks

The oldest Paleozoic formation is the Riley formation (Bridge, Barnes, and Cloud, 1947) of Upper Cambrian age. This formation consists of three members which from oldest to youngest are (1) Hickory sandstone, (2) Cap Mountain limestone, and (3) Lion Mountain sandstone. The Hickory sandstone member locally is ferruginous, but the iron content is small, and this material cannot be considered iron ore. The glauconitic Lion Mountain sandstone member weathers to yield a siliceous hematite which is found on outcrops and as float. Pieces range in size from pebbles to boulders; they are mostly rounded and commonly are polished. Broken surfaces reveal numerous sand grains, and corneous brachiopods or fragments of fossils are almost always present in the hematite. This material is not sufficiently abundant to be of commercial value. The Riley formation is overlain by the Wilberns formation, which is divided into five members. From oldest to youngest the members are (1) Welge sandstone, (2) Morgan Creek limestone, (3) Point Peak shale, (4) San Saba limestone, and (5) Pedernales dolomite. These Cambrian units crop out in the vicinity of Iron Mountain and are shown on the map of that area (fig. 2).

Above the Cambrian strata are rocks of the Ellenburger group (Cloud, Barnes, and Bridge, 1945; Cloud and Barnes, 1948) of Lower Ordovician age. These formations, from oldest to youngest, are (1) Tanyard formation, (2) Gorman formation, and (3) Honeycut formation. Small deposits of limonite occur in limestones of the Ellenburger group in a fault zone bordering the eastern flank of the Riley Mountains. These gossan deposits are southeast of Llano and north of Click (fig. 1).

IRON ORES

General Description

The iron deposits of the Llano region are composed chiefly of magnetite with varying amounts of hematite which appears to be an alteration product of the magnetite. Hematite formed in this manner contains more or less residual magnetite and is called martite. The Gamble prospect in northeastern Mason County (fig. 1) is a martite deposit. With a few exceptions, notably the Olive mine prospect south of Lone Grove in eastern Llano County and the prospects along Willow Creek west of Llano, which are in the Packsaddle schist, the magnetite deposits are in the Valley Spring gneiss. The magnetite occurs in massive beds or lenses, in relatively thin layers, and also as granular grains disseminated in the gneiss. Quartz, feldspar, and biotite are the most common impurities. Pyrite in small quantities was noted in samples from a number of the localities. The ore on the old stock piles on the Olive mine property contains appreciable amounts of pyrrhotite. More detailed descriptions of the ore are given in the discussions of the localities.

Origin

Paige (1911, pp. 56–70) has shown that the banded character and the relations of the magnetite to the country rock indicate that the iron is syngenetic and of sedimentary derivation. All analyses available to Paige showed a relatively low content of phosphorus, averaging less than 0.10 percent. This chemical feature was puzzling to Paige, because ores of sedimentary origin generally contain appreciable amounts of phosphorus. Recent analyses show a considerable range in the content of phosphorus, and analyzed samples from Iron Mountain range from 0.022 to 0.99 percent P. The average P content for the deposit as a whole is 0.194 percent. It seems likely that igneous action in connection with the intrusion of granitic magma into the sedimentary series, which was metamorphosed to produce the Valley Spring gneiss and the Packsaddle schist, was more effective than held by Paige who placed primary stress on dynamic metamorphism. Locally the original iron content of the invaded materials probably was considerably redistributed and concentrated. In the Olive mine prospect, pyrrhotite was developed in the ore.

Description of Prospects

Iron Mountain

Location and access.—The Iron Mountain magnetite deposit is 12 miles northwest of Llano and 1 mile northwest of Valley Spring along the southwest side of the Llano-Brady road. The surface is owned by Mr. J. F. Parks of Valley Spring, and the mineral rights are owned by Mrs. T. B. Moss of Llano. Several thousand tons of magnetite ore produced by surface mining have been hauled by truck to Llano and shipped by railroad.

History.—The mine workings at Iron Mountain were under development at the time of Paige's (1911) work in this area in 1908 and 1909. Sketches of the surface outcrop and of the mine workings and ore body are given in Paige's description, and the results of diamond-drill prospecting on the property are summarized. Six holes appear to have been drilled, but commercial ore was found in none. Apparently no attempt was made to locate the deposit by magnetic survey prior to the drilling.

Geology.—Iron Mountain is a small knoll of Valley Spring gneiss preserved by the outcrop of resistant magnetite. In 1942 the outcrop was about 85 feet in length, 30 feet in width, and stood about 7 feet above the ground surface of the Valley Spring gneiss. Some ore was mined during the war, and in December 1946 a pit approximately 35 feet deep occupied the site of the former outcrop. The magnetite of the outcrop is massive, finely to coarsely granular, and appears to be relatively pure. There is a well-developed mineral alinement which pitches 22 degrees to the southeast. Except in a few test pits and in the walls of the mine workings, the Valley Spring gneiss is weathered and poorly exposed. Dikes of aplite and pegmatite cut the gneiss, and in one of the test pits at the southeastern end of the outcrop the magnetite is sharply bounded by aplite. The exposure is not large enough to permit determination of the size or attitude of the aplite dike. Approximately 1,000 feet south of the outcrop the Hickory sandstone member of the Riley formation of Upper Cambrian age is downthrown against the Valley Spring gneiss along an east-west

Sample No.	Sample length in feet	Average thickness of bed in feet	Weight percent Fe	P	SiO_2
17	9	6.5	56.78	------	------
18	15	11.0	48.24	------	------
19	8	5.0	40.97	0.10	34.47
20	12	7.0	37.58	------	------

Gravity observations. — The gravitational map (Pl. VII) corrected for the regional gradient shows two principal closures of the 0.60 milligal line, forming an anomalous figure which is long and narrow but not high or sharply defined. This indicates a diffused anomalous mass with no large dense concentrations. The northwest trend of the anomaly and the closer spacing of the equal force lines on the southwest side reflect the regional structure and the dip of the gneiss to the northeast. The gravity meter observations were made on a 100-foot grid using the dip-needle stations. In addition some lines across the prospect were observed at 50-foot intervals, and stations were established along lines away from the prospect for information on the regional gradient (Pl. VI).

Exploration.—The drilling on the Bader prospect shows that magnetite gneiss is common but that there is little high-grade material. It is probable that there is a reserve of about 1,000,000 tons of low-grade magnetite gneiss averaging about 15 percent iron. Five holes were drilled on the strongest dip-needle anomalies, and a trench approximately 175 feet long was excavated along a line that is essentially parallel with the Bader incline and about 50 feet southeast. The locations of four samples from this trench are shown in figure 6. Analyses of these samples by the Bureau of Mines (1944; Evans, 1947) are given in the table above.

The material sampled in the trench is of a higher grade than the samples recovered in the core drilling; see appendix (table 5). Descriptions of the cores are given in the appendix (table 2) and are shown graphically in Plate VIII.

GAMBLE PROSPECT

Location and access.—The Gamble prospect is on the G. W. Miller ranch in the northeast corner of Mason County, 3 miles southeast of Fredonia and about half a mile south of the San Saba County line (fig. 1). The Gamble pit is on a small ridge approximately 1,700 feet northeast of the Miller ranch house. Mineral rights are owned by Mrs. T. B. Moss of Llano. The ore mined to date has been hauled by truck to Llano.

History.—The Gamble prospect apparently was drilled by G. M. Wakefield at the time he drilled the Bader prospect in the 1890's. Old drill sites can be located approximately on the ground. A vertical hole was drilled on the outcrop, and five or six additional holes were drilled at points away from the outcrop and inclined toward the vertical drill hole. The results of this drilling could not be obtained.

Geology.—The Gamble ore is in the form of layers or lenses in the Valley Spring gneiss. The fine-grained, saccha-

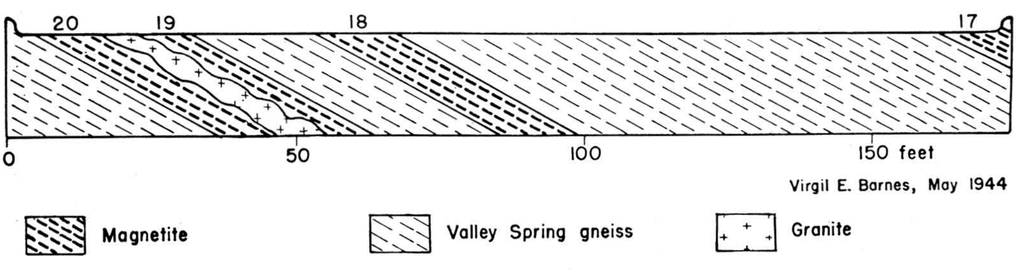


Figure 6. Sketch of U.S. Bureau of Mines trench showing location of samples, Bader prospect, Llano County, Texas.

roidal gneiss is banded with streaks composed of larger grains of muscovite and biotite. The gneiss crops out as an inlier in the Hickory sandstone member of the Riley formation of Upper Cambrian age and forms a hill about half a mile in length in a north-south direction with an average width of about one-fourth mile. The strike is N. 10° W., and the dip is variable. The ore-bearing gneiss appears to be a crumpled fold (fig. 7). The ore is granular, distinctly layered, and contains considerable amounts of mica and quartz. It crops out in a surface ledge from 1 to 12 feet thick over an area of approximately 1 acre. The pulverized material is red in color and only a small fraction can be picked up by a strong hand magnet, indicating a large proportion of hematite which was formed by alteration of magnetite. This material is referred to as martite.

Magnetic observations.—The magnetic anomalies found with the dip needle are small and rather formless (fig. 7). Because the ore exposed at the surface contains a large amount of hematite, the magnetic survey was not considered conclusive.

Gravity observations.—Results of the gravity-meter survey of the Gamble prospect clearly indicated that there is no possibility for an ore body. The force map (fig. 8) was not corrected for regional gradient, because the results did

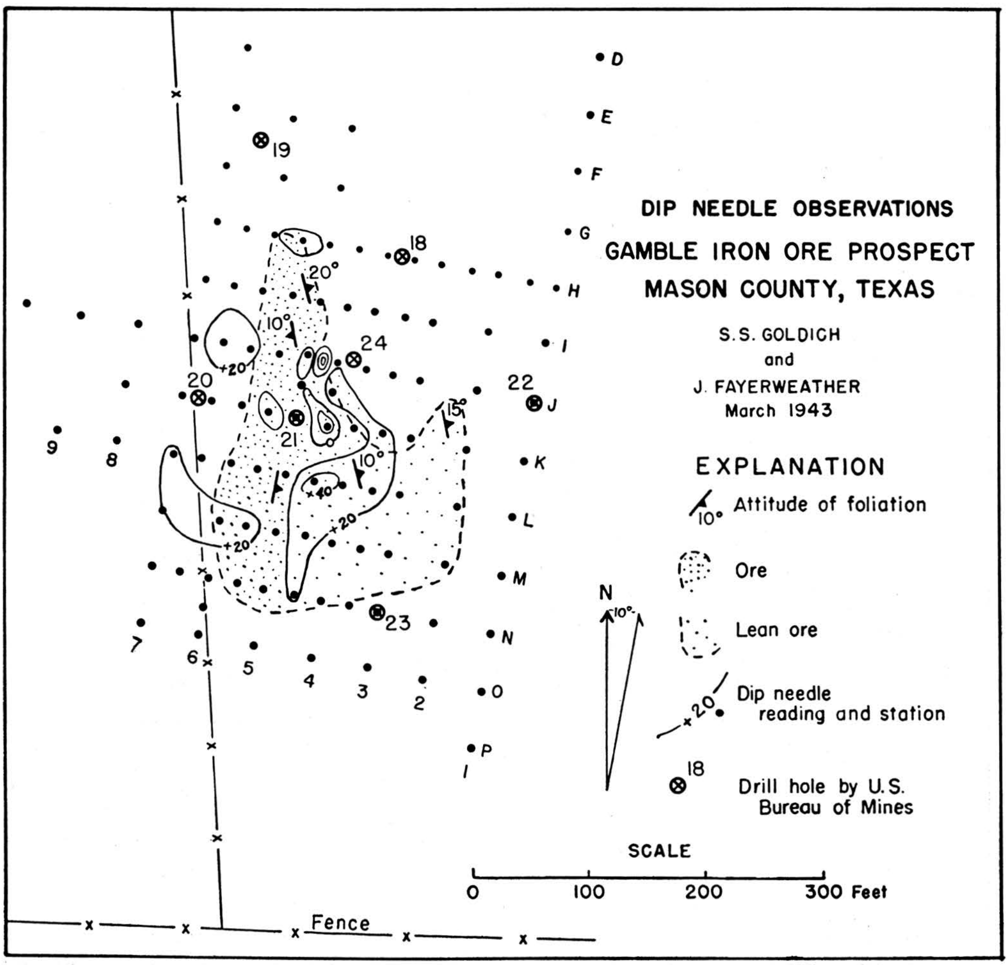


Figure 7. Dip-needle observations, Gamble iron-ore prospect, Mason County, Texas.

not warrant the expenditure of time necessary to establish the gradient.

Exploration.—The gravity-meter survey of the Gamble prospect was not available at the time recommendations were made for drilling, and as mining operations were being conducted at the Gamble, it was considered desirable to drill the prospect to check the inconclusive dip-needle surveys and to determine whether the surface operations could be expanded. Seven holes were drilled by the Bureau of Mines (fig. 7). The cores are de-

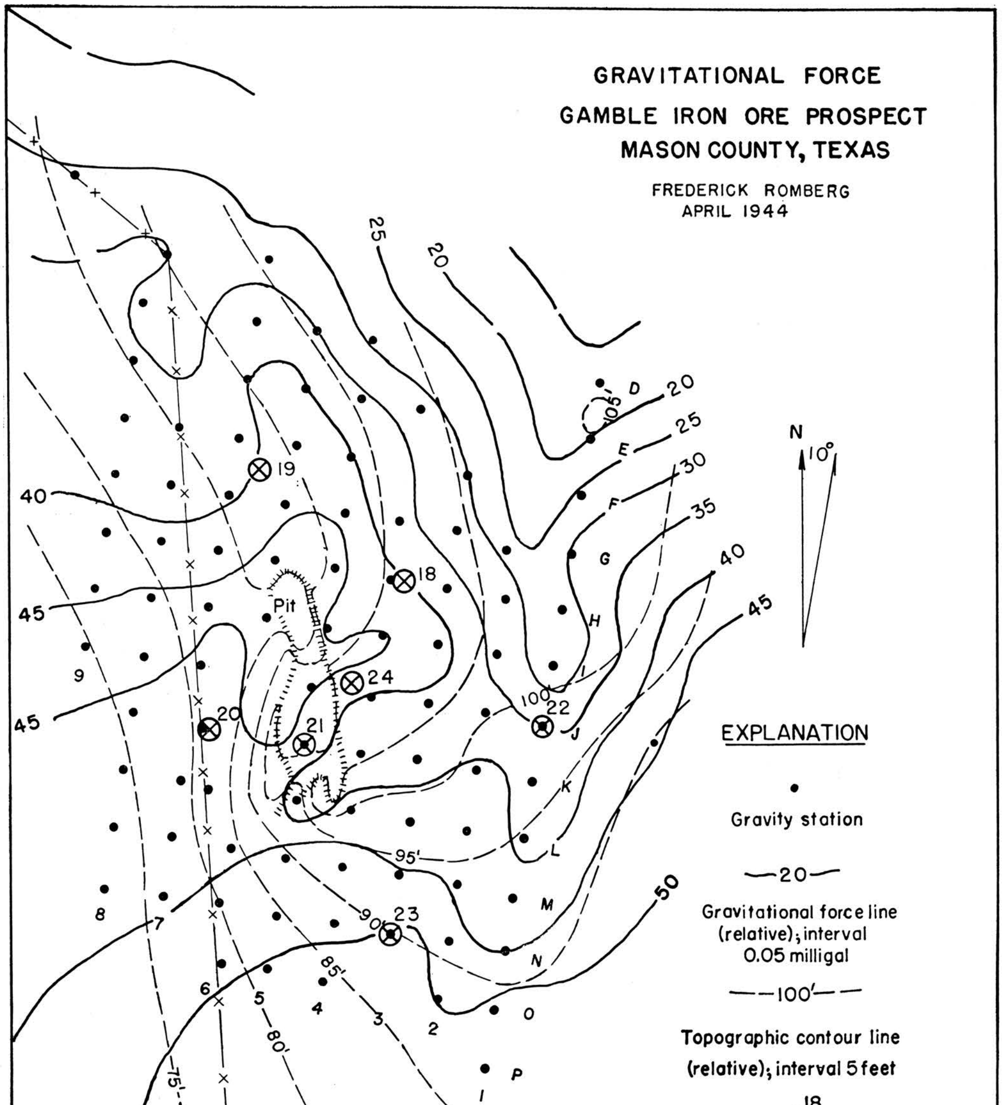


Figure 8. Gravitational force, Gamble iron-ore prospect, Mason County, Texas.

scribed in the appendix (table 3) and are shown graphically in Plate VIII. The drilling showed that no ore exists away from the outcrop or in depth, substantiating the findings of the gravity-meter survey. Four channel samples representative of the outcrop, taken and analysed by the Bureau of Mines (1944; Evans, 1947), averaged 43.64 percent iron. A typical sample contained 0.018 percent phosphorus and 36.52 percent silica. The only material worthy of analysis encountered by the drill was in hole No. 18 from 19½ to 22 feet in depth and contained 37.26 percent iron. The reserves in the Gamble prospect are limited to the surface outcrop, a large part of which has been mined. The ore remaining is to be measured in terms of a few hundred tons.

OLIVE MINE PROSPECT

Location and access.—The Olive mine prospect is just east of Little Llano River, 1 mile south of Lone Grove, and about 6 miles east of Llano (fig. 1). The property is on the ranch of the Fitzsimons Land and Cattle Company of San Antonio, Texas. The mineral rights are owned by the R. N. Downman estate of New Orleans, Louisiana, and the Fitzsimons Land and Cattle Company. At one time a spur connected the mine workings with the Texas and New Orleans Railroad about 1 mile to the south.

History.—The discovery of magnetite in a shallow excavation near the site of the Olive mine appears to have been accidental. The deposit was opened by an incline in about 1892. The incline was dug at a point northwest of Station E-19 (fig. 9) and carried to a depth of about 30 feet. It was continued in a drift which was driven southeast to a point near the location of the vertical shaft where the magnetite body was encountered. The shaft was sunk in 1892 or 1893 and was connected with the drift and incline. Crosscuts were driven on the ore at 50-, 100-, 150-, and 200-foot levels. An incline was made from the 200-foot level and encountered ore at a depth of 250 feet. With the exception of the uppermost crosscut which was driven to the northeast, the crosscuts and the lower incline all were driven toward Little Llano River. Spencer (*in* Paige, 1911, p. 30) reproduced an old sketch map of the workings, but this drawing appears to be in error, because it shows the discovery incline northeast instead of northwest of the vertical shaft as it is shown in figure 9. Both incline and shaft are situated on the east bank of the river about 25 feet above low-water level. The incline is collapsed and blocked, and the shaft, which is said to have been boarded over, is filled with debris to within 30 feet of the surface.

Geology.—The Olive mine prospect lies in a small sliver of the Packsaddle schist which is practically surrounded by granite. The discovery incline and the vertical shaft are both in the pre-Cambrian metamorphic rock in close proximity to a large granite mass. This granite extends from Little Llano River eastward beyond Colorado River, a distance of approximately 12 miles. The pink, coarse-grained granite is composed of alkalic feldspar, quartz, and biotite. Exposures of the rock are numerous in the bed of the river and generally show inclusions or schlieren of schist which were engulfed in the invading magma and incorporated in the granite in various stages of reaction and digestion. The Packsaddle schist in this area is composed of mica and hornblende schists, quartzite, and marble. The quartzite is exposed in a ridge on the east bank of the river just north of the shaft, but good exposures are best seen on the west side of the river southwest of the mine dump. The general geologic relations are shown on the geologic map by Spencer, Paige, and Kay (Paige, 1911). Spencer concluded that the Olive ore body strikes northeast and dips steeply to the northwest beneath Little Llano River. The schist exposed in the vertical shaft strikes about N. 60° W. and dips 45 degrees to the south-southwest. A short distance north of the shaft the regional strike is N. 20° W., and this change in strike may account for the bend in Little Llano River at this locality.

Much of the magnetite on the old stock piles is good clean massive ore; however, a considerable amount is banded with layers of silicate minerals, chiefly biotite and chlorite, and a part of the ore is rich in iron sulphide, pyrrhotite, which in many specimens is intergrown intimately with the magnetite. According to Mr. Pat Mayes, a resident of Lone Grove who visited the mine while it was in operation, the sulphide is abundant in the ore in the lower levels of the mine. Some of the pyrrhotite was analysed by Mr. J. J. Fahey of the U. S. Geological Survey and was found to contain no nickel.

Magnetic observations.—Magnetic observations over the Olive mine prospect show a small anomaly with sharply defined positive and negative poles near Station F-20 (fig. 9). Anomalous readings were obtained at other stations, but they are scattered and of small magnitude. Because of the uncertainty as to the location of the underground workings, it cannot be stated positively that the anomaly is caused by the magnetite body that was mined, although it is probable that this is so. The anomaly shown in figure

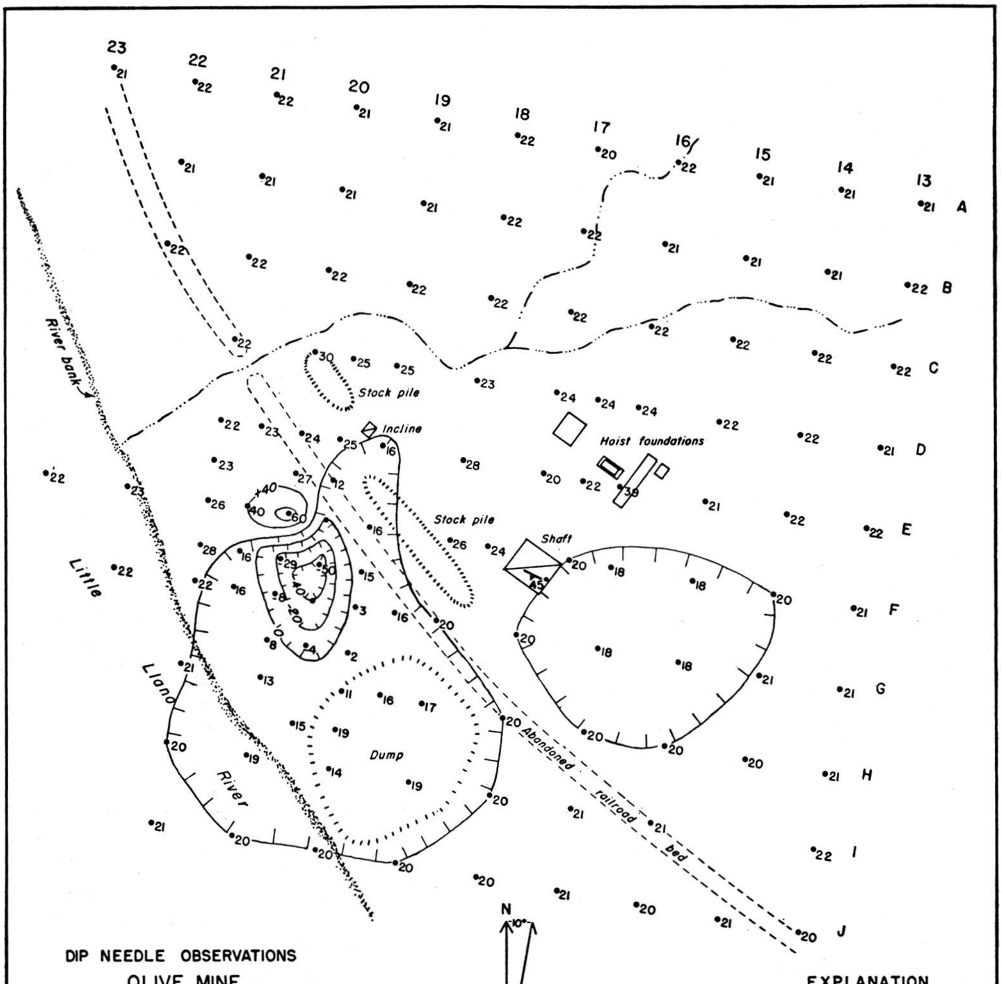


Figure 9. Dip-needle observations, Olive mine prospect, Llano County, Texas.

9 is considered to be caused by a small tabular body of magnetite oriented with its longest dimension northwest-southeast, plunging slightly to the southeast and dipping steeply to the southwest. The body is relatively small, and its mass is estimated to be of the order of a few thousand tons of magnetite.

Reserves.—Dip-needle observations on the Olive mine property and in the adjacent areas failed to reveal deposits of magnetite of notable size. The presence of the coarse-grained granite in the immediate vicinity surrounding the known deposit precludes the possibility of large bodies of magnetite being found and renders the area unfavorable for prospecting. The presence of pyrrhotite greatly reduces the desirability of the ore. Drilling on the property was not recommended. There are several hundred tons of magnetite in the old stock piles.

MINOR PROSPECTS

Besides the four main prospects described there are a large number of smaller prospects and showings. These prospects are located on the index map (fig. 1). Each has been inspected and tested with the dip needle so far as was practical.

Willow Creek area.—A number of magnetite occurrences along San Fernando and Willow creeks northwest of Llano were described by Spencer (*in* Paige, 1911) under the heading "Section Thirteen and Vicinity." The most important of the prospects is located about 1,000 feet southwest of the junction of San Fernando and Willow creeks on the property of Mr. August Otto. Mineral rights are controlled by the R. H. Downman estate. Spencer described two ore bands exposed by pits. A third band is indicated a few hundred feet to the east of the pits by a small but consistent magnetic anomaly. The magnetite-bearing Valley Spring gneiss strikes N. 10° W. and dips 25° E. The ore in the larger of the two pits consists of two 1-foot, massive beds containing about 20 percent of siliceous impurity. Feldspathic magnetite gneiss separates the ore beds. The anomalies over the ore bands are limited to narrow strips and can be traced on the ground for a distance of several hundred feet.

There are two pits west of the prospects just discussed and south of the fork in Willow Creek. The ore appears to be impure and is limited in amount.

To the north of Willow Creek there is still another pit in the Valley Spring gneiss. Magnetic anomalies of small magnitude are limited to an area of about 100 square feet.

About a mile west of San Fernando Creek on the property of Mr. Fritz Otto a number of showings are found. They are in the vicinity of the old Taylor house. Mineral rights are said to be owned by the R. H. Downman estate and by Mr. E. M. House of New York. The ore occurs in the Packsaddle schist and is distinctly banded with layers of dark, schistose, fine-grained rock. The bodies appear to be lenticular, and magnetic anomalies are small.

Secondary showings in the area include some magnetite float on the west bank of San Fernando Creek just south of the highway. A locality on the east side of the creek and north of the highway proved to be fossiliferous hematite float. Two localities indicated by Paige about 2 miles to the northeast could not be located.

Keyser Creek area.—About 4 miles south-southeast of Castell and along Keyser Creek in Mason County several martite prospects occur on the property of Mr. Edward Stein of Fredericksburg. They were described by Spencer under the heading "Keyser-Jones Tract." About 700 feet southeast of the old Judge Jones ranch house on this property is a small outcrop estimated to be about 100 feet long and 50 feet wide with a strike somewhat west of north. A pegmatite dike cuts off the ore to the west of the outcrop, and to the north massive felsic Valley Spring gneiss that contains no ore is exposed. The magnetic anomalies were limited to the area of the outcrop. Two additional showings occur 1,200 and 1,500 feet south and just west of the north-south fence line. They are both small. Float of martite ore appears to be relatively pure, but the unweathered material contains larger amounts of silicates. West of the ranch house there is an outcrop of ore in a meadow. This outcrop is about 30 feet long and 3 feet thick, but float and observed magnetic anomalies suggest that the ledge is somewhat longer.

Elm Creek area.—The deposits described by Spencer as the Elm Creek ores include several groups situated north and east of Castell along Elm Creek. Showings of ore are found over a considerable area, but most of them are highly siliceous. Ore on the property of Mr. Martin Kowierschky is a mixture of hematite and magnetite with from 20 to 50 percent quartz. The zone of ore-bearing gneiss is from 10 to 25 feet wide and was traced for a distance of about 800 feet.

On the C. C. Schneider property to the north and parallel to Elm Creek there are thin beds of magnetite in Valley Spring gneiss in a zone rarely more than a few feet wide. Although these showings extend over a considerable area, they are of no commercial value.

In the pasture northwest of Mr. Martin Ever's house, referred to as Schneider's pasture by Spencer, more of the same highly siliceous ore in the Valley Spring gneiss is found. The showing is in the form of poor exposures and float in an east-west band less than 200 feet in width and several hundred feet in length.

The localities indicated by Spencer to the west on the Schneider property showed a small amount of float and two outcrops of the same type of ore. Paige's map indicates still another prospect 1½ miles north of Castell, but only a little float could be found at this place.

Martin (Deep) Creek area.—North and west of Castell along Deep Creek, shown as Martin Creek on the county map, are three groups of magnetite showings on the property owned by members of the Tatsch family. The ores seem too siliceous to be of value. The best showing is located 800 feet northeast of Mr. Ben Tatsch's house just southeast of the bend in the creek (fig. 1). At this locality there are two deposits which are probably conformable with the Valley Spring gneiss which strikes northwest-southeast. The western body does not crop out but is marked by a small amount of float and can be traced continuously for a distance of over 400 feet with the dip needle. The ore-bearing zone probably does not exceed 25 feet in width. About 300 feet northeast of this zone is a second area marked by float and a single outcrop. The float and magnetic anomalies indicate that the area is several hundred feet square. The magnetite float probably does not contain more than 30 percent of quartz, feldspar, and mica. A small amount of sulphide was noted in one specimen.

North of the creek, inside the bend, there is some float of Cambrian hematite, but as granite crops out over the whole of the area, there is little possibility of ore being present in quantity. On the hillside 1,500 feet north of the bend and west of the creek there are at least 10 small outcrops, marked by accumulations of float ore, not more than 100 feet long and several feet wide. The ore is banded magnetite gneiss commonly containing about 30 percent magnetite but locally as much as 80 percent. These deposits appear to be lenses in the Valley Spring gneiss. They are limited in size and are too low grade to be of value. North of the Mason-Castell road and along the creek there are several showings of similar ore.

Northeastern Gillespie County.—In Gillespie County a prospect hole 800 feet east of Coal Creek along the northern edge of a large serpentine mass (Barnes, 1945, fig. 22) exposes 21 inches of blocky magnetite in a schistose rock within a few feet of the serpentine boundary. A dip-needle examination shows that the magnetite extends for only a few feet on each side of the test pit. No additional deposits were detected in the vicinity. A few magnetite schlieren seen in the big serpentine mass are of no commercial importance.

SHOWINGS

Iron ore showings are widespread in the Llano region. Many of them are small accumulations of float, a number of which are shown on the index map (fig. 1). These showings are of very minor importance, and generally a close but brief inspection of the locality together with a few dip-needle observations sufficed to demonstrate their small extent.

North of Llano.—The outcrops described by Paige as the Goodwin prospect 3 miles southwest of Babyhead lie on the Mary Freeman ranch and are located about 1 mile north of the ranch house. The ore is magnetite in Valley Spring gneiss.

Two old pits on the Parkhill ranch north of Llano and about 1 mile east by south of Horse Mountain reveal a small amount of magnetite in the gneiss.

The prospect mentioned by Paige as being 1 mile northwest of Miller Mountain was not found. A careful reconnaissance of this area, owned by Mr. T. K. Bush, showed no ore.

Some thin bands of magnetite in the Valley Spring gneiss were found on the southern slope of Miller Mountain on the property of Mr. J. F. Kuykendall. They have little significance.

Waters Creek area.—This showing is indicated on Paige's map as being 1 mile southwest of the junction of Waters Creek with the Llano River. The prospect lies on the Fitzsimons Land and Cattle Company ranch and was not visited.

South of Valley Spring.—The float mentioned by Spencer on the Lively tract about one-half mile south of Valley Spring was not derived from an outcrop that could be located in the immediate vicinity.

There are several small showings of magnetite in the Valley Spring gneiss described by Spencer as the Becton ore 3 miles southeast of Valley Spring.

Waddell property.—Three miles south of Pontotoc in Mason County on the property of Mr. E. L. Waddell a bed of magnetite and hematite in gneiss crops out on a hill about 1,000 feet northwest of the ranch house. The outcrop is 60 feet long. The gneiss is micaceous and resembles the gneiss on the Gamble property to the west.

RESIDUAL DEPOSITS

Garrett property.—Residual ores of two types occur in the Llano region. The first is illustrated by the deposit of limonite on the J. T. Garrett ranch 10 miles south of Llano and about 2 miles east of Oxford. The ore is a residual weathering product of sideritic layers in the pre-Cambrian marble of the Packsaddle schist. The band of limonite ranges from 20 to 50 feet in width and can be traced in a northwest-southeast direction for almost half a mile. The ore is shallow and limited in quantity. It contains abundant quartz and other siliceous impurities and is considered to have no value. Although the ore is reputed to be manganiferous, borax bead tests showed only faint traces of manganese. Black botryoidal goethite may have been confused with manganese oxides.

Riley Mountain area.—A great north-south fault brings the Paleozoic sedimentary rocks against the pre-Cambrian metamorphic series in the area north of Click. In the rocks of the Ellenburger group in the vicinity of Honey Creek there are a number of prospects located on veins which parallel the fault but lie from 50 to 100 feet west of the trace of the fault. Pyrite gossans on these veins were mined on the Robert ranch in 1909. According to Spencer the iron cap in the mine south of Honey Creek gave way to original sulphides, arsenical iron pyrites, within 20 feet of the surface. A careful search of the material on the dumps failed to reveal any of the original sulphides. During 1945 Mr. Bert P. Fischer of Houston investigated the possibilities of mining the iron oxides in this area. In this work he uncovered some of the sulphide, which appears to be marcasite. These deposits have little value as a source of iron.

SUMMARY and CONCLUSIONS

The magnetic iron ores in Llano and Mason counties of central Texas have been re-examined. The prospects occur in pre-Cambrian metamorphic rocks which are assigned to the Valley Spring gneiss and the Packsaddle schist. Preliminary field work was done with a dip needle, followed by surveys with a gravity meter and finally by diamond drilling. The main points of these investigations are briefly summarized as follows:

(1) Dip-needle surveys were made of four prospects which were considered most promising, namely, (1) Iron Mountain, (2) Bader, (3) Gamble, and (4) Olive mine.

(2) Well-defined magnetic anomalies over the Iron Mountain prospect indicated a magnetite deposit composed of two masses. Investigation with a gravity meter outlined the deposit. Diamond drilling and other exploration by the U. S. Bureau of Mines, as interpreted by Barnes, indicated a reserve of 65,000 long tons of ore. Earlier estimates of the Iron Mountain deposit from the gravity survey were of the same order of magnitude.

(3) The Bader prospect showed numerous magnetic anomalies in a strip approximately 250 feet in width and over 8,000 feet in length. This prospect was tested as the most promising of a large tonnage of low-grade ore suitable for magnetic concentration. However, drilling showed that the magnetite gneiss is cut by numerous intrusions of granite, aplite, and pegmatite, and the tenor of the ore is low. A gravity-meter survey indicated a diffused anomalous mass with no marked dense concentrations.

(4) The Gamble prospect consists of a surface outcrop of martite ore. Because of the large amount of hematite in the ore, the dip-needle survey was considered inconclusive. A gravity-meter survey completed just before the prospect was drilled indicated that the property was unpromising. This was confirmed by the drilling which showed no ore away from the outcrop or in depth.

(5) A well-defined magnetic anomaly was obtained over the Olive mine prospect, but because of the limited extent of the anomaly, this property was eliminated from further consideration.

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APPENDIX

Tables 1–3. Logs of Diamond-Drill Holes Llano and Mason Counties, Texas.

Brief descriptions of the diamond-drill cores are given in tables 1, 2, and 3, which follow. Mr. A. M. Evans of the U. S. Bureau of Mines described some of the cores from holes No. 9, 13, 14, 16, and 17, and these intervals are indicated by an asterisk. Elevations for the Iron Mountain drill holes were determined by Barnes and are referred to U.S.G.S. bench mark 1442.8 west of the prospect (fig. 2). Elevations for Bader drill holes were determined by the U. S. Bureau of Mines. For inclined drill holes on the Iron Mountain prospect, the direction of inclination given is that which Barnes determined by using an oriented plane table. The direction of inclination of holes on the Bader and Gamble prospects was determined by using a Brunton compass. The inclination of banding is given in degrees referred to the axis of the core. Specific gravity determinations were made in the field by Mr. A. M. Evans of the U. S. Bureau of Mines by determining the volume of the water displaced by the cores. An Alnico magnet was used to test cores for the presence of magnetite. The typical gneiss in the Iron Mountain and Bader prospects shows a more definite banding and is coarser in grain than the gneiss in the Gamble prospect. The gneiss is pink to reddish, dominantly felsic, and contains less than 5 percent of mafic or dark-colored minerals. The gneiss in the Gamble area locally contains appreciable quantities of muscovite.

TABLE 1. IRON MOUNTAIN

Depth in feet	*Recovery in inches*	*Description*	*Inclination of banding in degrees*
HOLE NO. 1			
Attitude: vertical			
Collar elevation: 1389.0 feet			
Ground elevation: 1388.0 feet			
0 –10.5	—	Three small pieces of martite and one of quartz	
10.5–16	40	25 inches gneiss; ¼ inch magnetite; 15 inches gneiss, banding indistinct	0–21
16 –22	58	Gneiss, banding indistinct; 7 inches pegmatite with 1-inch crystals of feldspar, quartz, mica	—
22 –27.5	40	Gneiss, banding indistinct	23
27.5–33	49	3 inches aplite; 46 inches gneiss, banding indistinct	20 and less
33 –41	49	Gneiss, banding indistinct	10–20
41 –46	56	As above	
46 –51	49	As above	
51 –57	48	As above	10–20
57 –62.5	61	As above	0–20
62.5–69	33	As above	
69 –71	13	7 inches gneiss; 2 inches hornblende schist with magnetite bands, 1/16 to ⅛ inch thick; 4 inches gneiss	0–25
71 –76.5	24	9 inches gneiss with 1/16-inch magnetite bands; 15 inches hornblende schist	10
76.5–78.5	17	Gneiss, banding indistinct; 1/16-inch magnetite at bottom	10
78.5–84	59	38 inches gneiss with about 10 percent magnetite in bands 1/16 inch thick; 21 inches gneiss	10–90
84 –89	60	Gneiss with minor magnetite	80
89 –94	60	As above	45–65
94 –99	60	13 inches gneiss, rare magnetite; 6 inches hornblende schist; 2 inches gneiss; 3 inches hornblende schist; 36 inches gneiss	10–45
99 –103	27	6 inches pegmatite; 10 inches gneiss; 1 inch pegmatite; ⅛ inch magnetite; 10 inches gneiss	10
103 –108	60	48 inches gneiss with thin magnetite streaks; 12 inches pegmatite; ¼ inch magnetite	10–25
108 –113	60	Gneiss with about 10 per cent magnetite in bands 1/16 inch thick; pegmatite 1 inch thick near middle cuts banding and is inclined 55 degrees	45–90
113 –118	52	Gneiss, reddish, altered in part to gray	10–55
118 –123	44	Gneiss, banding indistinct	10–45
123 –128	48	45 inches gneiss with indistinct banding; 3 inches pegmatite	
128 –134	11	Gneiss, banding indistinct	
134 –140	60	Gneiss, banding indistinct; two 2-inch pegmatite layers just below middle	
140 –145	57	Gneiss, banding indistinct	0–10
145 –150	32	29 inches gneiss with 3-inch pegmatite band near middle	
Total depth: 150.0 feet. Bottom in Valley Spring gneiss.			
HOLE NO. 2			
Attitude: inclined 45° N. 36° E.			
Collar elevation: 1391.6 feet			
Ground elevation: 1390.6 feet			
0 –14	3	Gneiss, banding indistinct	
14 –17	5	As above	
17 –21	18	As above	
21 –25	32	8 inches weathered hornblende(?) schist; 24 inches gneiss	45–50

Depth in feet	Recovery in inches	Description	Inclination of banding in degrees
25 –26	12	Gneiss, banding indistinct	
26 –28	20	As above	40
28 –31	36	As above	0–40
31 –37	21	As above	
37 –43	40	Gneiss, slightly weathered	0–10
43 –56	24	Gneiss	5
56 –60	27	11 inches gneiss, banding indistinct; 1 inch biotite schist; 2 inches pegmatite; 12 inches magetite with some feldspar and quartz	
60 –64	40	6 inches magnetite with some feldspar and quartz; 6 inches pegmatite; 13 inches magnetite with some feldspar and quartz; 15 inches magnetite with very little feldspar	
64 –65.7	6	Magnetite; ¼ inch feldspar	
65.7–69	24	Magnetite with small amount of feldspar	35
69 –71.7	22	As above	
71.7–73	16	As above	44
73 –76.4	22	As above	45
76.4–78	21	As above	37
78 –81	5	3 inches magnetite; 2 inches pegmatite; magnetite in sludge	
81 –83	22	2 inches pegmatite; 20 inches magnetite with very little feldspar	
83 –86	13	Magnetite with little feldspar	
86 –88.8	25	5 inches magnetite with little feldspar; 6 inches magnetite and feldspar about equal; 3 inches pegmatite; 11 inches magnetite with some feldspar	
88.8–91.3	20	Magnetite with very little feldspar	
91.3–93.8	9	As above	
93.8–96	0	Magnetite in sludge	
96 –99	22	1 inch magnetite; 12 inches pegmatite with some magnetite and biotite; 9 inches gneiss, banding indistinct	
99 –104	58	36 inches gneiss with indistinct banding; 22 inches hornblende schist containing two ½-inch pegmatites	
104 109.5	59	25 inches hornblende schist; 26 inches gneiss and pegmatite, mixed; 1½ inches magnetite; 6½ inches gneiss with magnetite in band, 1/16-inch to ¼ inch thick	50
109.5–114.5	57	6 inches gneiss with 1/16-inch layers of magnetite; 20 inches gneiss; 31 inches gneiss with bands of magnetite 1/16 to ½ inch thick	35–45
114.5–120	57	6 inches gneiss; 10 inches magnetite containing hornblende and feldspar; 10 inches gneiss with minor hornblende; 9 inches gneiss; 10 inches gneiss with minor magnetite; 12 inches hornblende-rich rock containing abundant feldspar and biotite	45–85
120 –125	58	Gneiss with closely spaced layers of magnetite 1/16 inch thick	
125 –127	15	As above	

Total depth: 127 feet. Bottom in Valley Spring gneiss.

HOLE NO. 3

Attitude: vertical
Collar elevation: 1389.6 feet
Ground elevation: 1388.6 feet

0 –5	14	Aplite; pegmatite; gneiss, weathered
5 –8	20	As above
8 –12	14	Gneiss, weathered, probably aplite in part
12 –15	12	As above
15 –21	6	Aplite (?)
21 –26	3	Aplite and hornblende schist
26 –29	2	Aplite (?)
29 –31	0	Magnetite in sludge
31 –32	8	Magnetite with minor feldspar
32 –34	15	As above

Depth in feet	Recovery in inches	Description	Inclination of banding in degrees
34 –39	59	50 inches magnetite with very little feldspar; 2 inches pegmatite; 7 inches magnetite	60 (?)
39 –44	60	Magnetite with some feldspar; indistinct banding	90 (?)
44 –49	60	As above	80–90
49 –54	33	Magnetite with some feldspar, indistinct banding	70 (?)
54 –58	47	As above	80 (?)
58 –63	60	36 inches magnetite with some feldspar; 24 inches magnetite, friable	80 (?)
63 –65.5	28	Pegmatite 75 percent; magnetite 25 percent	65–70
65.5–71	54	Magnetite with very little feldspar	20
71 –75	39	12 inches magnetite; 4 inches pegmatite; 6 inches gneiss with some magnetite; 2½ inches pegmatite; 14½ inches gneiss with magnetite layers 1/16 inch thick	45–65
75 –79	34	9 inches gneiss with magnetite bands 1/16 inch thick; 3 inches hornblende-mica rock; 9 inches magnetite with some feldspar; 10 inches gneiss with some magnetite; 3 inches magnetite	60
79 –84	31	Gneiss with bands of magnetite 1/16 to ½ inch thick	20–45
84 –89	55	13 inches magnetite with rare feldspar; 2 inches gneiss; 40 inches gneiss with magnetite in layers 1/16 to ½ inch thick	25
89 –94	39	Gneiss with bands of magnetite 1/16 inch thick	10–35
94 –99	27	As above	45–50

Total depth: 99 feet. Bottom in Valley Spring gneiss.

Hole No. 4

Attitude: vertical
Collar elevation: 1385.9
Ground elevation: 1384.9

0 –4	1	One piece of martite float	
4 –12	2	Gneiss, banding indistinct	
12 –14	6	As above	
14 –17	8	As above	
17 –19	8	As above	
19 –21	16	As above	
21 –23	18	As above	
23 –25	10	2 inches pegmatite; 8 inches gneiss, indistinct banding	
25 –27	14	Gneiss; poorly banded	
27 –30	26	5 inches gneiss, indistinct banding; 12 inches pegmatite; 5 inches gneiss; 1 inch pegmatite; 3 inches gneiss, indistinct banding	
30 –31.3	11	Gneiss, indistinct banding, cores when wet show thin stringers of pegmatitic material suggesting lit-par-lit injection	
31.3–32.5	18	As above	45
32.5–34	12	As above	60
34 –37	30	As above	
37 –41	32	As above	
41 –42.3	10	As above	
42.3–45	18	As above	
45 –46	8	As above	
46 –51	42	38 inches gneiss; 4 inches pegmatite	50–70
51 –56	60	Pegmatite	
56 –61.5	58	28 inches pegmatite; 20 inches aplite; 10 inches pegmatite; pegmatite grades into aplite	
61.5–66.5	47	6 inches pegmatite; 3 inches schistose hornblende, weathered; 35 inches gneiss with layers of martite ⅛ to ½ inch thick, weathered; 2 inches martite; 4 inches weathered gneiss	20–40
66.5–69	22	16 inches weathered gneiss; 6 inches aplite	
69 –72.8	15	2 inches pegmatite; 5 inches magnetite; 6 inches pegmatite; 2 inches magnetite; magnetite in sludge	
72.8–74.7	6	Pegmatite with some magnetite	
74.7–80.1	57	Magnetite with a little feldspar	

Depth in feet	*Recovery in inches*	*Description*	*Inclination of banding in degrees*
80.1–85.1	50	38 inches magnetite with very little feldspar; 12 inches gneiss with some magnetite; 4 inches magnetite with some feldspar; 6 inches gneiss with some magnetite	
85.1–90.3	55	Magnetite with very little feldspar	
90.3–95.3	60	27 inches magnetite; 28 inches gneiss with magnetite layers 1/16 to ¼ inch thick; 5 inches chlorite schist	10–40
95.3–101	59	21 inches chlorite schist; 20 inches pegmatite with lower 8 inches about ⅓ magnetite; 9 inches chlorite schist; 2 inches gneiss; 3 inches chlorite schist; 4 inches gneiss	50
101 –106.3	58	Gneiss with magnetite in 1/16-inch layers	60
106.3–112	60	Gneiss with magnetite in 1/16-inch layers and two 1-inch bands of chlorite in lower 6 inches	70

Total depth: 112 feet. Bottom in Valley Spring gneiss.

HOLE NO. 5
Attitude: vertical
Collar elevation: 1382.2 feet
Ground elevation: 1381.2 feet

0 –5	2	Martite float	
5 –10	8	Gneiss, indistinct banding	
10 –16	48	As above	
16 –17	5	As above with some pegmatite	
17 –20	36	6 inches gneiss; 24 inches pegmatite, 6 inches gneiss	
20 –27	38	Gneiss, indistinct banding	10–20
27 –29	6	As above	
29 –33	45	Gneiss, well banded	70
33 –38	60	Gneiss, good to indistinct banding	70
38 –40	24	Gneiss, indistinct banding	
40 –46	28	As above	
46 –47	0		
47 –53.5	58	Gneiss, indistinct banding	45
53.5–59	53	As above	60
59 –64	31	As above	
64 –67	23	As above	
67 –72	59	12 inches gneiss; 47 inches coarse-grained gneiss which may be igneous rock	
72 –75	21	Gneiss, indistinct banding	60
75 –79	33	As above	
79 –81	12	6 inches gneiss as above; 1 inch hornblende schist; 5 inches gneiss	
81 –83	16	Gneiss	60
83 –85.3	16	2 inches gneiss; 14 inches magnetite with some feldspar	40
85.3–90.5	60	Magnetite with some feldspar	
90.5–95.5	59	As above	
95.5–101	30	1 inch magnetite with some feldspar; 8 inches pegmatite; 20 inches gneiss; 1 inch magnetite (left ore at 95.5 and entered ore at 98.8)	
101 –107	55	Magnetite with some feldspar; 2 inches pegmatite in lower part	
107 –112	57	6 inches magnetite; 6 inches pegmatite with two ½-inch bands of magnetite; 29 inches magnetite with some feldspar; 2 inches pegmatite; 2 inches magnetite; 7 inches gneiss with magnetite layers 1/16 inch thick; 1 inch magnetite; 4 inches gneiss with magnetite bands	25–45
112 –117	56	37 inches gneiss with 1/16-inch layers of magnetite in upper part; 19 inches schistose hornblende feldspar rock	25–55
117 –122	58	20 inches gneiss, banded; 7 inches chlorite schist; 31 inches banded gneiss	45

Total depth: 122 feet. Bottom in Valley Spring gneiss.

HOLE NO. 6
Attitude: vertical
Collar elevation: 1378.4 feet
Ground elevation: 1377.4 feet

0 –10	4	2 inches gneiss; 2 inches martite float	

Depth in feet	Recovery in inches	Description	Inclination of banding in degrees
10 –12	5	Gneiss with indistinct banding	
12 –15	8	As above	
15 –17	4	As above	
17 –20	3	Hornblende schist; 1 piece gneiss	
20 –23	6	Gneiss, indistinct banding	
23 –24	12	As above	
24 –25	6	As above	
25 –25.5	3	As above	
25.5–27	6	Banded gneiss	25–30
27 –28	4	Gneiss, banding indistinct	
28 –29	12	As above	
29 –31	16	As above	
31 –32	12	As above	
32 –35	16	As above	
35 –35.5	6	As above	
35.5–37	8	As above	
37 –38.5	14	As above	
38.5–39.5	12	As above	
39.5–40	4	As above	
40 –46	23	As above	
46 –49	15	Gneiss, banded in lower part	45
49 –50	8	Banded gneiss	
50 –56	50	Gneiss, banding indistinct	
56 –61	55	As above	
61 –63	24	As above	30
63 –65	17	As above	
65 –70	26	As above	
70 –74	20	As above	
74 –80	45	As above	
80 –84	48	As above	
84 –86	20	As above	30
86 –89.3	33	5 inches gneiss with indistinct banding; 10 inches hornblende schist; 18 inches gneiss	30
89.3–94.7	60	Gneiss, banding indistinct	
94.7–100	46	4 inches gneiss: 3 inches schistose hornblende-feldspar rock; 8 inches gneiss; 3 inches magnetite; 13 inches gneiss; 12 inches biotite schist; 3 inches gneiss	
100 –105.3	57	35 inches gneiss; 22 inches magnetite with some biotite in upper 6 inches and considerable feldspar in lower part	25–30
105.3–110.7	59	10 inches magnetite with considerable feldspar; 49 inches magnetite with minor feldspar	30
110.7–115.9	44	7 inches pegmatite containing about 25 percent magnetite; 4 inches magnetite; 4 inches pegmatite, about 30 percent magnetite; 29 inches magnetite with minor feldspar	
115.9–121.7	46	25 inches magnetite with minor feldspar; 21 inches chlorite schist with 2 inches pegmatite near middle	
121.7–127	14	10 inches pegmatite; 4 inches gneiss	
127 –133	59	Gneiss with some bands of magnetite 1/16 to ⅛ inch thick in upper part	10–20
133 –139	47	Gneiss with bands of magnetite 1/16 inch thick in upper 6 inches	20–30

Total depth: 139 feet. Bottom in Valley Spring gneiss.

HOLE No. 7
Attitude: inclined 45° N. 42° W.
Collar elevation: 1391.9 feet
Ground elevation: 1390.9 feet

0 –5	0		
5 –12	0		
12 –16	14	Weathered gneiss	45
16 –17	6	Aplite	
17 –23	3	Aplite	
23 –26	4	Aplite	
26 –27	7	Aplite	

Depth in feet	Recovery in inches	Description	Inclination of banding in degrees
27 -28	8	Aplite	
28 -31	4	Aplite	
31 -37	5	Aplite	
37 -41	3	Aplite	
41 -45	27	Magnetite with some feldspar	
45 -49	18	12 inches magnetite with some feldspar; 6 inches gneiss	
49 -54	18	12 inches pegmatite with minor magnetite; 6 inches gneiss	
54 -56.7	6	Magnetite	
56.7-60	27	14 inches magnetite; 8 inches pegmatite; 4 inches magnetite; 1 inch pegmatite	
60 -65.8	0	Sludge shows 18 inches pegmatite; remainder magnetite	
65.8-68	18	Pegmatite	
68 -73	0	Magnetite in sludge	
73 -78	18	17 inches magnetite; 1 inch pegmatite	
78 -84	60	Gneiss with thin bands of magnetite	70
84 -91	40	As above	60-70
91 -96	42	Gneiss	30-40
96 -102	45	9 inches hornblende schist; 36 inches gneiss, banding indistinct	45
102 -108	55	25 inches gneiss; 3 inches chlorite schist; 2 inches gneiss; 25 inches crumpled chlorite schist	
108 -114	23	11 inches gneiss; 6 inches chlorite schist; 6 inches gneiss	
114 -116	3	Gneiss	
116 -122	51	Gneiss	
122 -127	41	Gneiss with 1 inch chlorite schist in upper part	22
127 -130	6	Gneiss	

Total depth: 130 feet. Bottom in Valley Spring gneiss.

HOLE NO. 8

Attitude: inclined 60° N. 48° E.
Collar elevation: 1380.3 feet
Ground elevation: 1379.3 feet

0 -15.5	0	
15.5-16	2	Pegmatite
16 -19	1	Pegmatite
19 -26	6	Pegmatite
26 -31	10	Pegmatite and gneiss
31 -33	10	As above
33 -33.5	6	Gneiss
33.5-34.5	8	Gneiss
34.5-36	18	Gneiss, some hornblende crystals
36 -37.3	15	As above
37.3-40	30	As above
40 -43	21	Hornblende schist
43 -45	16	11 inches hornblende schist; 5 inches gneiss, banding indistinct
45 -47	17	Gneiss, banding indistinct
47 -47.5	6	As above
47.5-50	20	As above
50 -50.9	9	As above
50.9-51.5	7	As above
51.5-56	34	As above
56 -57	10	As above
57 -58.5	20	As above
58.5-59.5	12	As above
59.5-61	12	As above
61 -62	10	As above
62 -63.5	9	As above
63.5-65	0	
65 -71	39	Gneiss, banding indistinct
71 -74	25	As above
74 -79	36	As above
79 -83	12	Gneiss with hornblende schist stringers
83 -85.5	18	As above

Depth in feet	*Recovery in inches*	*Description*	*Inclination of banding in degrees*
85.5–90	19	3 inches hornblende schist; 16 inches gneiss	
90 –95.5	53	Gneiss	
95.5–101	57	40 inches gneiss; 7 inches hornblende schist; 10 inches gneiss	
101 –106.3	53	Gneiss	
106.3–109.2	21	Gneiss	
109.2–113	30	20 inches gneiss; 8 inches hornblende schist; 2 inches gneiss	
113 –114	6	Gneiss	
114 –119.6	48	5 inches gneiss; 22 inches hornblende schist; 10 inches gneiss; 3 inches hornblende schist; 8 inches gneiss	
119.6–124.3	42	9 inches pegmatite; 33 inches gneiss	
124.3–126	13	Gneiss	
126 –130.5	37	Gneiss	
130.5–132	15	Gneiss	
132 –135	23	Gneiss	
135 –136.5	3	Gneiss	
136.5–141.5	18	Gneiss	
141.5–145	36	Gneiss	
145 –149	31	5 inches pegmatite; 26 inches gneiss	
149 –150.3	11	Gneiss	
150.3–154.5	22	Gneiss	
154.5–158.5	13	Gneiss	
158.5–163	44	16 inches magnetite with abundant feldspar; 4 inches pegmatite; 12 inches magnetite with abundant feldspar; 12 inches gneiss and chlorite schist with little magnetite	
163 –168.3	30	3 inches magnetite; 24 inches chlorite schist; 3 inches magnetite	
168.3–171	14	Gneiss with magnetite bands 1/16 inch thick	
171 –178	51	15 inches gneiss; 36 inches pegmatite	
178 –183.6	53	Gneiss	
183.6–190	54	6 inches pegmatite; 48 inches gneiss	
190 –196	46	18 inches pegmatite; 18 inches chlorite schist; 4 inches pegmatite; 6 inches gneiss	

Total depth: 196 feet. Bottom in Valley Spring gneiss.

HOLE No. 9

Attitude: 45° N. 48° E.
Collar elevation: 1389.8 feet
Ground elevation: 1388.8 feet

0 –6	0	
6 –19	6	Hornblende schist
19 –22	4	Hornblende schist
22 –26	6	Hornblende schist
26 –35	4	Pegmatite
35 –51	9	Pegmatite and hornblende schist
51 –53	7	Hornblende schist
53 –56	15	Gneiss
56 –59.5	21	Gneiss
59.5–64.5	45	Gneiss
64.5–67	22	Gneiss
67 –69	10	Gneiss
69 –70	3	Gneiss
70 –71	6	Gneiss
71 –72.5	13	Gneiss
72.5–75	19	Gneiss
75 –78.5	21	Gneiss
78.5–84	23	Gneiss
84 –84.6	6	Gneiss
84.6–86	2	Gneiss
86 –89	10	Gneiss with 3 inches pegmatite in lower part
89 –90.3	6	Gneiss
90.3–92.3	15	Gneiss

Depth in feet	Recovery in inches	Description	Inclination of banding in degrees
* 92.3–97.8	56	9 inches magnetite; 2 inches gneiss; 31 inches magnetite; 3 inches magnetite and pegmatite; 21 inches magnetite, sp. gr., 4.53	
* 97.8–103.3	30	5 inches gneiss with some magnetite; 24 inches magnetite; 1 inch pegmatite; sp. gr. of 30-inch core, 4.20	
*103.3–108.2	52	Magnetite, sp. gr., 4.47; 12 inches gneiss and pegmatite	
*108.2–111.4	26	Gneiss and pegmatite; average sp. gr., including 12 inches of gneiss and pegmatite from interval above, 2.6	
*111.4–116	41	Pegmatite, magnetite, and chlorite schist; 6 inches magnetite, sp. gr., 3.16	
*116 –121.7	16	Magnetite, sp. gr., 4.9	
*121.7–127.7	36	23 inches magnetite; 11 inches gneiss; 3 inches magnetite; sp. gr. of core, 4.1	
*127.7–133.2	44	22 inches gneiss; 22 inches magnetite, sp. gr., 3.95	
*133.2–140	61	11 inches magnetite; 38 inches magnetite with considerable pegmatite; 12 inches magnetite; sp. gr., 3.84	
140 –146	40	Gneiss with a few thin streaks of magnetite	
146 –151	?	Gneiss	

Total depth: 151 feet. Bottom in Valley Spring gneiss.
Mean specific gravity for interval 92.3–140 feet: 4.08.

Hole No. 10

Attitude: inclined 75° N. 48° E.
Collar elevation: 1389.8 feet
Ground elevation: 1388.8 feet

0 –12	2	Gneiss
12 –15	2	Gneiss
15 –20	0	
20 –25	0	
25 –31	8	Gneiss and hornblende schist
31 –35	23	Hornblende schist
35 –41	12	Hornblende schist and gneiss
41 –46	27	Gneiss
46 –51	23	Gneiss
51 –55	22	Gneiss
55 –57	13	Gneiss with some pegmatite
57 –60	12	Gneiss
60 –62	20	Gneiss
62 –66	10	Gneiss
66 –68.5	15	Gneiss with some hornblende schist
68.5–72	18	Gneiss
72 –75	29	Gneiss
75 –78	26	Gneiss with some pegmatite
78 –79.5	8	Gneiss
79.5–82	22	Gneiss
82 –84	15	Gneiss
84 –89.5	50	Gneiss
89.5–95.7	26	Gneiss with hornblende schist in lower part
95.7–100	21	As above
100 –102	14	Gneiss with hornblende schist in upper part
102 –105	34	Gneiss with minor chlorite schist
105 –110	56	Gneiss with 3 inches pegmatite in lower part
110 –113	24	Gneiss, 4 inches pegmatite in upper part
113 –116	18	Gneiss; some hornblende schist
116 –120.7	38	Hornblende schist; 8 inches pegmatite; gneiss; hornblende schist in lower part
120.7–126	34	Gneiss with hornblende schist in upper part
126 –132	30	Gneiss with pegmatite near middle
132 –135	12	Gneiss
135 –136.6	12	Gneiss
136.6–139.5	24	Gneiss
139.5–144.5	34	Gneiss with pegmatite in lower part
144.5–145.5	4	Gneiss
145.5–146.8	12	Hornblende schist

Depth in feet	*Recovery in inches*	*Description*	*Inclination of banding in degrees*
146.8–152	15	Pegmatite	
152 –155	8	Pegmatite and gneiss	
155 –159	12	As above	

Total depth: 159 feet. Bottom in Valley Spring gneiss.

HOLE No. 11

Attitude: inclined 45° N. 32° E.
Collar elevation: 1398.0 feet
Ground elevation: 1397.0 feet

0 –10	2	Gneiss	
10 –16	2	Gneiss	
16 –19	4	Gneiss and pegmatite	
19 –23	9	As above	
23 –28	4	Gneiss	
28 –31	0		
31 –36	2	Gneiss	
36 –40	8	Hornblende schist and gneiss	
40 –46	11	Gneiss	
46 –49	13	Gneiss	
49 –51	17	Gneiss	
51 –52	8	Gneiss	
52 –54	19	Gneiss	
54 –56	19	Gneiss	
56 –58	10	Gneiss and pegmatite	
58 –60	10	Gneiss	
60 –61.5	17	Gneiss	
61.5–64.5	26	Gneiss	
64.5–69	40	Gneiss	
69 –73	25	Gneiss	
73 –74.8	20	Gneiss	
74.8–76.8	15	Gneiss	
76.8–82	52	Gneiss	
82 –85	25	Gneiss	
85 –86.5	13	Gneiss	
86.5–92	13	Gneiss with two stringers of pegmatite	
92 –97	36	Chlorite schist and gneiss	
97 –101	15	Gneiss	

Total depth: 101 feet. Bottom in Valley Spring gneiss.

HOLE No. 12

Attitude: vertical
Collar elevation: 1373.5 feet
Ground elevation: 1372.5 feet

0 –10	0		
10 –16	0		
16 –21	26	Weathered gneiss	
21 –25.5	35	Gneiss	
25.5–27	13	Gneiss	
27 –29	17	Gneiss	
29 –31	19	Gneiss	
31 –31.5	6	Gneiss	
31.5–33	18	Gneiss	
33 –34	6	Gneiss	
34 –39	21	Gneiss	
39 –44	46	7 inches gneiss; 3 inches pegmatite; 16 inches gneiss; 3 inches gneiss with magnetite spots and layers ¼ to ½ inch thick; 6 inches gneiss; 3 inches pegmatite; 8 inches gneiss	
44 –49	11	3 inches gneiss; 4 inches chlorite schist; 4 inches gneiss	
49 –54	27	21 inches gneiss; 4 inches pegmatite; 2 inches gneiss	
54 –59	29	Gneiss	
59 –64.9	58	19 inches gneiss; 2 inches pegmatite; 6 inches gneiss; 4 inches pegmatite; 9 inches gneiss; 1 inch pegmatite; 10 inches gneiss; 5 inches pegmatite; 2 inches gneiss........	45

Depth in feet	*Recovery in inches*	*Description*	*Inclination of banding in degrees*
64.9–68	34	Gneiss	
68 –72	43	34 inches gneiss; 9 inches pegmatite	
72 –77	59	6 inches pegmatite; 53 inches gneiss	
77 –80.5	48	Gneiss	
80.5–86	57	5 inches gneiss; 32 inches chlorite schist; 19 inches gneiss; 1 inch chlorite schist	
86 –91	43	20 inches gneiss; 6 inches chlorite schist; 17 inches gneiss	
91 –93	24	Gneiss	
93 –99	45	25 inches gneiss; 10 inches chlorite schist; 10 inches gneiss	
99 –103.5	54	Gneiss	40–45
103.5–107	45	Gneiss	
107 –112	60	Gneiss	
112 –116.2	41	27 inches gneiss; 3 inches hornblende schist; 5 inches gneiss; 2 inches hornblende schist; 1 inch magnetite; 4 inches chlorite gneiss; 2 inches hornblende schist; 1 inch gneiss; 1 inch hornblende schist; 2 inches gneiss	
121.7–125.5	53	2 inches gneiss; 12 inches magnetite with some schist; 1 inch chlorite schist; 1 inch magnetite; 4 inches chlorite schist; ¾ inch magnetite; 2 inches chlorite schist; ¼ inch magnetite; 2½ inches chlorite schist; ½ inch magnetite; 2½ inches chlorite schist; ½ inch magnetite; 2 inches hornblende schist; 2 inches pegmatite; 17 inches hornblende schist; 3 inches gneiss	40
125.5–127.5	18	Gneiss	
127.5–129	13	Gneiss	
129 –131.5	21	Gneiss	
131.5–132.3	5	Gneiss	
132.3–137	23	Gneiss	

Total depth: 137 feet. Bottom in Valley Spring gneiss.

TABLE 2. BADER PROSPECT

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
HOLE No. 13 Attitude: vertical Collar elevation: 994 feet Ground elevation: ?				
0 –7	5	Iron-ore fragments, float	4.57	
7 –9	9	1 inch hornblende schist; 1 inch magnetite; 3 inches aplite and pegmatite	3.32	
9 –11	6	Aplite and pegmatite	2.54	
11 –13	2	Weathered gneiss	2.54	
13 –18	3	Weathered gneiss	2.41 (?)	
18 –23	14	Weathered gneiss	2.65	
23 –26	2	Weathered gneiss	-----	
26 –31	20	Gneiss with numerous magnetite bands 1/16 to 1/32 inch thick	3.02	30
31 –36	33	16 inches magnetite; 2 inches gneiss with about 50 percent magnetite; 2 inches gneiss; 2 inches magnetite; 11 inches gneiss with magnetite bands 1/16 to ¼ inch thick	3.93	30–40
36 –40	27	Gneiss, numerous magnetite bands 1/16 to 1/32 inch thick and some ¼ inch thick	3.02	33
40 –45	28	Gneiss, numerous magnetite bands 1/32 to 1/16 inch thick	2.81	33
45 –46	4	As above	2.81	
46 –51	56	As above	2.74	
51 –56	34	13 inches gneiss with many magnetite bands 1/32 to 1/16 inch thick; 4 inches hornblende schist; 17 inches pegmatite	2.66	45

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
56 -63	56	1 inch pegmatite; 33 inches gneiss with thin magnetite and hornblende (?) layers; 4 inches pegmatite; dip 33°; 8 inches gneiss and hornblende schist; 10 inches gneiss	2.78	
63 -66	1	Gneiss	—	
66 -71	48	31 inches gneiss with many bands of magnetite 1/32 to 1/16 inch thick; 2 inches pegmatite; 8 inches gneiss with thin magnetite bands; 3 inches aplite; 4 inches gneiss with many magnetite bands 1/32 to 1/16 inch thick	2.90	33
71 -76	15	3 inches aplite; 11 inches gneiss, many magnetite bands 1/32 to 1/16 inch thick; 1 inch aplite	2.79	
76 -77.7	10	Aplite	—	
77.7-80.2	22	Gneiss, several magnetite bands 1/32 to 1/16 inch thick	2.75	33
80.2-83.8	19	Aplite	2.54	
83.8-86	25	Aplite	2.55	
86 -87.2	1	Aplite	—	
87.2-89	17	Aplite	2.60	
89 -93.8	41	Aplite	2.58	
93.8-96.5	34	Aplite	2.60	
96.5-100.2	37	Aplite	2.56	
100.2-102	20	Aplite	2.50 (?)	
102 -103.9	17	Aplite	2.71	
103.9-106.8	15	Aplite	—	
106.8-109.7	22	Gneiss with magnetite bands 1/32 to 1/16 inch thick		30
109.7-111	9	As above		34
111 -112.2	2	As above		
112.2-117.3	59	1 inch pegmatite; 58 inches gneiss with 1/16-inch thick bands of hornblende, minor magnetite, rare pyrite		35
117.3-120.2	35	Gneiss, stringers of magnetite		36
120.2-123.4	35	Gneiss, some hornblende, very thin magnetite bands		36
123.4-128.4	60	As above, but more magnetite		30
128.4-133.4	42	As above; 1 magnetite band ¾ inch thick		35
133.4-137.4	40	5 inches aplite; 14 inches gneiss with about 20 percent magnetite; 4 inches aplite; 17 inches gneiss, some magnetite		0-45
137.4-140	28	22 inches gneiss, some magnetite; 6 inches hornblende schist		10
140 -141	3	Mylonite		
141 -145	17	4 inches gneiss; 10 inches hornblende schist; 3 inches pegmatite		20
*145 -149.5	42	Gneiss with some magnetite		
*149.5-155	60	As above		
*155 -159.3	46	As above		
159.3-162.2	33	Gneiss, small amount of magnetite		15-30
162.2-163.8	16	7 inches gneiss, minor magnetite; 7 inches aplite; 2 inches gneiss, minor magnetite		20
163.8-165.7	17	5 inches gneiss; 4 inches hornblende schist; 8 inches pegmatite		35
165.7-167.7	8	2 inches pegmatite; 6 inches aplite		
167.7-169.8	2	Aplite		
169.8-172.8	21	6 inches aplite; 13 inches gneiss, minor magnetite		25
172.8-176.3	26	12 inches aplite; 14 inches gneiss, some magnetite		20
176.3-178.7	19	11 inches gneiss, some magnetite; 2 inches pegmatite; 4 inches gneiss, some magnetite; 2 inches aplite		20
178.7-181	4	3 inches gneiss, some magnetite; 1 inch aplite		

Depth in feet	Recovery in inches	Description	Specific gravity	Inclination of banding in degrees
181 –181.3	2	Pegmatite		
181.3–182	0			
182 –184	22	Aplite		
184 –188.8	56	8 inches aplite; 48 inches gneiss, some hornblende, rare magnetite		35
188.8–190.2	14	9 inches gneiss, minor magnetite; 5 inches pegmatite		35
190.2–191.2	6	3 inches gneiss; 3 inches aplite		
191.2–193.7	20	1 inch aplite; 3 inches gneiss and hornblende; 12 inches aplite; 4 inches hornblende schist		
193.7–198	46	6 inches gneiss, minor magnetite; 4 inches hornblende schist; 32 inches gneiss, rare magnetite; 4 inches aplite		30
198 –200.7	28	Aplite or fine-grained gneiss; no magnetite		
200.7–206.3	45	25 inches gneiss, trace magnetite; 10 inches aplite; 10 inches gneiss		30
206.3–211	31	Gneiss, very little magnetite		25–45
211 –216	59	8 inches aplite; 12 inches gneiss (?); 8 inches hornblende schist; 21 inches gneiss, no magnetite		

Total depth: 216 feet. Bottom in Valley Spring gneiss.

HOLE NO. 14
Attitude: vertical
Collar elevation: 985 feet
Ground elevation: ?

Depth in feet	Recovery in inches	Description	Specific gravity	Inclination of banding in degrees
0 –7	2	Weathered gneiss	—	
7 –10	4	Weathered gneiss	2.54	
10 –14	2	Weathered gneiss	—	
14 –16	10	Weathered gneiss	2.60	
16 –18	2	Weathered gneiss	—	
18 –21	14	6 inches pegmatite; 8 inches weathered gneiss	2.64	
21 –24.2	9	Weathered gneiss	2.78	
24.2–28.7	3	Magnetite (black sludge)	4.15	
28.7–30.6	1	2 small pieces magnetite schist; 1 small piece pegmatite (black sludge)		
30.6–35.5	7	Magnetite; magnetite schist and pegmatite	3.39	
35.5–38.2	11	4 inches magnetite schist; 7 inches gneiss or aplite	2.90	45
38.2–41	11	Aplite, or possibly gneiss	2.64	
41 –44	9	Aplite	2.58	
44 –46	5	Aplite	2.56	
46 –49	32	Aplite or gneiss; 1 inch biotite schist near bottom	2.65	
49 –49.5	5	Gneiss or aplite	2.64	
49.5–51	3	Gneiss or aplite	2.66	
51 –55	21	Aplite or pegmatite, some magnetite grading into gneiss with bands of magnetite and chlorite schist	2.78	30
55 –57	8	4 inches pegmatite or aplite with about 25 percent magnetite; banded gneiss	2.81	
57 –61	29	Gneiss, in part banded	2.72	10–30
61 –62	3	Gneiss	2.54	
62 –65	21	Pegmatite, in part brecciated, about 20 percent magnetite	3.21	
65 –66.8	12	Aplite	2.55	
66.8–69	10	Gneiss with about 20 percent magnetite in spoltches and bands	3.12	
69 –73.2	26	As above, but about 50 percent magnetite	3.42	
73.2–74.4	5	Gneiss and pegmatite	2.63	15
74.4–77	3	Pegmatite	2.58	
77 –78.3	12	Gneiss, thin bands hornblende schist	2.61	10
78.3–79.5	10	Gneiss, abundant hornblende, approaching hornblende schist	2.64	20

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
79.5–81.8	26	Hornblende schist grading downward to gneiss	2.76	33
81.8–85.8	24	8 inches aplite; 13 inches gneiss; trace magnetite; 3 inches pegmatite	2.71	35
85.8–90	27	Aplite	2.63	
90 –94	26	Aplite	2.62	
94 –96	10	Aplite	2.63	
96 –100.8	13	Aplite; a few fragments of gneiss	2.66	
100.8–104	4	Aplite	2.56	
104 –108	5	Aplite		
108 –112	14	7 inches hornblendic gneiss; 7 inches pegmatite		
112 –113	7	Aplite		
113 –115	10	Aplite		
115 –115.7	9	Aplite		
115.7–117	14	Aplite		
117 –118	3	Aplite		
118 –119.7	15	Aplite		
119.7–122.5	12	Aplite		
122.5–124	7	Aplite		
124 –126.5	18	15 inches aplite; 3 inches gneiss		
126.5–127.5	5	Aplite		
127.5–128.1	9	Aplite		
128.1–129.8	19	13 inches aplite; 2 inches gneiss; 4 inches aplite		50
129.8–131.8	23	Hornblende gneiss; trace magnetite		40
131.8–133.7	13	As above		
133.7–138	44	As above		
138 –143	57	4 inches hornblendic gneiss, trace of magnetite; 2 inches pegmatite; 35 inches gneiss with abundant hornblende and trace magnetite; 6 inches pegmatite; 8 inches hornblende gneiss, trace magnetite; 2 inches pegmatite		
143 –145	20	Pegmatite; some gneiss		
*145 –146 *146 –147 *147 –151	56	Gneiss with some magnetite		
151				

Total depth: 151 feet. Bottom in Valley Spring gneiss.

Hole No. 15

Attitude: inclined 60° S. 63° W.
Collar elevation: 992 feet
Ground elevation: ?

0 –11	2	Aplite		
11 –16	5	Aplite		
16 –24.7	3	Aplite, some gneiss		
24.7–26	3	Gneiss	2.84	
26 –28.7	4	Gneiss and pegmatite	2.75	
28.7–31.7	23	Gneiss	2.69	0–5
31.7–34.7	23	Gneiss	2.64	0–5
34.7–35.6	8	Gneiss	2.64	
35.6–40	42	Gneiss	2.67	10–15
40 –43	23	Gneiss with ½ inch hornblende schist 6 inches from top of core and ½ inch hornblende	2.67	15
43 –49	19	4 inches pegmatite; 15 inches gneiss	2.67	
49 –55	13	Gneiss	2.61	
55 –60.5	49	23 inches pegmatite; 2 inches gneiss; 4 inches pegmatite; 20 inches gneiss with about 20 percent magnetite in thin bands	2.80	5
60.5–66	17	Gneiss with about 20 percent magnetite in thin bands	3.05	
66 –69.2	24	Gneiss with a few magnetite bands	2.85	0–5
69.2–70.2	4	Gneiss, trace magnetite	—	
70.2–72	8	As above	—	
72 –73.6	13	Gneiss with about 5 percent magnetite	2.72	15
73.6–75	14	As above	2.87	10–15

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
75 –76.6	12	As above	2.74	
76.6–77.3	6	As above	2.73	
77.3–82	55	10 inches gneiss, about 15 percent magnetite; 8 inches gneiss, 50 percent magnetite; 5 inches gneiss, 5 percent magnetite; 14 inches gneiss, 30 percent magnetite; 12 inches gneiss, 5 percent magnetite; 6 inches gneiss, 20 percent magnetite	3.22	0–15
82 –84	20	15 inches aplite; 5 inches gneiss, about 20 percent magnetite	2.69	
84 –87.2	36	Gneiss, about 5 percent magnetite	2.85	0–10
87.2–90.7	38	Gneiss, about 10 percent magnetite; some ½-inch magnetite bands	3.02	0–10
90.7–93	23	Aplite	2.64	
93 –97.4	32	Aplite	2.62	
97.4–102	25	12 inches pegmatite with about 10 percent magnetite; 13 inches pegmatite, trace magnetite	2.90	
102 –105	12	Hornblendic gneiss	2.85	20–30
105 –108	10	Aplite	2.60	
Total depth: 108 feet. Bottom in aplogranite.				
HOLE No. 16				
Attitude: inclined 60° S. 78° W.				
Collar elevation: 994 feet				
Ground elevation: ?				
0 –8	1	One piece of quartz		
8 –14	8	Aplite		
14 –28	15	4 inches gneiss, trace magnetite; 11 inches aplite		
* 28 –34	17	Gneiss with some magnetite		
* 34 –40	28	As above		
* 40 –44	20	Gneiss, some magnetite bands		5–10
* 44 –47	29	10 inches gneiss, some magnetite; 2 inches pegmatite; 11 inches gneiss; some magnetite; 2 inches pegmatite; 4 inches gneiss and magnetite		5–10
* 47 –50	33	Gneiss, some magnetite		20
* 50 –55	41	As above		10–15
* 55 –60	53	As above		10–25
* 60 –64.3	27	As above		10–20
* 64.3–67	16	As above		10–15
* 67 –69.5	18	Aplite		
* 69.5–72.2	15	Aplite		
* 72.2–77.7	17	4 inches aplite; 13 inches gneiss; some magnetite		0–5
* 77.7–81.2	25	18 inches gneiss, some magnetite; 2 inches aplite; 5 inches gneiss, some magnetite		10
* 81.2–83.5	9	Hornblende schist		
* 83.5–89	7	1 inch hornblende schist; 6 inches gneiss, some magnetite		
* 89 –92	8	1 inch gneiss; 7 inches aplite		
* 92 –97	47	22 inches gneiss; 6 inches pegmatite; 19 inches gneiss		0–10
* 97 –102	38	Gneiss with some magnetite		
102 –107	56	25 inches gneiss, trace magnetite; 31 inches aplite		
107 –110	27	Aplite		
110 –111.7	7	Aplite		
111.7–116	36	4 inches aplite; 32 inches gneiss, some magnetite		
116 –121.5	56	44 inches gneiss, some magnetite; 6 inches pegmatite; 6 inches gneiss, some magnetite		
121.5–124.5	31	Gneiss, some magnetite		

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
124.5–127	22	3 inches gneiss, some magnetite; 5 inches pegmatite; 14 inches gneiss, some magnetite		
127 –132	55	Gneiss, some magnetite		
*132 –134.7	27			
*134.7–139	32			
*139 –142.2	68	Gneiss and magnetite		
*142.2–145.2				
*145.2–150.5	44			
150.5–156	58	Aplite		
156 –158	30	Aplite		
*158 –163.4	60	Gneiss, some magnetite		
163.4–166.5	36	Gneiss, minor magnetite		
166.5–168	17	11 inches gneiss, minor magnetite; 6 inches hornblende schist		25
168 –172	51	24 inches gneiss, minor magnetite; 27 inches aplite		20

Total depth: 172 feet. Bottom in aplite.

Hole No. 17
Attitude: vertical
Collar elevation: 986 feet
Ground elevation: ?

0 –19	4	Gneiss		60
19 –25	11	6 inches gneiss; 5 inches pegmatite		
25 –27.2	6	Aplite		
27.2–28.8	6	Aplite		
28.8–30.3	10	Aplite		
30.3–31.5	7	Aplite		
31.5–32.6	15	Aplite		
32.6–33.7	8	Aplite		
33.7–36	13	2 inches aplite; 11 inches pegmatite		
36 –38.5	16	8 inches pegmatite; 8 inches gneiss, minor magnetite		
38.5–42.8	20	Gneiss, small amount magnetite		32
42.8–47	42	11 inches aplite; 21 inches gneiss, minor magnetite; 5 inches pegmatite; 5 inches aplite		20
47 –48.5	16	5 inches gneiss, small amount magnetite; 4 inches aplite; 7 inches gneiss, small amount magnetite		30
48.5–51.8	36	Gneiss, some magnetite; one magnetite band 1 inch thick		20–30
51.8–54.8	32	Gneiss, some magnetite; 4-inch zone of hornblende and magnetite near middle		25
54.8–56.4	16	Gneiss, some magnetite		25
56.4–59	25	As above		25
59 –62.3	29	As above		25
62.3–67.7	54	4 inches hornblende schist; 35 inches gneiss, trace magnetite; 5 inches chlorite schist; 10 inches hornblende schist		20–35
67.7–71.6	42	26 inches hornblende schist; 15 inches gneiss, some magnetite; 1 inch hornblende schist		30–35
71.6–73.2	15	2 inches hornblende schist; 13 inches gneiss, some magnetite		35
73.2–75.6	26	3 inches gneiss, some magnetite; 3 inches magnetite; 20 inches gneiss, some magnetite		30
75.6–77.1	16	Gneiss, some magnetite		30
77.1–78.5	12	As above		40
78.5–80	14	Gneiss, in part brecciated, considerable magnetite		
* 80 –82.7				
* 82.7–85	45			
* 85 –90	60	Gneiss with a little magnetite		
* 90 –95	60			
* 95 –100	60			

Depth in feet	Recovery in inches	Description	Specific gravity	Inclination of banding in degrees
100 –105	50	Gneiss, small amount magnetite; 2 inches pegmatite in upper part		25
105 –107	25	Gneiss, small amount magnetite		20
107 –112	59	22 inches gneiss, small amount magnetite; 17 inches hornblende schist; 2 inches pegmatite; 10 inches hornblende schist; 4 inches gneiss; 4 inches aplite		15–20
Total depth: 112 feet. Bottom in aplite.				

TABLE 3. GAMBLE PROSPECT

Depth in feet	Recovery in inches	Description	Specific gravity	Inclination of banding in degrees
HOLE NO. 18				
Attitude: vertical				
Collar elevation: ?				
Ground elevation: ?				
0 –9	3	1 inch quartz; 2 inches gneiss		
9 –14	50	Gneiss		15
14 –16	21	Gneiss		
16 –20.7	59	24 inches gneiss, ¼ inch martite; 8 inches gneiss; 12 inches martite-muscovite mixture; 15 inches martite		10–15
* 20.7–26	49	10 inches martite; 39 inches martite in muscovite schist with some pegmatite and some biotite near top		
26 –30	28	Gneiss, some biotite		0–10
30 –35	57	2 inches gneiss; 21 inches gneiss with abundant biotite; 10 inches gneiss; 9 inches gneiss, some biotite; 15 inches gneiss		0–5
35 –40	13	2 inches quartz; 9 inches gneiss; 2 inches biotite schist		
40 –45.7	55	9 inches biotite-muscovite schist; 7 inches gneiss; 2 inches gneiss, some biotite; 18 inches gneiss; 3 inches gneiss, some biotite; 12 inches gneiss; 4 inches gneiss, abundant bioite		10–20
45.7–49.5	39	Biotite-muscovite schist		0–30
49.5–54.9	44	21 inches gneiss, some biotite; 9 inches gneiss; 5 inches gneiss, abundant biotite; 4 inches quartz		5–120
54.9–60.1	33	4 inches quartz; 29 inches gray gneiss, some biotite		60–120
60.1–63	20	11 inches gray, crumpled biotite schist; 6 inches gneiss, some biotite; 3 inches gneiss		40
63 –66	30	Gneiss, some biotite		30
66 –71	56	18 inches gneiss, some biotite; 6 inches gneiss; 2 inches gneiss, some biotite; 4 inches gneiss; 6 inches gneiss, abundant biotite; 3 inches biotite schist; 17 inches gneiss, some biotite		15–30
71 –75	41	10 inches gneiss, abundant biotite; 31 inches biotite schist		20
75 –79.3	44	Gneiss, trace magnetite		20
79.3–85	59	46 inches gneiss; 2 inches biotite schist, golden colored; 6 inches gneiss, some biotite; 1 inch biotite schist; 4 inches gneiss		15–25
Total depth: 85 feet. Bottom in gneiss.				

Depth in feet	Recovery in inches	Description	Specific gravity	Inclination of banding in degrees
Hole No. 19				
Attitude: vertical				
Collar elevation: ?				
Ground elevation: ?				
0 –4	3	2 inches quartz; 1 inch gneiss		
4 –21	17	2 inches gneiss; 15 inches biotite schist		5–10
21 –27	31	15 inches biotite schist, trace magnetite; 16 inches crumpled gneiss, some biotite, trace magnetite		5–70
27 –31.5	39	6 inches biotite schist; 33 inches gneiss, as above		24–45
31.5–37	60	Gneiss, trace magnetite; 1 inch martite		40–50
37 –42.2	58	Gneiss, some biotite, trace magnetite		45–120
42.2–47	40	As above		20–40
47 –52.2	56	As above		25–30
52.2–56	29	As above		20
Total depth: 56 feet. Bottom in gneiss.				
Hole No. 20				
Attitude: vertical				
Collar elevation: ?				
Ground elevation: ?				
0 –12	0			
12 –17	30	Gneiss, some biotite		10–25
17 –19	30	Gneiss, trace magnetite and biotite		
19 –24	0			
24 –29	29	Gneiss, trace magnetite and biotite		10–15
29 –33	18	Gneiss, abundant biotite		25
33 –37	19	As above		15
37 –40.5	28	Gneiss, some biotite		15–20
40.5–45.8	58	30 inches gneiss; 8 inches biotite schist, trace magnetite; 20 inches gneiss		
45.8–51	48	8 inches gneiss; 18 inches gray biotite schist; 22 inches gneiss		5–25
51 –53	18	2 inches gneiss; 10 inches gray biotite schist; 6 inches gneiss		30–60
53 –60.5	45	Gneiss		5
60.5–65.8	55	19 inches gneiss, minor biotite; 20 inches gneiss; 4 inches gneiss, abundant biotite; 12 inches gneiss		5–10
65.8–69.5	27	Gneiss		
69.5–73.6	21	12 inches biotite schist; 9 inches gneiss		20
73.6–79	60	49 inches gneiss, trace magnetite; 11 inches black biotite schist		5–10
79 –82.3	22	8 inches gray biotite schist; 14 inches gneiss, trace magnetite, small amount biotite		0–5
Total depth: 82.3 feet. Bottom in gneiss.				
Hole No. 21				
Attitude: inclined 60° due west				
Collar elevation: ?				
Ground elevation: ?				
0 –7	17	Gneiss, a little muscovite and biotite		
7 –16	51	28 inches gneiss, some muscovite; 16 inches muscovite schist; 7 inches gneiss, some muscovite		45–90
16 –23	19	4 inches gneiss, some muscovite; 15 inches gneiss		60
23 –28	59	Gneiss		
28 –34	13	11 inches gneiss; 2 inches bronze-colored mica schist		
34 –39.4	26	9 inches bronze-colored schist; 17 inches gneiss		20

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
39.4–43.4	34	20 inches gneiss; 2 inches biotite schist; 12 inches gneiss		30
43.4–47.5	47	Gneiss		
47.5–48.6	10	Gneiss		
48.6–53.7	55	Gneiss		
53.7–57	38	25 inches gneiss; 5 inches pegmatite; 8 inches gneiss		
57 –62	44	Gneiss		25
62 –66	42	Gneiss with 1 inch pegmatite		

Total depth: 66 feet. Bottom in gneiss.

HOLE No. 22

Attitude: vertical
Collar elevation: ?
Ground elevation: ?

0 –7	15	Gneiss, small amount martite; 1 inch quartz		
7 –8	6	Gneiss, 10 to 20 percent martite		
8 –12.3	39	31 inches gneiss, some martite, 2 inches biotite schist; 6 inches gneiss, some quartz		10
12.3–15	19	Gneiss, considerable martite		
15 –16	3	As above		
16 –18	8	As above		
18 –26	77	14 inches gneiss, some martite; 63 inches gneiss, trace martite		10–20
26 –29	25	Gneiss, a little martite		35
29 –31	24	As above		25
31 –35.7	38	36 inches gneiss; 2 inches biotite schist		
35.7–38	19	Gneiss, considerable biotite		80–90
38 –43.7	36	2 inches gneiss with abundant biotite; 6 inches biotite schist; 28 inches gneiss		30
43.7–47	36	7 inches biotite schist; 29 inches gneiss, some biotite		0–10
47 –53	41	Gneiss, some biotite		0–120

Total depth: 53 feet. Bottom in gneiss.

HOLE No. 23

Attitude: vertical
Collar elevation: ?
Ground elevation: ?

0 –8	2	Gneiss		
8 –9	11	Gneiss, some biotite		Variable
9 –14	19	As above		Variable
14 –20	44	19 inches gneiss, some biotite; 4 inches biotite schist; 21 inches gneiss		0–5
20 –25	59	Gneiss		
25 –27.3	27	Gneiss, trace martite		5–10
27.3–32.7	51	As above		5–30
32.7–35.7	30	As above		
35.7–40	38	Gneiss, abundant biotite		20–30
40 –45	45	Gneiss, some biotite		25
45 –46.4	11	As above		
46.4–51	27	As above		25

Total depth: 51 feet. Bottom in gneiss.

HOLE No. 24

Attitude: inclined 35° S. 73° W.
Collar elevation: ?
Ground elevation: ?

0 –11	4	Martite, mixed with feldspar and mica, coarsely crystalline		
11 –16	24	10 inches martite as above; 4 inches chlorite schist, some martite; 1 inch martite with feldspar and mica; 7 inches chlorite schist; 2 inches martite in schist		

Depth in feet	*Recovery in inches*	*Description*	*Specific gravity*	*Inclination of banding in degrees*
16 -21	37	16 inches gneiss, abundant martite; 21 inches biotite gneiss		
21 -25	38	Biotite gneiss		35
25 -29.4	45	Fine-grained gneiss		
29.4–30.2	7	As above		
30.2–34	8	As above		
34 -40	41	As above		
40 -46	34	Medium-grained gneiss		
46 -50.7	41	6 inches biotite schist; 35 inches gneiss, medium grained		
50.7–56	22	Gneiss, medium grained, some biotite		90
56 -62	0			
62 -66	18	Gneiss, medium grained, some biotite		45–80
66 -72	55	Fine-grained gneiss		
72 -73	6	As above		
73 -79	57	As above		50
79 -84	58	As above		
84 -90	55	As above, 2 pegmatite layers		
90 -95	55	Gneiss with some pegmatite		
95 -99	41	Gneiss		
99 -101	18	Gneiss		
101 -106	49	Gneiss		
106 -111	43	38 inches gneiss; 4 inches quartz; 6 inches biotite schist		

Total depth: 111 feet. Bottom in biotite schist.

TABLES 4 AND 5. ANALYSES OF SAMPLES FROM DIAMOND-DRILL HOLES, LLANO, TEXAS

The analytical data on core and sludge samples obtained by the U. S. Bureau of Mines from holes drilled on the Iron Mountain prospect (table 4) and the Bader prospect (table 5) are as follows (Evans, 1947, pp. 7–14).

TABLE 4. IRON MOUNTAIN

Depth in feet and inches		Percent iron	
From	To	Core	Sludge
	Hole No. 2		
59	60	54.11	——
60	64	61.07	30.29
64	65–8"	67.88	52.97
65–8"	69	65.93	56.86
69	71–8"	68.77	62.21
71–8"	73–11"	65.61	57.19
73–11"	76–5"	67.23	62.21
76–5"	78–11"	69.17	60.59
78–11"	81	68.53	45.52
81	83	66.58	60.26
83	86	68.85	53.62
86	87	46.66 }	51.60
87	88–10"	67.23 }	
88–10"	91–4"	69.34	60.75
91–4"	93–10"	67.15	54.59
93–10"	96	No core	49.09

Depth in feet and inches		Percent iron	
From	To	Core	Sludge
	Hole No. 3		
29	31	No core	48.60
31	32	64.96	54.92
32	34	69.66	65.29
34	39	68.20	66.58
39	44	67.07	66.57
44	49	67.88	67.39
49	54	60.43	65.77
54	58	66.58	67.47
58	63	68.04	68.53
63	65–11"	55.08	46.90
65–11"	71	67.63	66.58
71	72	66.89 }	46.98
72	75	23.65 }	
75	79	43.09	51.19
79	84	19.20	40.50
84	89	63.66	61.07
	Hole No. 4		
69	72–10"	50.06	43.25
72–10"	74–8"	14.66	54.59
74–8"	80–1"	68.04	63.91
80–1"	83–6"	63.83 }	53.54
83–6"	85–1"	32.32 }	
85–1"	86–1"	57.67 }	63.10
86–1"	90–4"	62.20 }	
90–4"	93	67.31 }	53.78
93	95	27.86 }	
95	101	——	17.98
101	106	——	19.60

Depth in feet and inches From	To	Percent iron Core	Sludge
	Hole No. 5		
83–6"	85–4"	59.78	41.88
85–4"	90–5"	66.26	57.83
90–5"	95–6"	66.99	58.16
95–6"	101	——	38.07
101	107	67.39	57.75
107	111	64.15	52.33
	Hole No. 6		
94–8"	100	——	15.07
103	105–4"	54.43	46.01
105–4"	110–8"	65.61	63.34
110–8"	112–4"	49.04 }	54.39
112–4"	115–11"	67.31 }	
115–11"	118–3"	64.30	56.05
	Hole No. 7		
39	41	54.13	——
41	45	62.91	61.06
45	48	51.79	53.48
54	57–6"	67.82	63.00
57–6"	60	No core	41.16
61–6"	65–10"	No core	47.12
68	73	No core	61.06
73	78	63.07	62.51

Depth in feet and inches From	To	Percent iron Core	Sludge
	Hole No. 8		
158–6"	161–6"	49.54	——
161–6"	163	32.94	25.29
163	168	——	21.34
	Hole No. 9		
92–4"	97–10"	56.95	54.37
97–10"	103–4"	53.97	58.48
103–4"	107–6"	67.18	60.33
115–6"	121–8"	64.28	47.52
121–8"	127–8"	64.92	46.88
127–8"	133–2"	49.54	54.69
133–3"	140	52.03	55.18
	Hole No. 12		
121–5"	122–5"	50.83	——
122–5"	125–6"	——	16.09

Composite Analyses

Hole No.	Depth in feet and inches From	To	Analyses Fe	P	SiO_2
		Cores			
2	59	93–10"	65.45	0.184	6.07
3	31	63	66.26	0.054	6.18
3	63	89	47.14	0.040	26.11
4	69	93	57.51	0.020	14.55
5	83–6"	95–6"	65.29	0.268	6.68
5	101	111	66.10	0.080	6.00
6	103	118–3"	62.53	0.314	6.45
7	39	48	57.42	0.376	10.87
8	158–6"	163	44.19	0.035	27.54
		Sludge			
2	60	96	52.81	0.262	14.97
3	29	63	65.29	0.100	5.86
3	63	89	53.38	0.045	14.55
4	69	94–4"	56.54	0.033	14.48
5	83–6"	95–6" }	52.00	0.153	17.85
5	101	111 }			
6	100	115–11"	55.08	0.376	11.76
7	41	49	57.18	0.423	9.93
7	54	60	51.13	0.139	20.21
7	68	78	61.78	0.070	9.92
8	61	68	22.42	0.162	42.58

TABLE 5. BADER PROSPECT

Depth in feet and inches From	To	Percent iron Core	Sludge
	Hole No. 13		
26	31	19.36	41.03
31	36	51.53	44.73
36	40	22.10	21.88
123	128	13.87	——
145	149–6"	46.78	——
149–6"	155	33.39	32.34
155	159	29.19	——
	Hole No. 14		
24	28–8"	——	26.87
28–8"	30–7"	——	19.79
30–7"	37–2"	——	27.50
67	73–2"	35.65	28.80
145	151	11.53	——

Depth in feet and inches From	To	Percent iron Core	Sludge
	Hole No. 15		
60–5"	66	21.13	——
77–3"	82	30.24	——
82	87–2"	11.29	——
87–2"	90–8"	24.92	——
	Hole No. 16		
28	34	27.90	——
34	40	12.18	——
97	102	6.05	——
132	135	31.86	——
135	139	23.71	——
139	145	24.52	——
145	150	29.60	——
150	163	16.05	——
	Hole No. 17		
80	85	24.79	——
85	90	35.64	——
90	95	28.03	——

COMPOSITE ANALYSES

Hole No.	Depth in feet and inches From	To	Analyses Fe	P	SiO_2
		Sludge			
13	26	40	36.61	0.023	36.52
14	24	37–6"	26.29	0.075	52.50
14	67–4"	72–6"	28.71	0.060	50.34

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