GEOLOGY OF THE CAIN CITY QUADRANGLE, GILLESPIE AND KENDALL COUNTIES, TEXAS

VIRGIL E. BARNES

GENERAL SETTING

Cain City quadrangle is south of the Llano region and is in the marginal portion of the Edwards Plateau where much of the plateau surface has been destroyed by erosion. Northeastward-trending lobes and outliers of the Edwards Plateau are present in the southern part. The rest of the quadrangle is in the gently undulating broad Pedernales River basin.

The geology of the Cain City quadrangle is shown on a planimetric map since the only topographic map available is the reconnaissance 30-minute Fredericksburg quadrangle. Elevations ranging between 1,512 and 1,902 feet were determined during traversing for control, but neither the highest nor the lowest elevation was reached. However, from the traverse it is estimated that the relief within the quadrangle is about 500 feet, ranging between about 1,500 and 2,000 feet in elevation.

The quadrangle is entirely within the Pedernales River drainage basin and is mostly drained by South Grape Creek, Menschack Creek, and numerous short branches of Pedernales River. Barons Creek and Palo Alto Creek empty into Pedernales River within the quadrangle.

The Cain City quadrangle is on the southern side of the Llano uplift, and rocks of Ordovician age outcrop as inliers surrounded by Cretaceous rocks. The faulting accompanying the Ouachita orogeny (Barnes, 1948) is not exposed but southeastward dips up to 8° are present in the Paleozoic rocks. The Cretaceous rocks are essentially horizontal, dipping mostly southward about 8 feet per mile. A gentle nose with a southeastward trend is present, and one of the few faults in Cretaceous rocks noted in the vicinity of the Llano uplift is in the southern part of the quadrangle.

Broader discussions of the stratigraphic, structural, economic, and geophysical problems of the region cannot be given in the space available. References cited below deal with some of these problems. This publication on the Cain City quadrangle is one of a series of similar publications, an index to which is shown on the opposite page. The reader is referred to this index map to locate other quadrangles mentioned in the present text.

GEOLOGIC FORMATIONS

PALEOZOIC ROCKS

ORDOVICIAN SYSTEM (LOWER ORDOVICIAN-ELLENBURGER GROUP)

Tanyard Formation

Staendebach member.—Outcrops of the Staendebach member are mostly along the banks and bed of Pedernales River and Palo Alto Creek and occur as isolated inliers in the northeastern portion of the quadrangle. The Staendebach is all dolomite, mostly very cherty and fine grained, except for the westernmost outcrop (all in bed of Pedernales River), which is coarse grained. From here downstream to the boundary of the quadrangle the bed of the Pedernales, except for the first 100 yards which appears to be alluvium, is fine-grained dolomite. The chert is mostly porcellaneous and dolomitic, but some banded concretionary chert in part dolomitic is also present. The dolomite is mostly flat lying or gently dipping and in the westernmost outcrop dips westward beneath the German formation.

Fossils from the Staendebach member identified by Dr. W. C. Bell are as follows:

Locality 5-20D, about 1.5 miles air-line north-northwest of Blumenthal—
Sinuopea cf. humerosa Butts
Polygnathus unicornatus (Calvin)
Ophileta sp.
"Helicotoma"?
A poorly preserved brachiopod
Branching objects which may be algal
Locality 6-19A, about 1.25 miles northwest of Blumenthal—
Trybliteis?
Nautiloid?
Algal chert

German Formation

Dolomitic facies. — The dolomitic facies of the German formation crops out in the bed and on the north bank of Pedernales River northeast of Rocky Hill School. The dolomite is mostly micrograndular and contains sand in several beds, one of which is directly above the coarse-grained Staendebach dolomite in the bed of the Pedernales. A reversal in dip with a dip of 8° southeastward near the western edge of the outcrop suggests that a fault may exist near-by beneath the alluvium and Cretaceous sediments. The rock is cherty, much jointed, and much of it is of a pleasing color.

A sample from this outcrop was described by Barnes (Barnes, Dawson, and Parkinson, 1947, p. 153), who thought it belonged to the Staendebach member of the Tanyard. Revision of mapping based on the work of Cloud and Barnes (1948) places it in the German in age. The sample is grayish-ivory with purple markings resembling diffusion banding. Color in the bands is more intense along incipient joints and between joints. The variation in color in the bands is caused by minute purple specks varying in density of distribution. The dolomite takes a good uniform polish. No fossils were seen.

Calcitic facies.—Two small exposures of the calcitic facies of the German formation crop out in the bed and on the north bank of Pedernales River north of the point where U. S. highway No. 290 crosses the river. The rock is predominantly limestone, but some microgranular dolomite is also present notably in the outcrop in the river bed. Two samples from the northern outcrop have been described by Barnes, Parkinson, and Dawson (1947, p. 153). One sample is light grayish-green with very faint purplish markings parallel to an undulatory structure, which suggests that this might be a stromatolitic limestone. Calcite veins cut the structure transversely. The other sample is of the same color except that it is sprinkled by small brown dolomite rhombs which in this section are banded parallel to the rhomb faces. Stylolites in the marble are tight, and a small amount of bright red material is concentrated along them. The two samples take an excellent polish.

MESOZOIC ROCKS

CRETACEOUS SYSTEM (LOWER CRETACEOUS)

Shingle Hills Formation

Hensell sand member (Barnes, 1948).—The Cretaceous rocks in the Cain City quadrangle dip only about 8 feet per mile to the south, and since the Hensell sand is the lowest member of the Cretaceous exposed, its maximum outcrop thickness is essentially the difference in elevation between the lowest point in the quadrangle and the base of the overlying unit, plus a small correction for dip. The lowest elevation is estimated to be about 1,500 feet, and the top of the Hensell sand along the road west of Cain City is about 1,630 feet, so that 130 feet, the difference in elevation, is about the maximum outcrop thickness of the Hensell sand. Additional beds are present in the subsurface.

The Hensell sand varies widely in color and composition and in the northern part of the quadrangle rests on rocks of the Ellenburger group, including the Staendebach member of the Tanyard formation and both the calcitic and dolomitic facies of the German formation. The Hensell is in general very poorly sorted and ranges from pebbles and granules through the various sand sizes to silt and clay. Some of conglomerate (Kshk(c)) mapped are mostly well indurated, basal conglomerate of the Hensell. Conglomeratic zones higher in the Hensell are not separately shown. Angular quartz granules and solution-sculptured microcline are common in the lower part of the Hensell especially in the vicinity of Pedernales River, Barons Creek, and Palo Alto Creek. The upper portion of the Hensell sand is much finer in grain size and contains abundant silt and clay, and in the vicinity of the base of the Glen Rose some of the beds are calcareous. An extensive outcrop of indurated, calcareous, fossiliferous, cross-bedded sandstone is in South Grape Creek at the Blanco road crossing. The cross-beds dip southward.

The Hensell sand is composed of two color facies, a lower one predominantly red and an upper one predominantly gray. The dividing line between these facies roughly parallels the base of the Glen Rose limestone and therefore rises stratigraphically northward, being controlled in part by the proximity of the shore during deposition of the sediments.

The Hensell is so little indurated that it readily breaks down and forms gentle slopes except immediately beneath the Glen Rose limestone. The more siliceous and coarser lower portion supports a growth of broad-leaf oaks which on aerial photographs shows as a featureless expanse of woodland. Little of the woodland still remains, having been cleared, the land now being under cultivation. The Hensell sand outcrop area, therefore, supports a denser population than does any other unit of the Cretaceous outcropping in the quadrangle.

Since the Hensell sand is so little indurated, sections more than 10 feet thick are rare, especially in the lower part of the member. In the Palo Alto Creek quadrangle along Barons Creek a short distance north of the Cain City quadrangle, however, a 75-foot section was measured.

No fossils were seen in the Hensell sand, but cycads have been reported from the Adolph Eckhardt property east of the San Antonio highway and north of Pedernales River where they were collected from gullies.

Glen Rose limestone member.—The Glen Rose limestone is about 240 feet thick in the vicinity of Cain City and this is probably near its maximum outcrop thickness within the quadrangle. Southward in the subsurface it should thicken. The base of the Glen Rose is placed at the base of the lowest bench-forming limestone, dolomite, or calcareous sandstone. In mapping, however, it is almost impossible to decide exactly at which point the bench-forming bed drops out, so the basal boundary of the Glen Rose is not mapped as a series of steps but is gradually rounded off from the base of one bench-forming bed to the base of the next. Most of the contact between observed points was traced on aerial photographs with the aid of a stereoscope, and since the terrace of any one bed gradually merges with the general slope it is also not in reality as easy or lower the contact to the next one.

The Glen Rose limestone consists of alternating beds of limestone, clay, and sand, or, more correctly stated, beds having various proportions of these materials. In the vicinity of Cain City about two dozen limestone, dolomite, and calcareous sandstone beds are present, separated by poorly exposed argillaceous and calcareous sediments. The top bed is limestone having a rusty brown upper surface, which is characteristic of the top of the Glen Rose where it is limestone in this portion of Gillespie County.

Portions of the Glen Rose limestone are quite fossiliferous and fossils identified by Dr. Ralph Imlay are listed from several localities.

Locality 6-20A, 3.5 miles east-northeast of Cain City—
Arctica medialis (Conrad)
Protocardia sp.
Cardita sp.
Homomya solida Cragin
Tapes sp.
Panopea? knowltoni (Hill)
Anatina sp.
Porocystis globularis (Giebel)
Ostrea sp.
Pylostoma regina (Cragin)
Lunatia? sp.

Locality 6-22A, 3.5 miles southeast of Cain City—
Panopea? knowltoni (Hill)
Serpula paleazoicus Hill
Holectypus cf. planatus Roemer
Porocystis globularis (Giebel)
Arctica texana (Conrad)
Arctica roemeri (Cragin)
Exogyra texana Roemer
Ostrea cf. camelina Cragin

Locality 9-2A, 0.4 mile east of Cain City—
Tapes sp.
Cucullaea sp.
Arctica roemeri (Cragin)
Arctica texana (Conrad)
Exogyra texana Roemer
Turbo? sp.
Pylostoma cf. regina (Cragin)
Lunatia? sp.

Locality 9-2B, 1.2 miles north-northeast of Cain City—
Lotula texana (Clark)
Cucullaea sp.
Trigonia sp.
Ostrea sp.
Lunatia? sp.

Locality 9-8A, south edge of Cain City—
Protocardia? sp.
Tapes sp.
Anomia sp.
Trapezium? sp.
Pinna? sp.
Modiola cf. concentrica - costellata Roemer
Arctica roemeri (Cragin)
Cucullaea sp.
Trigonia sp.
Cardita sp.
Cyprimeria sp.
Cassiope sp.
Pylostoma sp.
Ostrea cf. perversa Cragin

Other collections are as follows:

Locality 9-15A, 3.2 miles west of Cain City—
Gastropods, small, high spired

Locality 9-16A, 3.4 miles west-southwest of Cain City—
Oysters, probably 2 species
Porocystis was seen in the road material pit half a mile east of locality 9-2B, and this is the westernmost occurrence of this species noted in Gillespie County.

Fredericksburg Group

Included within the Fredericksburg group of Cain City quadrangle is about 150 feet of Edwards limestone, 29 feet of Comanche Peak limestone, and up to about 14 feet of Walnut clay. The boundaries of the units are gradational, and so far as this quadrangle is concerned, Thompson's (1935) observation that these units should have about the rank of members seems logical. However, instead of introducing a new name, Fredericksburg could well be dropped from group to formational rank, especially since the U.S. Geological Survey explores the Kiamichi clay from the Fredericksburg group (Wilmarth, 1938, p. 776).

Walnut clay.—A thickness of 14 feet of Walnut clay was measured on a hill south of Cain City. Elsewhere in the quadrangle it appears to be thinner. The Walnut rests on various beds of the Glen Rose limestone, and from Cain City westward into the Bear Creek quadrangle it rests mostly on a rusty brown limestone which in places is composed mostly of oysters. Eastward in Blanco County it is not uncommon to find a mollusk-bored limestone bed beneath the Walnut clay. The Walnut clay grades upward into the Comanche Peak limestone, and the contact is placed at the point where the calcareous content becomes sufficiently high to cause the rock to have some resistance to weathering. Within the Cain City quadrangle the bench formed by the Walnut clay is wide enough to map in only a few places, mostly on points of ridges. One isolated outlier of Walnut was mapped southeast of Cain City. Most of the outcrop within the quadrangle is represented by a solid color line on the map.

The Walnut clay is too thin to influence noticeably the vegetation or culture of the area. Collections from some of the Walnut clay localities contain fossils from the basal portion of the overlying Comanche Peak limestone since the fossils from both units weather free and intermingle. At one place, however, (locality 9-3A) no Comanche Peak limestone remains above the Walnut clay and it is assumed that there is no contamination.

Fossils in the Walnut clay identified by Dr. Ralph Imlay are listed as follows:

Locality 9-3A, 1.4 miles east-southeast of Cain City—
Apyrrhais? cf. subfusiformis (Shumard)
Ylostoma regina (Cragin)
Protocardia sp.
Tapes cf. aldamense Böse
Cyprimeria texana (Roemer)
Cucullaea sp.
Ioscardia sp.
Pecten (Neithea) occidentalis (Conrad)
Modiola concentrico-costellata Roemer
Metagonoceras cf. inscriptum Hyatt
Exogyra texana Roemer
Gryphaea mucronata Gabb
Gaillaster texanus (Roemer)
Holectypus cf. planatus Roemer

Locality 9-17A, 3.9 miles south-southwest of Cain City—
Turritella sp.
Lunatia? sp.
Tapes cf. whitei Böse
Tapes cf. aldamense Böse
Trapezium? sp.
Cyprimeria texana (Roemer)
Trigonia sp.
Modiola concentrico-costellata Roemer
Pecten (Neithea) occidentalis (Conrad)
Modiola concentrico-costellata Roemer
Gryphaea mucronata Gabb
Gaillaster texanus (Roemer)
Holectypus cf. planatus Roemer

Another collection, locality 130T see 86T.9-18A, was made near the southern edge of the quadrangle in Kendall County along a road 1.5 miles west of the old San Antonio highway, west of and within a few hundred feet of the fault.

Apyrrhais? sp. subfusiformis (Shumard)
Neritina texana Roemer?
Turritella sp.
Protocardia texana (Conrad)
Protocardia sp.
Tapes cf. aldamense Böse
Tapes sp.
Cyprimeria texana (Roemer)
Tapes cf. whitei Böse
Mactra? sp.

Arctica sp.
Pecten (Neithea) occidentalis (Conrad)
Ioscardia sp.
Modiola concentrico-costellata Roemer
Trochoseris pedernalis (Roemer)
Cryphaeus mucronata Gabb
Exogyra texana Roemer
Gaillaster texanus (Roemer)
Trochotaxia texana (Roemer)
Holectypus planatus Roemer
Holectypus engerrandi Lambert

Comanche Peak limestone.—The Comanche Peak limestone is 29 feet thick in the vicinity of Cain City and probably averages very near this thickness throughout the quadrangle. It grades downward into the Walnut clay and upward into the Edwards limestone. The upper boundary is arbitrarily placed at the base of a thin-bedded, very fine-grained limestone, which in some outcrops contains flattened chert nodules. The Comanche Peak limestone contains considerable argillaceous material, especially in its basal part. Much of the Comanche Peak limestone has been extensively burrowed and the lower part is nodular. The top few feet, unlike the lower portion, is well bedded and locally has been used for a building stone.

The Comanche Peak is softer than the overlying Edwards limestone and has eroded into a steep slope which is characteristic of its outcrop throughout the quadrangle. It is massive and where undercut by streams breaks off in housesized blocks. On aerial photographs the Comanche Peak limestone on north slopes shows as a distinctive black band caused by a thick growth of vegetation dominated by a narrow-leaf oak. Cuyler (1931) identifies the oak as "*Quercus texana* Sargent (Texas oak)" and states that it is the dominant tree on the Walnut and Comanche Peak.

In mapping the Comanche Peak limestone, points at which its boundaries cross roads were placed on aerial photographs. Additional points of contact were chosen at many places between roads and on all outliers. On portions of the photographs having stereoscopic coverage the boundaries were traced under the stereoscope, and where stereoscopic coverage was lacking the boundaries could still be very closely approximated from the vegetational banding.

The elevation of the base and top of the Comanche Peak limestone on the hill south of Cain City is 1,882 and 1,911 feet respectively. Beds suitable for local building stone are situated about 19 to 26 feet above the base, and a honeycombed bed, perhaps from weathering of burrows, is 10 feet above the base.

The Comanche Peak limestone is fossiliferous, especially in its basal portion, and indications of fossils are abundant throughout much of the rest of it. Caprinids are common in some areas. Collections were not made from the Comanche Peak limestone alone, but fossils from it are included with collections from locality 9-17A and locality 9-18A listed above.

Edwards limestone.—The Edwards limestone attains a thickness of about 150 feet in the southwestern part of the Cain City quadrangle in the vicinity of the R. L. Raborn, Jr., No. 1 Hohenberger well. The lower boundary is placed at the base of a chert-bearing, thin-bedded limestone. The Edwards limestone varies widely in composition and lithology from bed to bed and this shows exceptionally well in aerial photographs. The outcrop of the Edwards has an average density of vegetation greater than that of the Glen Rose limestone, and in addition the vegetation is better segregated into bands. Above the abrupt slope of the Comanche Peak limestone the Edwards limestone flattens out into gently sloping surfaces. The hard limestones weather slowly and have only a thin soil covering or are bare and nearly void of vegetation. The softer beds develop a more adequate soil and are thickly vegetated mostly by a scrub oak locally known as "shinnery." Cuyler (1931) identifies it as "*Quercus havardii* Sargent (mountain scrub oak)."

The Edwards surface is mostly rocky and above some beds is chert strewn. A section was not measured within the Cain City quadrangle, but about 2 miles south along the old San Antonio highway a section was measured which includes about 77 feet of Edwards limestone. No fossil collections were obtained from the Edwards limestone in the Cain City quadrangle.

QUATERNARY DEPOSITS

High gravel.—Some of the deposits mapped as high gravel are essentially deposits of colluvium which have moved down slope from the Comanche Peak scarp in the Palo Alto Creek quadrangle. These deposits are largely derived from the Edwards limestone and may at one time have practically masked the Comanche Peak limestone in the quadrangle. Many of the remnants now remaining are in divide areas where erosive forces can attack them only slowly.

The high gravel is composed of pebbles, cobbles, and finer materials, some of which have been calcitified. Much of the material is limestone, chert, and dolomite from the Edwards limestone and limestone from the Comanche Peak. Quartz pebbles present are reworked from the Hensell sand and an occasional pebble may be one of the erratics from the Comanche Peak limestone.

The high gravel deposits mapped along the major streams in part contain less calliche and may be largely reworked material from colluvial deposits. No line of demarcation exists in border-line cases between deposits that are truly colluvial and those that are deposited by stream action. For this reason the deposits are not mapped separately. The high gravel supports a climax vegetation, live-oak mottes being common.

Alluvium.—Alluvial deposits are mostly situated along Pedernales River and Barons, South Grape, and Palo Alto Creeks. Narrow belts and patches of alluvium follow many of the lesser drainages in the area but are insignificant and have not been mapped. The alluvium is composed of sand and silt at the surface and of coarser materials beneath.

Many of the areas of alluvium are cultivated, but some areas are not cleared support a dense vegetation including trees, vines, and undergrowth, which on aerial photographs is even denser and darker than the pattern on the stereoscope, and where stereoscopic coverage was lacking the boundaries could still be very closely approximated from the vegetational banding.

The elevation of the base and top of the Comanche Peak limestone on the hill south of Cain City is 1,882 and 1,911 feet respectively. Beds suitable for local building stone are situated about 19 to 26 feet above the base, and a honeycombed bed, perhaps from weathering of burrows, is 10 feet above the base.

The Comanche Peak limestone is fossiliferous, especially in its basal portion, and indications of fossils are abundant throughout much of the rest of it. Caprinids are common in some areas. Collections were not made from the Comanche Peak limestone alone, but fossils from it are included with collections from locality 9-17A and locality 9-18A listed above.

Edwards limestone.—The Edwards limestone attains a thickness of about 150 feet in the southwestern part of the Cain City quadrangle in the vicinity of the R. L. Raborn, Jr., No. 1 Hohenberger well. The lower boundary is placed at the base of a chert-bearing, thin-bedded limestone. The Edwards limestone varies widely in composition and lithology from bed to bed and this shows exceptionally well in aerial photographs. The outcrop of the Edwards has an average density of vegetation greater than that of the Glen Rose limestone, and in addition the vegetation is better segregated into bands. Above the abrupt slope of the Comanche Peak limestone the Edwards limestone flattens out into gently sloping surfaces. The hard limestones weather slowly and have only a thin soil covering or are bare and nearly void of vegetation. The softer beds develop a more adequate soil and are thickly vegetated mostly by a scrub oak locally known as "shinnery." Cuyler (1931) identifies it as "*Quercus havardii* Sargent (mountain scrub oak)."

The Edwards surface is mostly rocky and above some beds is chert strewn. A section was not measured within the Cain City quadrangle, but about 2 miles south along the old San Antonio highway a section was measured which includes about 77 feet of Edwards limestone. No fossil collections were obtained from the Edwards limestone in the Cain City quadrangle.

SUBSURFACE GEOLOGY

Samples have been examined from three wells within the Cain City quadrangle, namely, E. L. Nixon No. 1 Mogford; R. L. Raborn, Jr., No. 1 Hohenberger; and R. L. Raborn, Jr., No. 1 Carl Hohenberger.

The Mogford well is located about 1,000 feet south of U. S. highway No. 290 and about 500 feet west of the road to Cain City. It is on the J. D. Watkins survey, section 26, and was drilled by cable tool. The samples were submitted by Mr. E. L. Nixon and are described below. The total depth of the well is unknown and the samples have rather large chips. The rock units encountered are interpreted as follows: From the surface to a depth of 155 feet the samples are Hensell sand; from 155 to 181 feet dolomitic facies of the German formation; from 290 to 309 feet the dolomitic facies of the Staendebach member of the Tanyard formation; and from 594 to 611 feet perhaps the same, but they could be upper Threadgill if the Tanyard rocks in this area are similar to those in the adjacent Gold quadrangle to the northeast.

The Lochte well is located in the Felipe Garza survey No. 87 about 1,000 feet east of Meusebach Creek, half a mile south of its junctcre with Pecan Creek. Samples with skips were submitted by Mr. R. L. Raborn and are described below. The well started in Glen Rose limestone, and it is estimated from contour data that Hensell sand was reached at about 65 feet. The driller's log indicates that the Ellenburger was reached at 183 feet. The base of the Ellenburger is tentatively placed at 575 feet, giving 392 feet of Tanyard rocks, all of which have characteristics of the Threadgill member. Such a thickness is about 100 feet more than measured elsewhere in the Llano uplift and if the boundary is correctly placed probably indicates that the lower portion of the Staendebach is being replaced in a southward direction by material having lithologic characteristics of the Threadgill member. Coarse-grained dolomite predominates from 575 to about 1,000 feet and is assigned to the Pedernales dolomite member of the Wilberns formation. Sublithographic limestone in the lower 25 feet of the well is not typical of limestone found in the Wilberns formation, except for some of the stromatolitic limestones of the Fort Peak shale and San Saba limestone members. To which member this limestone should be assigned cannot be determined without deeper drilling.

The Hohenberger well is in Kendall County about 1,000 feet south of the Gillespie County line. It is situated in the H. & G. N. RR. Co. survey No. 950 and was drilled to a total depth of 703 feet. Samples submitted by Mr. R. L. Raborn are described below. The well started in the Edwards limestone perhaps 150 feet above its base, and the first sample received is from 240 feet. The base of the Glen Rose is probably at about 560 feet and the top of the Ellenburger is at 650 feet, making the Hensell sand about 90 feet thick. About 53 feet of Ellenburger rocks were drilled, and the elongated fragments in the chert from the last sample resemble *Rhabdoporella*, indicating that the samples are from the top 100 feet of the Staendebach member of the Tanyard formation.

The wells are widely separated yet all three enter rocks of Ordovician age beneath the Cretaceous. Considering the faulting which has taken place in the pre-Cretaceous rocks of the Llano uplift, it is possible that other units of the Ordovician and many units of the Cambrian are present beneath the Cretaceous.

The information about the pre-Cambrian rocks upon which the Paleozoic rocks lie is limited to some gravity data. A 15 to 20-milligal high having its apex in the eastern portion of the quadrangle is apparently a continuation of the gravity high running northwest-southeast through the Live Oak quadrangle but is separated from it by a deep saddle in the vicinity of the northwest quadrangle corner. In areas of outcropping pre-Cambrian rocks in the Llano uplift, large gravity maxima are associated with Packsaddle schist (Romberg and Barnes, 1944, and subsequent unpublished data). However, large masses of basic igneous rock would produce the same effect.

MINERAL RESOURCES

The mineral resources of the quadrangle are limited to nonmetallic substances and water. Outside of underground water and soils, the most productive of which are from the Hensell sand, the most important mineral resource is construction materials.

CONSTRUCTION MATERIALS

Building stone.—In the southwestern portion of this quadrangle, limestone from beds in the lower part of the Edwards limestone is being quarried on the Carl Hohenberger ranch for building purposes. The bed being quarried is 18 inches thick and splits readily into slabs about 4 inches thick. The limestone is exceptionally white and is used for rock veneer. Other beds which could be similarly used are probably present within the Edwards limestone. Near the top of the Comanche Peak limestone several beds of soft limestone are present which are suitable for local building. Much stone from this horizon has been used within the Palo Alto Creek and Live Oak Creek quadrangles, but little has been used within the Cain City quadrangle. The stone is soft and easily worked and has suitable weathering characteristics for the local climate. However, the stone is drab and no new stone of this type has been quarried in recent years.

Some beds of limestone in the upper portions of the Glen Rose may also be suited to local building. The Glen Rose limestone in general are soft and weather rapidly, but some beds are hard and resistant. The weathering behavior of the stone in the field should be examined before limestone from the Glen Rose is used.

Barnes, Dawson, and Parkinson (1947, pp. 143 and 153) have described some of the Ellenburger limestones and dolomite within the quadrangle. The calcitic facies of the German exposed downstream from the highway bridge over Pedernales River was sampled. The rock is of a pleasing color and takes a high polish but is mostly too thinly bedded to be quarried as saw-blocks. The outcrop is small and is not favorably situated for quarrying. Dolomite sampled along the Pedernales River about 2 miles upstream from Blumenthal, while of pleasing color, is too cherty to be of value as a building stone. The stone is of value for crushing, but the deposit is too near river level and any quarry established would be subject to overflow.

Road material.—Road material has been produced from three geologic units within the Cain City quadrangle. Six of the pits mapped are within the Glen Rose limestone and are marly materials used on local roads. One pit is in a terrace deposit of gravel and two series of pits are in river bottom alluvium. The high gravel deposit is used mostly for base course material, whereas the deposits along the river are used for gravel and sand for building purposes, as well as for road construction materials.

Base course materials used in the present highways cause freeze damage, and as these highways are replaced better materials should be used. Much of the material used so far has come from the softer formations. Base course materials probably should be produced from harder rocks such as are found in portions of the Edwards limestone. Granules could be produced from the dolomitic German outcropping along Pedernales River or from the Staendebach member of the Tanyard formation in the northeastern corner of the quadrangle.

WATER

A ground-water survey of Gillespie County was made by Shield (1937). About 42 wells in the Cain City quadrangle were inventoried and of these about 30 started in Hensell sand and the rest started in Glen Rose limestone and mostly penetrated to the Hensell sand. The wells range in depth from 21 to 360 feet and in 1936 the water level stood from 23 to 234 feet below the surface. The total solids range from 291 to 1,031 parts per million with only four wells having more than a thousand parts per million. The main easily available source of ground water in the area is, therefore, the Hensell sand.

Beneath the Cretaceous within the quadrangle only rocks of the Tanyard and German formation have been encountered by drilling and rocks of similar age crop out in the vicinity of Pedernales River. From the evidence at hand it appears that the sandstones in the Cambrian will be present throughout most of the quadrangle. The Wolfcamp and Lion Mountains series will be the shallowest, but their quality as aquifers is unknown. The Welge at least should contain some water. The Hickory sandstone, which will be perhaps 500 or 600 feet deeper, is known to contain an abundance of water in some localities in central Texas. Its depth, which in some portions of the quadrangle at least can be estimated, is excessive, ranging between about 1,500 and 2,000 feet.

Farther north and west an aquifer exists near the base of the Edwards limestone, but within the quadrangle no springs were noted at this horizon and no wells penetrate it.

SELECTED REFERENCES

Barnes, V. E. (1940) Pre-Cambrian of Llano region with emphasis on tectonics and intrusives, in Guidebook to excursions offered in connection with 53rd annual meeting [Austin, Texas]: Geol. Soc. Amer., pp. 44-55.

——— (1948) Ouachita facies in central Texas: Bur. Econ. Geol., Rept. Inv. 2, 12 pp.

——— ———, Dawson, R. F., and Parkinson, G. A. (1947) Building stone of central Texas: Univ. Texas Pub. 4246, Dec. 8, 1942, 198 pp.

Bridge, Josiah, Barnes, V. E., and Cloud, P. E., Jr. (1947) Stratigraphy of the Upper Cambrian, Llano uplift, Texas: Bull. Geol. Soc. Amer., vol. 58, pp. 109-124.

Cloud, P. E., Jr., and Barnes, V. E. (1948) The Ellenburger group of central Texas: Univ. Texas Pub. 4621, June 1, 1946, 473 pp.

Cuyler, R. H. (1931) Vegetation as an indicator of geologic formations: Bull. Amer. Assoc. Petr. Geols., vol. 15, pp. 67-78.

Romberg, Frederick, and Barnes, V. E. (1944) Correlation of gravity observations with the geology of the Southwestern granite mass, Llano County, Texas: Geophysics, vol. 9, pp. 79-93.

Shield, Eugene (1937) Records of wells, drillers' logs, and water analyses in Gillespie County, Texas: State Board of Water Engineers, 51 pp.

Thompson, S. A. (1935) Fredericksburg group of Lower Cretaceous with special reference to north-central Texas: Bull. Amer. Assoc. Petr. Geols., vol. 19, pp. 1508-1537.

Wilmarth, M. G. (1938) Lexicon of geologic names of the United States, Part 1: U. S. Geol. Survey Bull. 896, 1244 pp.

SAMPLE DESCRIPTIONS

E. L. Nixon No. 1 Mogford Well

	Depth in feet
Sand—composed of coarse grained quartz and containing microcline fragments up to half an inch in size	65
Sand—medium to coarse and admixed with some red clay	75
Sand—medium to coarse. Caliche present probably as cavings	85
Sand—medium to coarse and some pebbles. Caliche present probably as cavings	95
Sand, glauconitic limestone, and sandy limestone—conglomerate?	105-116
Sand, chert, and conglomerate	121
Sand—medium to coarse, with much chert and considerable yellow clay	129
Sand—medium to coarse and considerable chert	132
Dolomite—fine grained and light gray, some sand	133
Dolomite—fine grained to very fine grained and micrograndular, and pink with some chips near white. Some limestone	133-140
Dolomite—micrograndular and beige	140-145
Dolomite—micrograndular, rose, beige, and other colors. Rare chips contain fine grained sand	145-150
Dolomite—fine grained, light to medium gray and red	160-162
Dolomite—fine grained	170-174
Dolomite—medium to fine grained, some micrograndular, and white to beige	174-179
Dolomite—micrograndular, some medium grained	179-181
Dolomite—coarse grained, light gray, and chert subgranular to porcellaneous	290-320
Dolomite—fine to medium grained, light gray, and chert subgranular to porcellaneous ranging from dolomolitic to intercritial	330-340
Chert—porcellaneous to subgranular, white, and with some quartz and fine to medium grained dolomite	340-350
Dolomite—fine grained, light gray, and chert scarce	360-370
Dolomite—very fine grained to fine grained	370-385
Dolomite—medium grained and with very abundant chert porcellaneous to subgranular and quartzose and ranging from dolomolitic to intercritial	380-390
Sand (cavings)	592
Dolomite—very fine grained to micrograndular and greenish gray	594
Dolomite—very fine grained and greenish gray	596
Dolomite—very fine grained and medium gray	610-611

R. L. Raborn, Jr., No. 1 E. and G. Lochte Well

	Depth in feet
Sandy limestone—mostly yellowish gray and similar in appearance to variegated materials seen in outcrop at the base of the Cretaceous interpreted as being ancient caliche. In addition there is considerable sand and numerous fragments of various Paleozoic rocks. This interval is interpreted as being conglomerate in part changed to caliche	172-177
Limestone—sublithographic, light gray to medium light gray and light olive-gray and in part silty. A few dolomite rhombs and pyrite crystals are present	230-240
Limestone and dolomite—ranging from fragments of one through mixtures to fragments of the other. The dolomite is very fine grained, light gray to beige and mostly very pale orange. The limestone is sublithographic and mostly yellowish gray	260-263
Limestone—sublithographic, light olive-gray to yellowish gray, silty, some dolomite rhombs and pyrite present	280-290
Limestone—sublithographic, yellowish gray, and some silty particles are a light olive-gray. Dolomite rhombs are common	305-310
Limestone—sublithographic, light brownish gray to yellowish gray. Dolomite rhombs, silt particles, and pyrite are common	310-315
Limestone and dolomite—mostly sublithographic limestone but with some chips containing dolomite and others being fine grained dolomite from light gray to yellowish gray	325-330
Limestone—sublithographic, very light gray in part with yellowish cast, and in part yellowish gray, silty, some pieces abundantly fine grained dolomite, and some pyrite is present. Between 355 and 360 feet some chips are light olive-gray (13 samples)	340-412
Limestone and dolomite—the limestone is sublithographic and predominately cherty gray. Dolomite and pyrite scarce between 412 and 421 feet; about 50 percent dolomite between 440 and 446 feet; considerable fine grained to very fine grained dolomite between 455 and 460 feet; some very fine grained dolomite between 460 and 481 feet; highly dolomite with very fine grained rhombs between 481 and 490 feet; about half very fine grained light olive-gray to olive-gray dolomite between 495 and 508 feet; considerable very fine grained to fine grained dolomite between 508 and 514 feet; about half very fine grained dolomite between 514 and 520 feet; considerable very fine grained dolomite between 531 and 560 feet; and a few fragments between 560 and 568 feet contain small green areas which might be glauconite (23 samples)	412-568
Limestone—mostly sublithographic and some that is granular. The granular limestone contains rounded darker areas and some clay-like, faint green mineral. Some fine grained to very fine grained dolomite is present	568-576
Limestone and dolomite—the limestone is granular to sublithographic and the dolomite is fine grained to very fine grained. Both are very light gray to yellowish gray and some chips are of a grayish orange color	576-585
Dolomite—finely ground and in part fine grained, but some may be medium grained or even coarse grained, very light gray to yellowish gray (4 samples)	620-632
Dolomite—medium grained to coarse grained and very light gray	632-633
Dolomite—fine grained to coarse grained, very light gray and light greenish gray	635-640
Dolomite—fine grained and some medium grained, very light gray and some light greenish gray	640-651
Dolomite—fine grained to medium grained, very light gray to light greenish gray, and considerable glauconite. Some granular limestone is also present (4 samples)	651-674
Dolomite—finely ground but probably fine to medium grained, very light gray to yellowish gray, glauconite scarce (3 samples)	674-691
Dolomite—finely ground but probably coarse grained, very light gray to white (3 samples)	689-701
Dolomite—mostly finely ground and apparently mostly coarse grained and white (9 samples)	701-748
Dolomite—mostly finely ground and apparently mostly coarse grained and white	754-760
Dolomite—coarse grained and white, with about 5 percent of greenish gray shale	760-766
Dolomite—coarse grained and white, with variable amounts of greenish gray shale, probably cavings (6 samples)	766-818
Dolomite—coarse grained, very light gray, and variable amounts of greenish gray shale probably cavings (2 samples)	818-834
Dolomite—coarse grained and mostly pinkish gray with a few greenish gray shale fragments probably as cavings. Between 906 and 924 feet the dolomite is white, and between 940 and 948 feet it is very light gray (13 samples)	834-948
Dolomite—fine to medium grained, light gray to yellowish gray (3 samples)	948-965
Dolomite—fine grained and very light gray to yellowish gray (2 samples)	980-994
Dolomite and limestone—dolomite fine grained and very light gray, and some limestone sublithographic and white	994-1001
Limestone—sublithographic and white	1001-1010
Dolomite and limestone—mostly very light gray calcitic, fine to medium grained dolomite and some white sublithographic limestone	1010-1019
Dolomite and limestone—about equally fine grained dolomite and white sublithographic limestone. A small amount of very fine grained glauconite is present	1019-1025

R. L. Raborn, Jr., No. 1 Carl Hohenberger Well

	Depth in feet
Calcareous clay—light greenish gray, dolomitic, and containing some shell fragments	240-260
Calcareous clay—light greenish gray and dolomitic	310-315
Calcareous clay—shell fragments are abundant and in one of the samples some limestone fragments are present	335-345
Shale, limestone, and dolomite—shale medium light gray; dolomite yellowish gray; and limestone light gray. Much of the dolomite and limestone is silty and contains fine sand	345-355
Clay—light greenish gray and slightly calcareous	355-365
Shale, sand and limestone—shale light olive-gray to medium light gray; sand poorly sorted and up to medium grained; and limestone mostly yellowish gray. *Orbitolina* common	420-430
Limestone and sand—limestone light yellowish gray and sandy; and sand poorly sorted and up to coarse grained. Fossil fragments are common and include echinoid spines	430-440
Sand and limestone—the bulk of the sample is fine to medium grained, light gray sand. A 2-inch fragment of white microcrystalline limestone contains a pelecypod cast	440-445
Sand—poorly