GEOLOGY OF THE HARPER QUADRANGLE, GILLESPIE COUNTY, TEXAS

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GENERAL SETTING

Harper quadrangle is in the Edwards Plateau province south of the Llano region. The plateau surface within the quadrangle is dissected by the Pedernales River and its tributaries in the southern part and by Threadgill and Edwards Creeks in the northern part.

The geology of the Harper quadrangle is shown on a planimetric map, and the only topographic map available is the reconnaissance 30-minute Kerrville quadrangle. Elevations ranging between 1,891 and 2,226 feet were determined during traversing for control, but only the highest point was reached. The lowest point is somewhere in the southeastern part of the quadrangle and is estimated to be at an elevation of about 1,800 feet, giving about 425 feet of relief for the quadrangle.

About two-thirds of the quadrangle is directly drained by Pedernales River and its branches. The northern third of the quadrangle is in the Llano River drainage basin and is drained by Edwards Creek, Maverick Spring Branch, and the headwaters of Threadgill Creek, which reach Llano River by way of Threadgill Creek and Beaver Creek.

The Harper quadrangle is on the south side of the Llano uplift, and Cretaceous rocks crop out in all of the quadrangle. Rocks of Cambrian and Ordovician age are not far beneath the more deeply incised streams. The Cretaceous rocks are essentially horizontal and may dip 2 or 3 feet per mile to the northwest.

Broader discussions of the stratigraphic, structural, economic, and geophysical problems of the region are given in references cited below. This publication on the Harper quadrangle is one of a series of similar publications, an index to which is shown on the opposite page. The reader is referred to the index map to locate other quadrangles mentioned in the present text.

GEOLOGIC FORMATIONS

MESOZOIC ROCKS

CRETACEOUS SYSTEM (LOWER CRETACEOUS)

Shingle Hills Formation

Hensell sand member (Barnes, 1948).—The Hensell sand does not crop out in the Harper quadrangle, but it is close to the surface at the point where Pedernales River leaves the quadrangle.

Glen Rose limestone member.—The Glen Rose limestone member is estimated to be about 90 feet thick in the southeastern part of the quadrangle and consists of alternating beds of limestone, dolomite, clay, and sand or, more correctly stated, beds having various proportions of these materials. Only 4 feet of Glen Rose beds are described in the section given below.

The Glen Rose limestone, consisting of beds having varying resistance to erosion, elsewhere in Gillespie County produces a terraced topography which shows clearly on aerial photographs. In the Harper quadrangle, however, the slopes are more gentle, colluvial materials are thicker, and little of the vegetational banding so common to the Glen Rose is present. The Glen Rose limestone is not very fossiliferous within the Harper quadrangle, and no fossil collections were made from it.

Fredericksburg Group

Included within the Fredericksburg group of the Harper quadrangle is about 307 feet of Edwards limestone, 30 feet of Comanche Peak limestone, and 3 feet of Walnut clay. The boundaries between the units are gradational, and for this quadrangle, 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 easily be dropped from group to formational rank, especially as the U. S. Geological Survey excludes the Kiamichi clay from the Fredericksburg group (Wilmarth, 1938, p. 776).

Walnut clay.—The thickness of the Walnut clay measured along Pedernales River is 3 feet. It rests on and fills cracks in the upper 2 feet of a clay bed in the Glen Rose. The clay of the Glen Rose is similar to that of the Walnut but does not contain *Exogyra*. Within the quadrangle the Walnut clay is shown on the map as a solid color line.

The Walnut clay is composed of highly calcareous, silty, fossiliferous clay mostly as films in impure nodular limestone. In fresh outcrop the Walnut is light greenish gray to light olive-gray, but in most outcrops it is weathered to a yellowish gray mottled by yellowish orange. It is too thin to influence noticeably the vegetation and culture of the area and in most of its outcrop is covered by material creeping down from the Comanche Peak limestone and Edwards limestone.

Many fossil collections made from the Walnut clay also contain fossils from the basal portion of the overlying Comanche Peak limestone because the fossils from both units weather free and intermingle. Fossils collected along Pedernales River, locality 17-23A, have been identified by Dr. Ralph Imlay as follows:

Tylostoma cf. regina (Cragin)
Nerinea texana Roemer?
Lunatia? sp.
Aporrhais? sp.
Lunatia? pedernalis (Roemer)
Protocardia texana (Conrad)
Protocardia multistriata Shumard
Cardita sp.
Protocardia sp.
Cyprimeria texana (Roemer)
Arrtica spp.
Brachydontes pedernalis (Roemer)
Exogyra texana Roemer
Gryphaea wardi Hill and Vaughan
Gryphaea sp.
Holectypus cf. planatus Roemer

Comanche Peak limestone.—In the section described below, the Comanche Peak limestone is 31 feet thick, which is slightly thicker than in the adjacent quadrangles to the north and east. The Comanche Peak limestone grades downward into the Walnut clay. Upward it grades into the Edwards limestone, and the boundary is arbitrarily placed at the base of a thin-bedded, very fine-grained limestone which contains chert in some outcrops in adjacent quadrangles.

The Comanche Peak limestone contains considerable argillaceous material especially in its basal part. The lower portion of the Comanche Peak tends to be nodular, is mostly burrowed, and is mostly fossiliferous. The upper portion is much less argillaceous, is well bedded, and is lighter colored.

The Comanche Peak limestone is softer and more massive than the overlying Edwards limestone and tends to erode into steeper slopes. Within the Harper quadrangle, however, the Comanche Peak slope is much less well developed than usual, and colluvial materials cover most of its outcrop. Along Pedernales River the massive character of the Comanche Peak is well displayed where the underlying softer Glen Rose beds have been removed, thus allowing house-size blocks of the lower portion of the Comanche Peak to topple to the river bed.

The Comanche Peak limestone has a distinctive vegetation which on north slopes in most areas shows clearly on aerial photographs as a black band. In the Harper quadrangle the more thickly vegetated band, while present, is not as distinctive as elsewhere where the colluvial cover is less. A narrow-leaf oak identified by Cuyler (1931) as "*Quercus* sp. near Sargent (Texas oak)" is the dominant tree on the Comanche Peak limestone.

In mapping the Comanche Peak limestone, points at which its boundaries cross roads were placed on aerial photographs. In addition points of contact were mapped at many places between roads. On portions of the photographs having stereoscopic coverage the boundaries were traced under the stereoscope, and where stereoscopic coverage is lacking, the boundaries can still be very closely approximated by following the vegetational banding. It is possible, however, that within the quadrangle in areas covered by colluvial material, the upper boundary of the Comanche Peak limestone has been mapped too high and that the outcrop belt of Comanche Peak shown is too wide.

The Comanche Peak limestone is fossiliferous especially in its lower portion, and indications of fossils are present elsewhere in it. Two collections were made directly from the Comanche Peak limestone, and, as explained above, some of the fossils from locality 17-23A are also probably from the Comanche Peak limestone. The fossils have been identified by Dr. Ralph Imlay as follows:

Locality 17-13A, along Edwards Creek in north portion of quadrangle—
Monopleura pingsiscula White
Caprinula crassilabra (Roemer)
Pseudonerinea? spp.
Pecten (Neithea?) dupliciosta Roemer

Locality 17-17A, about 5.6 miles east-southeast of Harper—
Holectypus cf. *enprrandi* Lambert

Edwards limestone.—The Edwards limestone cropping out in the Harper quadrangle is about 307 feet thick, providing the beds between Pedernales River and Maner triangulation station are horizontal. The lower boundary, as explained above, is gradational and is arbitrarily placed at the base of a thin-bedded limestone which in quadrangles to the east is chert bearing. The Edwards limestone within the quadrangle is composed of a variety of rock types including limestone, dolomite, chert, and perhaps gypsum. The limestone and dolomite vary widely in composition, texture, thickness of beds, and hardness, and the expression of this variation is very well shown on aerial photographs by vegetational banding. The outcrop of the Edwards limestone has an average density of vegetation greater than that of the Glen Rose limestone, and in addition is much better segregated into bands. The Edwards limestone mostly forms gently sloping surfaces, and the hard limestone beds in the sequence 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 identified by Cuyler (1931) as "*Quercus fusiformis* Sargent (mountain scrub oak)?"

The Edwards surface below the gypsum horizon is mostly rocky with hard limestone beds and chert. The chert has a fairly general distribution, but some outcrop bands are free of it. Some of the chert in the Edwards limestone is of a quality suitable for the manufacture of artifacts, and because it was used so extensively by the aborigines, is mostly referred to as flint. The Edwards limestone within the quadrangle is so gently sloping and the rocks so poorly exposed that it is practically impossible to measure a complete section. The basal portion of the Edwards limestone along Pedernales River, however, is exposed in a bluff section and is described below.

The portion of the Edwards limestone above the gypsum horizon in general is composed of softer materials, and immediately above the gypsum horizon many of the limestone beds are tilted at various angles, indicating collapse. The Edwards limestone forming the highest outcrops within the quadrangle appears to be undisturbed and to have a very well-developed vegetational banding, whereas the soft disturbed zone beneath has very little banding. The softer portion of the Edwards limestone is extensively cultivated but tends to have a more uniform cover of vegetation in the uncultivated portion than does the Edwards either above or below.

Gypsum is present about 140 feet above the base of the Edwards limestone in north-central Gillespie County; however, no exposure was seen in the Harper quadrangle. The gypsum bed is thought to have extended over a wide area but, as indicated by collapse structures within the quadrangle, is probably now mostly removed by solution.

No fossil collections have been made from the Edwards limestone within the Harper quadrangle, but fossils in chert have been seen at several places at approximately the level of the gypsum horizon.

QUATERNARY DEPOSITS

High gravel.—The high gravel within the quadrangle is probably mostly stream deposited and consists chiefly of pebbles, cobbles, and finer materials including some caliche. Much of the material is limestone, chert, and dolomite from the Edwards limestone, and some is limestone from the Comanche Peak. All of the deposits are located in the southeastern portion of the quadrangle.

Alluvium.—Deposits of alluvium are mostly situated along Pedernales River and its tributaries. A small amount in the northern part of the quadrangle is along Edwards Creek and Maverick Spring Branch. Narrow belts and patches of alluvium follow many of the lower drainages in the area but are insignificant and have not been mapped. Some of the alluvium is cultivated and some that is not cleared supports a growth of pevan trees.

SUBSURFACE GEOLOGY

No rocks of pre-Cretaceous age crop out within the quadrangle, and only one well is known to have gone through the Cretaceous. To the east in the Spring Creek quadrangle, the Rowe-tree No. 1 Kott well entered the Honeycut formation of Ordovician age, and to the southwest in the Dry Branch quadrangle, the Owen No. 1 Tatsch well entered rocks of Pennsylvanian age. In view of the extensive faulting in the pre-Cretaceous rocks of the Llano uplift, many rock units may be present. It seems likely that all units of the Ordovician and possibly some units of the Mississippian and Pennsylvanian may underlie the Cretaceous within the quadrangle. The presence of Cambrian or even pre-Cambrian rocks beneath the Cretaceous is possible.

The C. G. Williams No. 1 Oliver Hopf well in the Martha Noered survey is about 600 feet south of U. S. highway No. 290 and half a mile west of Flag Creek. Scattered samples received between depths of 405 and 615 feet are from the Hensell sand and its basal conglomerate. Below 615 feet the well is in dolomite and limestone of the Honeycut formation of the Ellenburger group. Description of the samples received to date of publication of this report is given below.

The information about the pre-Cambrian rocks is limited to gravity data. The entire quadrangle is in an area of high gravity values, and the highest value is near the eastern border of the quadrangle. Large gravity maxima in areas of outcropping pre-Cambrian rocks in the Llano uplift are associated with Packsaddle schist (Romberg and Barnes, 1944, and subsequent unpublished data). A well in the Spring Creek quadrangle situated to the east of the center of the maximum entered diorite. It is unlikely that the maximum is caused entirely by diorite, and since a poorly defined superimposed maximum exists to the west of the well, it is likely that a large diorite mass has intruded the Packsaddle schist.

MINERAL RESOURCES

The known mineral resources of the quadrangle are limited to nonmetallic substances and water. Outside of the soil, which is mostly used for range land, the most important nonmetallic resources are construction materials.

CONSTRUCTION MATERIALS

Building stone.—Some limestone beds in the Edwards limestone are of about suitable thickness for ledge-stone to be used in building. A few of these beds are of hard, light-colored limestone which should be an attractive building stone.

Road material.—Caliche derived from the weathering of Edwards limestone has been used for the surfacing of secondary roads and for base-course materials in highway construction. This material while of use for surfacing secondary roads has little value for base-course material since it causes freeze damage. Zones are present in the Edwards limestone, however, which should make good base-course material. Some of the rock in the Edwards may be hard enough for granules. Outcrops of hard limestone in the Edwards are present about 2 miles southeast af Harper along Pedernales River. A section along Pedernales River including the basal portion of the Edwards limestone is described below.

Sand and gravel.—The alluvial deposits along Pedernales River are thin, much silt and clay are associated with the gravel, and sand is limited to particles of chert and limestone. The deposits in general are of little value for sand and gravel. Some of the Edwards limestone, however, is suitable for the production of crushed rock.

WATER

A ground-water survey of Gillespie County was made by Shield (1937). Most of the nine wells and springs inventoried within the Harper quadrangle are located in the Edwards limestone outcrop area. In three of the wells water is probably produced from the Hensell sand, and in the other three, the water is from near the base of the Edwards limestone. Two of the springs issue from near the base, and the other is located about 100 feet above the base of the Edwards limestone. The wells range from 77 to 283 feet in depth, and the water level in 1936 stood between 19 and 232 feet below the surface. The total solids range from 214 to 354 parts per million.

A zone near the base of the Edwards limestone is the most readily utilizable aquifer within the quadrangle, and the Hensell sand beneath should also contain some water. No information is available on the rocks beneath the Cretaceous within the quadrangle, but it is unlikely that much of the Cretaceous will be underlain by water-bearing rocks reasonably close to the surface. The sandstones of the Cambrian probably are present beneath the quadrangle, but if their depth can be judged from wells to the east and west of the quadrangle, they still range from about 2,500 to 4,000 feet in depth.

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STRATIGRAPHIC SECTION

Pedernales River Cretaceous Section

Description	Thickness in feet Interval	Thickness in feet Cumulative	Feet above base
Fredericksburg group: 80 feet measured			
Edwards limestone: 46 feet measured			
1. Limestone—mostly extremely fine grained, yellowish gray, and massive but with some thinner bedded intervals. From 50 to 53.5 feet highly burrowed with burrows weathering to form honeycombed limestone; 53.5 to 55 feet massive but recessive; 55 to 57.5 feet resistant and honeycombed from burrows; 57.5 to 60 feet massive and recessive; 60 to 67 feet massive, resistant, dolomitic, and in upper 4 feet honeycombed from the weathering out of burrows; 67 to 69 feet argillaceous, recessive, and burrowed; 69 to 84 feet well-bedded limestone ranging from medium hard to soft. From 69.5 to 70.5 feet the limestone is a coquinite mostly of gastropods. Siphoneous algae were collected from fallen blocks in river and probably came from the 2-foot bed between 80 and 82 feet. Siphoneous algae were also seen at 70 feet and there is a slight possibility that the block could have come from this horizon. The limestone bed from 80 to 84 feet is mostly shell fragments, foraminifera, and some siphoneous algae. This bed also contains some flat pebbles which are intraformational in origin. A thin section of rock from 57 feet is limestone composed of minutely crystalline calcite and some scattered fine to medium grained calcite. Considerable indistinct organic material including foraminifera is present and much pellet-like material of the size of the foraminifera may be foraminifera with the tests destroyed. A thin section of rock from 70 feet is limestone composed of minutely crystalline calcite and about 15 percent coarse grained calcite in part replacing fossils and in part between fossils. The rock is a mass of fossils, most of which are gastropods and some of which are foraminifera. A thin section of rock from 73.5 feet is composed of minutely crystalline calcite containing numerous foraminifera and considerable other fossil material, mostly poorly preserved. A thin section of rock from 82 feet is limestone composed of minutely crystalline calcite and some fine to medium grained calcite. The rock is a mass of foraminifera and other fossil material. Many cloudy areas having the size of foraminifera are without tests. An area containing fewer fossils is sharply banded and is probably a pebble.	34	34	50 – 84
2. Dolomite—microgranular, porous, yellowish gray, resistant and containing some holes up to 2 inches in diameter. A thin section of rock from 48 feet is composed of large areas of dolomite and of limestone. The calcite is minutely crystalline and contains much organic material including some well-preserved foraminifera. Some dolomite is present in the calcitic areas. The dolomite is microgranular, contains no fossil remains but does contain rounded small cloudy areas.	2	36	48 – 50
3. Limestone—very fine grained, white to yellowish gray, well bedded, and having a wide variation in thickness of beds. From 38 to 39.5 feet very thinly bedded; 39.5 to 43 feet massive and containing dusky brown to dark yellowish brown chert as a layer of large nodules near base, another layer of nodules within 1 foot of top, and as sporadically distributed nodules in between; 43 to 46 feet beds one-fourth inch to 3 inches thick, recessive, and containing an inch-thick, dark yellowish brown chert layer at base having upward-extending protuberances; 46 to 48 feet one bed which is perhaps argillaceous and dolomitic, is recessive, and contains dark yellowish brown chert as a layer of bulbose nodules near base and as scattered nodules near top of interval. A thin section of rock from 44 feet is limestone composed of minutely crystalline calcite. It contains some organic structures including spine-like objects.	10	46	38 – 48
Comanche Peak limestone: 31 feet thick			
4. Limestone—microgranular, highly dolomitic, trace of sand, soft, yellowish gray containing some yellowish orange specks, well bedded, and bottom and top beds massive, being about 3 to 4 feet thick. The middle portion is in beds ranging from about 2 to 6 inches in thickness.	12	58	26 – 38
SHIFT 75 feet down Pecan Branch to Pedernales River and down Pedernales River a short distance to a good exposure. The portion of the section below 9 feet in interval 5 is described from a point 2,500 feet farther downstream.			
5. Limestone—fine grained, argillaceous, in part dolomitic, contains some fine to very fine sand which decreases in amount upward, yellowish gray, and highly fossiliferous. The bed between 8 and 9 feet is in part rusty, indurated, and cross-bedded with the cross-beds mostly dipping northwestward. In lower part it is a mass of pelecypod and gastropod casts, and in upper part it is a granular shell debris. The rest of interval is argillaceous, nodular, highly burrowed, in lower part highly fossiliferous, and in upper part sparsely fossiliferous. The fossils are mostly abundant pelecypod and gastropod casts and in lower part of interval some *Exogyra*.	19	77	7 – 26
Walnut clay: 3 feet thick			
6. Limestone and clay—the limestone is highly argillaceous, nodular, yellowish gray, highly fossiliferous, and makes up most of the interval. The clay is present as thin films mostly in the lower part of the interval. *Exogyra* and casts of pelecypods and gastropods are abundant. *Gryphaea* and echinoids are common. Fossils collected from this interval, locality 17-23A, are listed above. The rock in this interval has characteristics which more nearly ally it with the Comanche Peak limestone and perhaps it should have been so included.	3	80	4 – 7
Shingle Hills formation: 4 feet measured			
Glen Rose limestone member: 4 feet described			
7. Clay—probably calcareous, light greenish gray, and cracked to depth of 2 feet with olive-gray Walnut clay filling the cracks. The cracks are irregular and some are interconnecting and ladder or lattice-like in cross section. The filled openings appear to be cracks and not burrows.	4	84	0 – 4

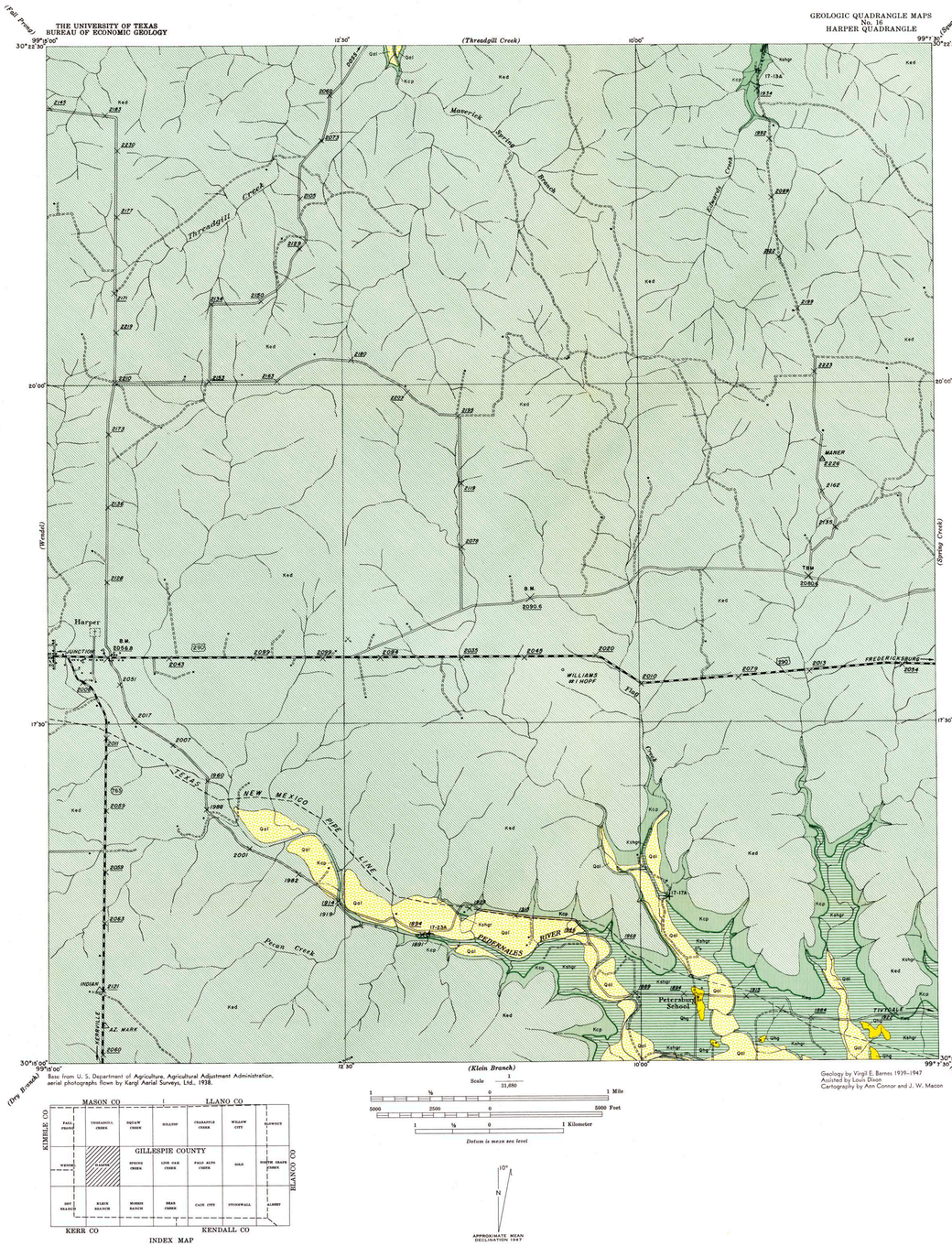
The amount of insoluble residue after hydrochloric acid treatment is as follows:

Feet above base	Percent residue
9–17	12.9
17–26	6.8
26–38	3.2
38–40	9.6
44–50	27.0
50–55	5.4
55–60	0.3
60–65	0.3
65–70	0.6
70–75	0.2
75–84	0.4

SAMPLE DESCRIPTION

C. G. Williams No. 1 Oliver Hopf Well

Description	Depth in feet
Sand, sandstone, caliche, and clay—the sand is angular, mostly quartz, and contains some microcline up to one-half inch in size. The sandstone is fine grained, silty, and brown. Caliche with much the appearance of limestone in the Ellenburger is sandy, and the clay is silty and red	405–410
Sand and caliche—the sand is very coarse, and is composed of quartz and some microcline. The caliche is similar to that from 405 to 410 feet	415–420
Sand—very coarse and composed of quartz and microcline	420–425
Sand and caliche—the sand is very coarse and is composed mostly of quartz and some microcline. The caliche is similar to that from 405 to 410 feet	425–426
Sand—coarse and composed of quartz and some microcline	570–575
Conglomerate—fragments of chert and dolomite from Ellenburger pebbles	595–600
Sand and conglomerate—the sand is similar to that described above, and the conglomerate is composed of weathered dolomite and chert from the Ellenburger	605–610
Dolomite—very fine grained, fine grained, and microgranular; light gray; and downward is finer grained and less cherty. The chert is white to light gray and porcelaneous to subchalcedonic	615–635
Dolomite—saccharoidal, mostly microgranular and some fine grained, and stained as if weathered. The chert is porcelaneous, mostly white, and some is stained pink	665–670
Dolomite—mostly very fine grained, incipiently altered, and has very fine pores partly filled by a powdery material. Chert is very scarce	670–675
Dolomite—very fine grained and some fine grained, mostly light gray and some is stained pink. Some porosity as in sample from 670 to 675 feet. Chert is very abundant, white, and porcelaneous	675–680
Dolomite—very fine grained, light gray, much of it stained pink, and porosity is common between grains	680–685
Dolomite—microgranular and yellowish gray. Abundant chert is semi-porcelaneous to subchalcedonic, and yellowish gray to pinkish gray	685–690
Dolomite—microgranular, yellowish gray, and some has a pinkish cast. There is a small amount of white porcelaneous chert	690–695
Dolomite—microgranular, and yellowish gray to pinkish gray. This sample contains some bright yellow mud, some white porcelaneous chert, and from 705 to 710 feet, some clear calcite	695–710
Dolomite—microgranular and yellowish gray. Abundant white chert grading to pink is porcelaneous, and some very white chert is tripolitic to granular. Calcite cleavage fragments are common	710–715
Dolomite—mostly microgranular, and a very small amount that is very fine grained, and yellowish gray to pinkish gray. White chert is both porcelaneous and tripolitic to granular	715–735
Dolomite—microgranular and pinkish yellowish gray	735–745
Dolomite—microgranular, light gray and some has a pinkish cast. The chert is very light gray and chalcedonic. Considerable sand has caved from the Cretaceous	745–750
Dolomite—very fine grained, very light gray, and some has a pinkish cast. A small amount of white chert is porcelaneous. Some Cretaceous material has caved	750–755
Dolomite—very fine grained, very light gray, and some has a pinkish cast	755–760
Limestone and dolomite—the limestone is sublithographic, yellowish gray, and the dolomite, very fine grained, very light gray, and a small amount of limestone	765–770
Limestone—sublithographic and white. The chert is white and porcelaneous	770–775
Calcite—large cleavage fragments	775–780
Dolomite—microgranular and white	780–790
Dolomite—microgranular, some approaching very fine grained, and yellowish gray to white some of it having a pinkish cast	790–795
Dolomite and limestone—mostly dolomite, as in above interval, and some white, sublithographic limestone. White, porcelaneous chert is rare	795–800
Limestone and dolomite—mostly white, sublithographic limestone, some microgranular dolomite, and some that is very fine grained and medium light gray. White subchalcedonic to porcelaneous chert is common	800–805
Dolomite—microgranular and very fine grained, and yellowish gray to medium light gray, the latter being somewhat pyritiferous. Chips of limestone are rare	805–810
Dolomite—microgranular, very light gray, and a small amount of medium gray, the latter being highly pyritiferous. Free pyrite is abundant	810–815
Dolomite—microgranular, very light gray, and contains rare pyrite	815–820
Dolomite—microgranular, very light gray, and contains a few rosettes of pyrite. White porcelaneous chert is common	820–825



GEOLOGIC MAP OF THE HARPER QUADRANGLE, GILLESPIE COUNTY, TEXAS

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