BUREAU OF ECONOMIC GEOLOGY
The University of Texas
Austin 12, Texas

JOHN T. LONSDALE, Director

Report of Investigations—No. 17

High Purity Marble Falls Limestone, Burnet County, Texas

By

VIRGIL E. BARNES

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HIGH PURITY MARBLE FALLS LIMESTONE, BURNET COUNTY, TEXAS

Virgil E. Barnes

ABSTRACT

Chemical analyses show that a reef approximately 100 feet thick in the lower portion of the Marble Falls limestone near Marble Falls, Burnet County, Texas, is exceptionally pure. Only the Honeycut formation, of the other formations described, contains limestone that might be of value. The type section of the Marble Falls limestone is described, including thin-section and insoluble residue descriptions.

GENERAL SETTING

The primary purpose of this paper is to report the presence and distribution of a high purity limestone in the Marble Falls limestone in the vicinity of Marble Falls. A secondary purpose, but the one responsible for the discovery of the high purity limestone, is to record the description of the type section of the Marble Falls limestone, which was flooded in mid-1951.

The writer, assisted by Mr. T. A. Anderson, mapped most of the 7½-minute Granite Mountain quadrangle (to be published at scale of 2 inches equals 1 mile and with accompanying text) during the spring of 1951. This map and text are inadequate for the description of the Marble Falls type section or accurate delineation of the reef areas within the Marble Falls limestone. Therefore, description of the section is given in this present paper for early publication pending the time when a comprehensive study of the Marble Falls limestone can be completed. Descriptions of the other formations in the restricted map area are included because general geological conditions will have some bearing on possible utilization of the reef limestone. All chemical analyses were made by Mr. R. M. Wheeler of the Bureau of Economic Geology.

GEOLOGIC FORMATIONS

ORDOVICIAN SYSTEM

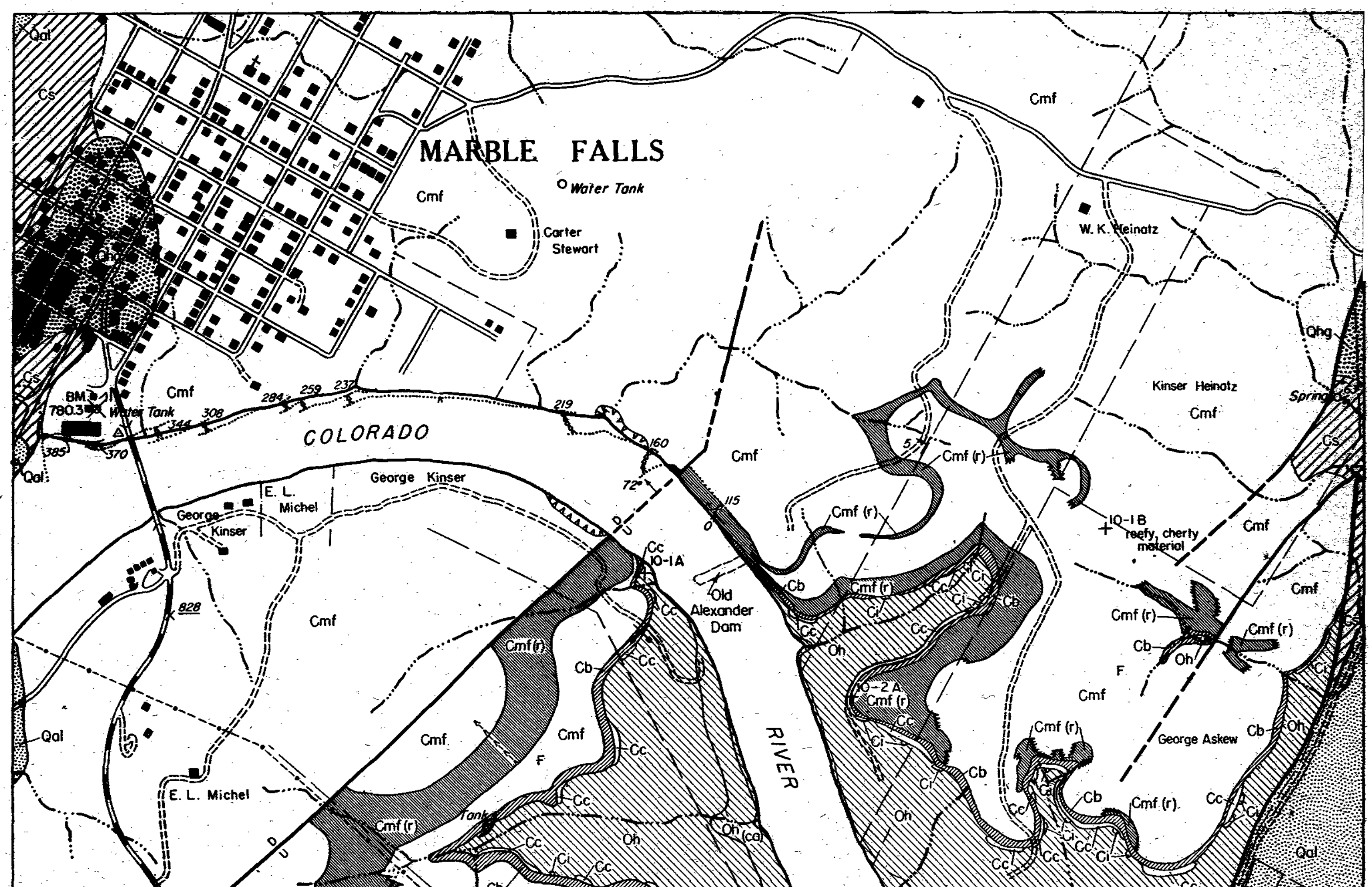
LOWER ORDOVICIAN (ELLENBURGER GROUP)

HONEYCUT FORMATION

The oldest rocks exposed within the map area (fig. 1) are of Ordovician age and include about 250 feet of the upper portion of the Honeycut formation of the Ellenburger group. An additional 100 feet of Honeycut beds was seen in cores taken from below river level in the exploration of the Marble Falls dam site. All together during the exploration about 250 feet of Honeycut rocks was cored, including about 150 feet of rocks above river level. Hole No. 21 south of the Colorado River is at an elevation of 832.3 feet, bottomed at 660 feet, and recovered about 150 feet of core out of a possible 172 feet. The rock preserved is described below, starting with the top of the core.

Description of core from Hole No. 21, Marble Falls dam site.

	Thickness in feet
Honeycut formation—	
Dolomite—very fine grained and very light gray	3
Limestone and dolomite—a mottled mixture	1
Limestone—sublithographic and white	6
Dolomite—very fine grained and light gray	1
Dolomite—very fine grained and very light gray	12
Dolomite—very fine grained and light gray	1.5
Dolomite and limestone—a mottled mixture	3.5
Dolomite—very fine grained and light gray	1
Limestone—sublithographic and white with considerable greenish shale in bottom foot	21
Dolomite—very fine grained and light gray	2
Limestone—sublithographic and white, some greenish shale	2.5
Dolomite—very fine grained and very light gray at top to light gray at bottom	11.5
Dolomite—microgranular, very light gray, and contains some greenish shale	3
Limestone—sublithographic and white, some dolomite in middle portion	9
Dolomite—very fine grained and light gray	11.5


MARBLE FALLS
Water Tank
Carter Stewart
W. K. Heinatz
Kinser Heinatz
COLORADO
RIVER
George Kinser
E. L. Michel
Old Alexander Dam
George Askew
10-1A
10-1B
reefy, cherty material
10-2A
BM 780.3
Spring
Tank
Cmf
Cmf (r)
Cb
Cc
Ci
Oh
Oh (ca)
Cs
Qal
Qhg
F
D
U

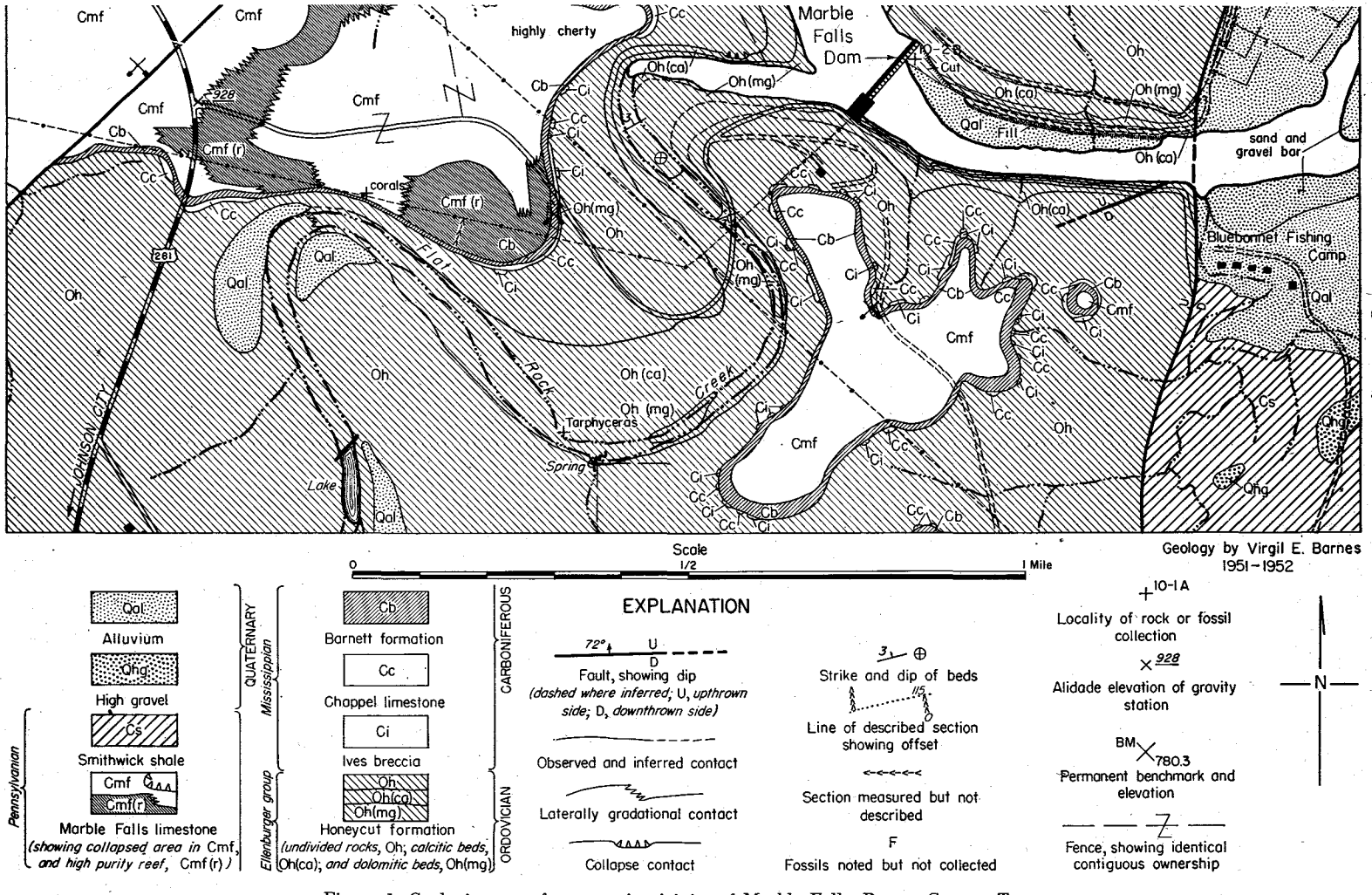


Figure 1. Geologic map of an area in vicinity of Marble Falls, Burnet County, Texas.

Honeycut formation—	*Thickness in feet*
Limestone—sublithographic and white	2.5
Dolomite—microgranular and very light gray	7
Dolomite—very fine grained and very light gray becoming slightly darker with depth	18
Dolomite and limestone—a mottled mixture	1
Dolomite—very fine grained and light gray	1.5
Limestone—sublithographic and white	7.5
Dolomite—very fine grained and light gray	1
Dolomite—microgranular and very light gray	7
Dolomite—very fine grained and light gray	4
Limestone—with some dolomite mottles toward bottom	7
Limestone—with some dolomite near bottom	4.5

Almost complete recovery of core was obtained from another hole, 99 feet deep, at the southwest corner of the power house; description of this core follows.

Honeycut formation—	*Thickness in feet*
Limestone—sublithographic and white, with numerous stylolites	5
Dolomite—very fine grained and light gray	1
Dolomite—microgranular and very light gray (this interval correlates with the fourth interval from the bottom of Hole No. 21)	7
Dolomite—very fine grained and light gray	4
Limestone—mottled by very fine grained, light gray dolomite, and with 1 inch of white, porcellaneous chert at top	4.5
Dolomite—very fine grained and light gray	1
Limestone and dolomite—a mottled mixture	1.5
Dolomite—very fine grained and light gray	0.5
Limestone—mottled to bedding streaked by dolomite	2.5
Dolomite—very fine grained and light gray	0.5
Limestone—sublithographic and white with stylolite near middle	4
Dolomite—very fine grained, light gray, and with mottles of limestone a few inches from base	4
Limestone—sublithographic and white	0.5
Dolomite—very fine grained and very light gray	4
Dolomite—very fine grained and light gray grading to very light gray at base	5
Dolomite—very fine grained and light gray	7
Limestone—mottled by dolomite	3
Dolomite—very fine grained and light gray	1
Limestone—mottled by dolomite	1
Limestone—with shale along stylolites in bottom 6 inches	3.5
Dolomite—very fine grained, light gray, has vertical and horizontal stylolites, and contains chert 1.5 feet above base	14.5
Dolomite—mottled by limestone	1.5
Dolomite—very fine grained and light gray	1
Dolomite and limestone—a mottled mixture with shale along stylolites in lower foot	2.5
Dolomite—very fine grained, light gray, somewhat stylolitic, and has vuggy porosity	2
Limestone—mottled by dolomite	6
Dolomite—very fine grained and light gray	1
Limestone—mottled by dolomite	6.5
Dolomite—microgranular, very light gray, and with vugs up to 1 inch in size	3.5

The cores examined are characteristic of the lithology and proportion of rock types to be found in the Honeycut formation within the map area. The cores are about 29 percent limestone; 9 percent microgranular, very light gray dolomite, 32 percent very fine-grained, light gray dolomite, 17 percent very fine-grained, very light gray dolomite (total 58 percent dolomite); and 4 percent mottled limestone-dolomite mixture, 8 percent dolomitic limestone, and 1 percent calcitic dolomite (total 13 percent of limestone-dolomite mixtures).

The cores from a number of other core holes in the area were examined. Lateral gradation is very common between the very fine-grained dolomite, especially the darker colored variety, and limestone. The

microgranular dolomite beds remain almost constant in thickness and provide excellent markers for structural work.

The 21-foot limestone in Hole No. 21 is more nearly constant in thickness than any of the other limestones encountered and forms prominent outcrops along both sides of Colorado River until it dips beneath the river at the old Alexander dam (now flooded). It also crops out along Flatrock Creek but was not mapped up Flatrock Creek beyond the point where it becomes cherty. The limestone has wide solution joints throughout most of its outcrop and locally oh the west side and near the mouth of Flatrock Creek has been entirely dissolved, allowing the overlying rock to collapse. This limestone appears to be rather pure but locally might be dolomitic. In most places the overburden increases rapidly beyond the outcrop, the limestone is rather thin to quarry, and where it crops out, the wide solution joints are in part filled by soil and clayey materials. Up Flatrock Creek beyond where the limestone was mapped, it is cherty, and some lateral gradation to dolomite was seen.

DEVONIAN SYSTEM

STRIBLING FORMATION

No Stribling rocks were found within the map area, but were seen within a hundred yards of the south border of the map area (fig. 1). The main outcrop which forms a hill about 4,000 feet south of the Marble Falls dam is composed of limestone, dolomite, and chert with rare *Leptocoelia* in the limestone. A granular, glauconitic rock is associated with the Stribling in a collapse structure which is about 50 feet lower in elevation than the main outcrop. Elsewhere rock of this type has been seen beneath the Stribling, and it is provisionally placed as a basal member within the Stribling. Other small outcrops of this basal unit are situated to the west.

MISSISSIPPIAN SYSTEM

IVES BRECCIA

The Ives breccia crops out widely and in all outcrops rests on the Honeycut formation. Much of the chert in the Ives appears to have been derived from the Stribling formation, and the rest is from the Honeycut formation. The Ives within the area is mostly less than a foot in thickness.

CHAPPEL LIMESTONE

The Chappel limestone crops out widely but probably no place within the area is as much as 2 feet thick, It contains considerable crinoid debris scattered in a fine-grained matrix. The limestone is tough, medium to rather dark gray, and has a brownish-olive cast. The Chappel limestone contains conodonts and other fossils such as trilobites and brachiopods, which are mostly diminutive.

BARNETT FORMATION

The Barnett formation forms a continuous outcrop beneath the Marble Falls limestone, is entirely exposed in two pits along roads near the Marble Falls dam, and is well exposed in a pit just south of the old Alexander dam. The Barnett formation, averaging about 10 feet in thickness, is composed of shale which contains a few limestone concretions averaging 2 feet in diameter by 6 inches thick. When freshly broken the concretions have a strong petroliferous odor.

PENNSYLVANIAN SYSTEM

MARBLE FALLS LIMESTONE

The Marble Falls limestone was first mentioned by Hill (1889) as being the basal formation of the Carboniferous in Burnet and Travis counties, Texas. In 1901 (pp. 93–96) Hill gave additional information about the Marble Falls limestone in the Marble Falls area, including supporting evidence for its Lower Pennsylvanian age. Paige (1912, p. 8) stated that the Marble Falls limestone is named for the typical exposure at Marble Falls, Burnet County. He briefly described the section along Colorado River downstream from Marble Falls, and this section has come to be designated the type section of the formation.

Plummer and Moore (1922), Cheney (1940), Plummer (1945b, 1947a, 1947b, 1950), and others have written extensively on the Marble Falls limestone and associated strata. Various classifications and interpretations of the stratigraphic sequence have been proposed. It is apparent that a comprehensive study of the Marble Falls

limestone should be made. A detailed study of the type section is one part of such a study. The section was carefully measured, sampled, footages painted, and described; the time for doing the work being dictated by the completion of the Marble Falls dam in mid-1951 followed by the flooding of the section, which in the past has been described near river level. It was during the course of this study that the high-grade reef limestone was discovered.

The section is still fairly well exposed above lake level but is not nearly so accessible for detailed work. Some segments of the present section and portions of others are above water level, and it is hoped that the following description is complete enough so that the section can be traced near lake level with the aid of the few painted footages that are not flooded. Some of the section will be missing at lake level in the collapsed area.

The section was chip-sampled at 5-foot intervals, and in addition chips were collected for thin sectioning. The chip-samples were crushed to simulate well cuttings and and examined under a binocular microscope. The amount of insoluble residue was determined, and the residue was examined under the binocular microscope. Samples from a portion of the section containing very little insoluble residue were chemically analyzed and found to be exceptionally pure limestone.

The pure limestone is a compact reef limestone, and the shape of the reef in the line of section can be best seen from the south bank of the Colorado River. Inter-reef cherty beds in the line of section lens out in both directions. Another small lens of similar rock is situated to the east, and in the vicinity of the old Alexander dam similar beds thicken rapidly southeastward along the bluff and swing inland as they rise higher topographically (fig. 1).

The upper portion of the reef where it leaves the bluff is less than 10 feet thick, and the upper surface displays the typical hummocky surface common to reefs of algal origin. This portion of the reef terminates eastward in about half a mile, grading to bedded siliceous limestone. The lower portion of the reef where it leaves the bluff is about 40 feet thick; after swinging around a prominent drain the reef terminates in less than half a mile from the point where it bifurcates in the bluff. The search for high purity limestone reefs was continued eastward, and additional small ones were found.

The massive, cherty limestone between one-half and three-quarters of a mile east of the old Alexander dam is probably mostly reef but has not been mapped as reef because of the chert. A few foot-thick, 10-foot long lenses of light olive-gray dolomite are also present. These rocks may be in an area where reef and inter-reef or flanking beds interdigitate.

Just to the east of this area the lower portion of the Marble Falls limestone is bedded spiculiferous limestone and some spiculite, whereas to the south the non-reef limestone at the same horizon is of entirely different appearance, being less well bedded and containing abundant chert in variously textured, colored, sized, and shaped masses. It is possible that the cherty beds may be inter-reef, and the spiculiferous limestone and spiculite may flank or be between reef areas. The point marked "F" (fig. 1) indicates an area where sponges made up of closely packed rod-like spicules are exposed on a bedding surface.

The reef southwestward from Colorado River continues for about a mile and dies out before it reaches the fault a mile south of Colorado River bridge. Throughout most of the distance, about 75 feet of the upper portion of the pure reef limestone appears to be present; the lower portion though still in part reefy is mostly highly cherty. The pure reef limestone extends to the bottom of the Marble Falls just east of U. S. highway No. 281, and an isolated outcrop, 45 feet thick, of pure reef limestone at the base of the Marble Falls forms a low hill to the east. Fossils at the point **marked "F" are numerous silicified bryo**zoans, in part in chert and in part weathering free, and some silicified brachiopods. The beds overlying the reef are mostly thin and cherty.

The description of the Marble Falls type section is as follows:

Description	*Thickness Interval*	*Thickness Cumulative*	*Feet above base*
The top of the section is on the north bank of Colorado River in Marble Falls and is a few feet southeast of the southwestern corner of the big building upstream from the Colorado River bridge. The overlying Smithwick shale is not exposed in the line of section.			
1. Spiculite—very fine grained, dark gray, highly cherty, beds plane, in part very thinly bedded and in part with beds up to 1.5 feet thick, but very finely laminated. The top bed is highly cherty and less laminated. Caudigalli are common.	15	15	370–385
SHIFT downstream 200 feet eastward to east side of power plant and continue down in section.			
2. Spiculite—very fine grained, dark gray, highly cherty, and beds plane mostly 1 to 1.5 feet in thickness, and faintly laminated but with laminae very closely spaced. The top 1.5 feet is honeycombed chert. Caudigalli are common.	6	21	364–370
A thin section from 365 feet is composed of closely compacted silica spicules, a small amount of calcite, and dark-colored carbonaceous material. The spicules are in part deformed from being so closely packed. The dark-colored material is erratically distributed along the bedding and the darker patches may indicate horizontal burrows. A burrow about 2 mm in diameter perpendicular to the bedding crosses the entire thin section.			
3. Limestone—fine grained except for the top 3 feet which is very fine grained, between light brownish gray and light olive gray, mottled as if burrowed, massive, and beds 2 to 5 feet thick. Chert is very scarce and that which is present is in thin, irregular patches along a few bedding planes. Microfossils are not abundant, and a few brachiopod cross sections were seen in the lower part of the interval.	20	41	344–364
A thin section from 345 feet is composed of closely packed fossil debris as well as some spicules and foraminifera in extremely fine grained, cloudy, interstitial calcite. Material of this type is separated by a stylolite from a small area composed of fine grained mostly clear calcite which contains fossil debris of about the same type but not nearly so abundant. Both areas contain rare grains of a green mineral which is probably glauconite.			
A thin section from 354 feet is composed of two different types of limestone separated by a stylolite. One is composed of extremely fine grained, cloudy calcite containing some fossil debris, siliceous and calcitic spicules, and some foraminifera. The other contains about the same proportion of fossil material, but the calcite is only slightly cloudy to clear and coarser grained. In this portion more of the fossil debris appears to be replaced by granular calcite.			
A thin section from 363 feet is a pelleted limestone in which the 0.1-mm pellets are cloudy, extremely fine grained, and in a groundmass of very fine grained clear calcite. Foraminifera are common as well as spicules, some of which are calcitic and others siliceous. Fossil debris, except for very finely comminuted material, is scarce. One zone crossing the thin section is much more spiculiferous than the rest of the section.			
SHIFT downstream 500 feet eastward crossing highway and continue down in section.			
4. Limestone and spiculite—the limestone is fine grained, highly spiculiferous, medium gray to medium dark gray, and the spiculite is dark gray. The rock is thin to medium bedded, being thin and nodular from 326 to 334 feet, and mostly in beds which are cherty, plane, and 1 to 6 inches thick from 334 to 336 feet. The limestone is highly spiculiferous and cherty from 336 to 342 feet and the top 2 feet is a massive, somewhat honeycombed chert, the holes resulting from the leaching of eyes of limestone. The chert is somewhat lighter in color than the interval as a whole, tending toward light olive gray and yellowish gray. Brachiopods are common in the lower 8 feet.	18	59	326–344
A thin section from 335 feet is composed of chert and highly siliceous limestone. The quartz grains forming the chert are rather large, 0.05 mm, but have the typical irregular extinction of chalcedonic silica. Silica spicules are very abundant in the chert and			

Description	Thickness Interval	Thickness Cumulative	Feet above base
some calcite is present. The siliceous limestone is very highly spiculiferous and the calcite contained is extremely fine grained, extremely cloudy, and brownish gray. Considerable dark brown, nearly opaque, carbonaceous matter is present. Some of the spicules are hexactinellid.			
A thin section from 338 feet is composed of abundant siliceous spicules, fossil debris, and foraminifera including fusulinids in an extremely fine grained, exceedingly cloudy, gray to brownish gray matrix. Circular areas interpreted as being burrows contain much less fossil material and are consequently slightly darker in color and appear to be finer grained. Dark brown, nearly opaque, carbonaceous material is common in the darker colored portions of the section.			
A thin section from 343 feet is composed predominantly of silica spicules so closely packed that many of them are deformed, and some interspicular very fine grained, highly cloudy calcite, dark brown carbonaceous material, and silica.			
5. Limestone—very fine grained, medium gray to medium dark gray in lower part and between medium gray and light olive gray in upper part, and beds about 1 foot thick in lower part and 4 to 6 inches thick in upper 2 feet. Brachiopods are common in the lower 2 feet, corals are abundant in the top bed, and microfossils are abundant in a bed at 324 feet but scarce in the rest of the interval.	8	67	318–326
A thin section from 324 feet is composed of extremely fine grained, highly cloudy, brownish calcite containing extremely numerous silica spicules and fossil fragments, and a few foraminifera, one of which may be a fusulinid. One circular area about 2 mm in diameter is composed of dark brown, slightly translucent material which may be filling a burrow.			
6. Limestone—very fine grained, between pale yellowish brown and light olive gray, massive, and beds starting at bottom of interval are 10 inches, 18 inches, and 5.5 feet thick followed by beds mostly between 1 and 2 feet in thickness. Fossils are involute gastropods in top surface, cup corals at 316 feet, and very small microfossils.	12	79	306–318
A thin section from 316 feet is of a breccia-type material containing angular to rounded fragments of extremely fine grained, highly cloudy limestone surrounded by less cloudy slightly coarser grained limestone, as if soft sea bottom had been disturbed with some of the soft mud remaining intact and some flowing between the fragments. Some clear, vein-like areas of fine grained calcite appear to have formed soon after the disturbance, and still later narrow well-defined veins of calcite cut everything. The breccia fragments contain much very small, curved, thin-walled, shell debris, a few foraminifera, and an occasional spicule. Very little fossil material except rare spicules are in the matrix surrounding the breccia fragments.			
SHIFT downstream 400 feet eastward and continue down in section.			
7. Limestone—very fine grained, between medium gray and light olive gray, highly spiculiferous, and massive except for rather thin bedding lamella and top 6 inches which is nodular. Foraminifera are present but are not abundant.	4	83	302–306
A thin section from 305 feet is composed of extremely fine grained, cloudy calcite containing abundant siliceous spicules and fossil debris, a few foraminifera, and a small amount of chert. Some of the fossil debris is replaced by very fine grained clear calcite. Some yellowish brown, highly spiculiferous limestone is in irregular contact with the rest of the limestone.			
8. Limestone—very fine grained, between light olive gray and light brownish gray, and massive. Some chert at 300 feet, and in top bed chert is mostly calcareous. Microfossils are common and at 298 feet, away from the line of section, there is a *Chaetetes* 5 by 11 inches in size.	5	88	297–302
A thin section of the *Chaetetes* reveals a beautiful cellular struc-			

Description	*Thickness Interval*	*Cumulative*	*Feet above base*
ture, the walls of which have aggregate polarization with indistinct extinction following the walls as the stage is rotated. Most of the cells are filled by 0.05-mm clear calcite mosaics, some are filled by one crystal of quartz, others by several crystals, and these grade into chalcedonic quartz which displays aggregate polarization. A few dolomite rhombs are associated with the latter.			
9. Limestone and spiculite—fine grained, medium gray to medium dark gray, spiculiferous, and beds in upper part 2 to 4 inches thick and nodular, and in lower part thicker and plane. Some thin layers are mostly spiculite. Fossils are a few brachiopods and cup corals and rare microfossils.	4	92	293–297
A thin section from 295 feet is composed of extremely fine grained, cloudy calcite containing some fossil debris, a brachiopod, a few foraminifera, some spicules both siliceous and calcitic, some stylolites, and some 0.5-mm pellet-like areas surrounded by very fine grained, clear calcite. The pellets are slightly darker than the rest of the section. Some millimeter-sized calcite crystals are within the brachiopod as well as some centrally located cloudy calcite similar to that of the rest of the section. Some of the fossil debris is replaced by 0.1-mm clear calcite. The stylolites are not well defined except where there is an accumulation of brown material or silica along them. Viewed with a hand lens the section has areas of slightly different color and texture which suggests that the limestone may be composed of intraformational pebbles modified in shape by solution along the stylolites.			
10. Limestone—fine to medium grained, beds 6 to 30 inches thick, and light olive gray mottled medium gray. The mottles anastomose and may be burrows. Network chert is common at several levels. The top few inches are either an intraformational conglomerate or a solution breccia. Fossils are abundant minute microfossils, and at 289 feet small fusulinids.	9	101	284–293
A thin section from 285 feet is composed of fine grained fossil debris and foraminifera of several species in a mostly fine grained, clear matrix. The matrix in a portion of the section is extremely fine grained and brownish gray. Disseminated chert is in one small area. Fossils are a few calcite spicules and fossil debris composed of crinoid and shell fragments.			
A thin section from 289 feet is composed of closely packed foraminifera, grains of limestone, perhaps a few oolites, and fossil debris. The matrix ranges from very fine grained, clear calcite to extremely fine grained, cloudy calcite. The limestone grains are highly cloudy and may in part be derived from an extremely fine grained limestone. The fossil debris is mostly crinoid and shell fragments.			
SHIFT downstream 600 feet eastward. The beds are lenticular and the shift is accurate within 1 or at most 2 feet.			
11. Limestone—very fine grained, medium gray to medium dark gray, mottled, highly cherty, contains many, spicules, and in two beds. The chert in the lower part is in a network with eyes of limestone, and in upper part is more nearly along the bedding planes and in plates half an inch thick. A cup coral in lowest bed.	5	106	279–284
12. Limestone—fine to medium grained, light olive gray, very massive, and perhaps in part a limesand. From 259 to 270 feet and 270 to 276.5 feet essentially two beds. Thin zones of siliceous material are at 265 feet and above 272 feet, and a well-developed layer of flattened, branching chert nodules is near the top of the interval. Foraminifera are especially abundant in the lower bed and upward become less numerous.	20	126	259–279
A thin section from 266 feet is composed of extremely fine grained calcite containing numerous foraminifera and oolites, and some calcareous spicules and fossil debris. A few of the shell fragments may be portions of ostracods.			
A thin section from 269 feet is very coarse grained fossil debris and sand derived from a much finer grained limestone in a fine grained clear matrix of calcite. Crinoid fragments predominate, ostracods are common, foraminifera and shell fragments are abundant,			

Description	Thickness Interval	Thickness Cumulative	Thickness feet above base
and some large whorls may be from small gastropods. Many of the whorls and some of the ostracods contain oolites and fossil debris not common to the matrix, indicating that the oolites and debris were emplaced elsewhere.			
SHIFT downstream 150 feet eastward.			
13. Limestone—very fine grained, medium gray, and in a bed about 2.5 feet thick resting on a 6-inch zone of thinly laminated recessive material which in turn rests on about a foot of dark gray chert which is in part calcareous and pyritic. A dark gray, 10-inch chert bed which is in part calcareous tops the interval. Fossils are numerous silica spicules and a few foraminifera.	5	131	254–259.
A thin section from 255 feet is mostly silica spicules and a few crinoid fragments in a matrix of gray, extremely fine grained calcite.			
14. Limestone—highly spiculiferous and cherty, being fine grained except for a few inches of coarse grained material at the bottom, and medium gray with some approaching light olive gray. The lower foot is in 3-inch beds with recessive zones between and the whole tending to be recessive. The rest of the interval is massive, being made up of a network of chert with eyes of spiculiferous limestone. Laterally as much as 6 inches of spiculiferous limestone replaces the chert. The top 2 feet is less cherty, and it appears that chertification is being selective with the unchertified material being perhaps burrows.	6	137	248–254
A thin section from 252 feet is composed of highly spiculiferous, in part cherty, brownish gray, extremely fine grained calcite which contains some crinoid debris, shell fragments, and quarter-inch burrows. The material in the burrows is lighter gray and contains numerous foraminifera, a few spicules, and much fossil debris. The bedding is disturbed as if thrust aside during the formation of the burrow.			
15. Limestone—very fine grained, slightly spiculiferous, lower 3 feet is pale yellowish brown, and rest of interval is between yellowish brown and light olive gray. A small amount of chert is parallel to the bedding near the middle of the interval. A few foraminifera and much unidentified small material is present. The beds are massive, being mostly a foot or more thick except for the top foot which is nodular and very irregularly bedded.	11	148	237–248
A thin section from 242 feet is composed of brownish gray, extremely fine grained calcite, silica spicules, crinoid debris, some shell fragments, a few foraminifera, and portions of pebbles much lighter colored than the matrix. The pebbles are flat and elongate, and in comparison with the matrix are slightly coarser grained, contain more foraminifera, less fossil debris, and fewer spicules.			
SHIFT downstream 300 feet eastward.			
16. Limestone—very fine grained, between light brownish gray and light olive gray, and contains a large amount of brownish gray chert in nodules to anastomosing layers of nodules which contain spicules and other small objects. The top surface has a burrowed appearance and in places contains rectangular pieces up to a foot in length which appear to be intraformational slabs.	7	155	230–237
A thin section from 236 feet is about half extremely fine grained, cloudy calcite containing numerous small foraminifera, rare spicules, and some scarcely recognizable fossil fragments. The rest of the section is highly spiculiferous, dark gray, extremely fine grained calcite in which portions of three-quarter-inch, much less fossiliferous, circular areas of lighter color are present which are probably burrows. These areas vary widely in the amount of fossil debris contained.			
17. Limestone or spiculite—fine grained, dark gray, and contains much grayish black chert and some that is brownish black. The lower part of the interval is almost entirely fissile spiculite which is thinly laminated and in plane beds, contrasting with the irregular beds lower in the section. Upward the rock is	11	166	219–230

Description	*Thickness Interval*	*Cumulative*	*Feet above base*
progressively more cherty, and the lamellae less plane and less numerous. Vertical calcite veins trend N. 52° W., and a prominent joint set trends N. 48° E.			
A thin section from 224 feet is composed of siliceous spicules and a few crinoid fragments in a matrix of extremely fine grained, dark gray calcite. One area of very fine grained calcite surrounded by concentric light brownish gray calcite may be a small burrow.			
SHIFT downstream 700 feet eastward.			
18. Limestone—very fine grained, between yellowish gray and light olive gray, mostly highly oolitic, and contains some foraminifera. The lowest bed contains some chert and is about 3 feet thick. The rest of the beds are mostly 18 to 24 inches thick. The interval is massive contrasting with the nodular zone below and the laminated spiculiferous zone above.	9	175	210–219
A thin section from 219 feet is a mass of oolites with well-developed concentric and radial structure, fossil debris, and foraminifera mostly in a matrix of very fine grained, clear calcite. The matrix in one thin zone is extremely fine grained cloudy calcite. Many of the fossil fragments and some of the foraminifera serve as nuclei for oolites, and few are without some secondarily deposited calcite. The fossil debris is mostly crinoid and shell fragments.			
19. Limestone—very fine grained and light olive gray and medium light gray. The lower bed, nearly 2 feet thick, contains numerous oolitic chert nodules and a few thin vertical chert seams in the upper portion. The rest of the interval is composed of nodular chert in part surrounded by shale and limestone. The upper 2-foot zone is recessive.	4	179	206–210
A thin section from 207 feet is a mass of fossil material, oolites, and oolitic pebbles. The oolites are truncated at the pebble boundaries. The pebbles are less fossiliferous, and the oolites are smaller and more abundant; otherwise they differ little in appearance from the rest of the rock. The fossil debris is mostly crinoid fragments, which show secondary enlargement, and shell fragments. Foraminifera are abundant and of several species, and a few ostracods are present.			
SHIFT downstream 950 feet eastward using the bed at 219 feet for making the shift.			
20. Limestone—very fine grained, mostly between light brownish gray and light olive gray and in part light olive gray, cherty, and extremely irregularly but thinly bedded with beds passing around the chert nodules. The lower part of the interval is resistant and perhaps less cherty than the upper part which has an especially nodular appearance. About 25 percent of the interval is chert of the same color as the limestone. Some of the chert contains spicules, and both the limestone and the chert contain many minute unidentified objects. The top foot of the interval is well exposed upstream about 950 feet, at which point the upper portion is comprised of elongate objects up to 1 foot long and 2 inches in diameter which are extremely fine grained and light olive gray in a slightly coarser grained matrix which weathers to a dark yellowish gray. The shape of chert nodules in the interval is little different from these objects, suggesting that the chert may be replacements of such objects.	20	199	186–206
A thin section from 206 feet is composed mostly of extremely fine grained, cloudy calcite and a few areas of fine to very fine grained, clear calcite. Siliceous spicules and small foraminifera are abundant. One elliptical area one-quarter by one-half inch in size is composed of brownish gray, extremely fine grained calcite, and circular to irregular areas of clear very fine grained calcite. The brownish gray calcite is concentric to the clear calcite areas, and the whole has a roughly concentric structure and is without fossil material. This feature may represent a burrow.			
21. Limestone—fine grained; mostly between light olive gray and yellowish gray; top foot medium gray; mostly highly oolitic;	6	205	180–186

Description	*Thickness Interval*	*Cumulative*	*Feet above base*
and recessive. Nodular zones alternate with plane beds and in some places abut as if considerable solution had taken place, allowing some collapse.			
A thin section from 181 feet is a mass of fossil debris consisting mostly of crinoid debris, some shell fragments, and foraminifera mostly in an extremely fine grained, cloudy calcite matrix. A fine grained clear calcite vein crosses the section, and some of the crinoid fragments are secondarily enlarged.			
22. Limestone—fine grained, between light olive gray and yellowish gray, two beds, and contains abundant ooids and foraminifera.	5	210	175–180
A thin section from 177 feet is mostly a limesand composed of several species of foraminifera; much crinoid and shell debris; grains of an extremely fine grained, very cloudy, micropelleted limestone; and a few ostracods mostly in a matrix of very fine to fine grained clear calcite,			
A thin section from 179 feet is similar except that the clear calcite is more abundant, microfossils less abundant, ooids very numerous, and many of the fossil fragments and a few foraminifera have a thin envelope of secondary calcite. A few irregular areas of extremely fine grained calcite are fossil free.			
23. Limestone—very fine grained, medium dark gray and toward top light olive gray, somewhat nodular, and contains beds of chert which are almost continuous and as much as 8 inches thick. The chert is grayish brown streaked medium yellowish brown and contains many vertical quartz veins. Fossil debris including crinoid fragments is abundant in upper part which also contains many foraminifera.	7	217	168–175
A thin section from 172 feet is composed of an intimate mixture of extremely fine grained, very cloudy calcite and chert, some of which is in veins. The vein chert is free of dolomite rhombs, whereas the rest of the chert contains numerous very small dolomite rhombs. Centrally located in the veins is an isotropic, medium brown, translucent substance white by reflected light, which is rare in the rest of the chert. Spicules are abundant in the limestone and in part lose their identity in the chert. Other fossil debris is absent except for much crinoid and shell debris near one edge of the slide.			
A thin section from 175 feet is composed of extremely fine grained, cloudy calcite and a small amount of very fine grained clear calcite. Abundant fossil debris *is* in part crinoid fragments showing secondary enlargement, and mostly shell fragments of diverse microscopic structure. Foraminifera including many which are fragmental are common.			
24a. Covered.	4	221	164–168
24b. Limestone—fine grained, between light brownish gray and light olive gray, crowded with small objects, and appears to be a breccia.	4	225	160–164
SHIFT about 600 feet eastward along top of chert at 160 feet beneath collapsed area. Some solution appears to have taken place in the interval from 160 to 169 feet after the shift, and some inaccuracy in thickness of the section may result. Since the interval from 160 to 169 feet after the shift is somewhat different, it is redescribed below.			
24c. Limestone—very fine grained, medium dark gray, unevenly bedded, and contains large bedding plane masses of grayish black chert.	7	223	162–169
24d. Limestone—fine grained, between light brownish gray and light olive gray, one bed, and crowded with small unidentified objects.	2	225	160–162
A thin section from 161 feet is composed in part, of extremely fine grained, very cloudy calcite and in part of very fine grained, clear calcite. Both portions contain abundant elliptical bodies, some of which have the shape of ostracods but without detectable valves. No structure is visible except that a very thin exterior layer is much finer grained and cloudy. Crinoid debris, finely comminuted shells, spicules, and foraminifera are common.			

Description	*Thickness Interval*	*Cumulative*	*Feet above base*
25. Limestone—very fine grained, between light brownish gray and light olive gray, massive, and forms an overhanging ledge. The lower 3 feet is chert free and the upper 2 feet contains considerable chert in ill-defined, mostly skeletal nodules and plates.	5	230	155–160
26. Limestone and shale—the limestone is very fine grained, light olive gray, nodular, and contains abundant chert of the same color. The shale is dark yellowish gray, makes up about 10 to 20 percent of the interval, and is wrapped about the limestone nodules. The interval is recessive.	5	235	150–155
27. Limestone—very fine grained and estimated to contain 25 to 40 percent of grayish black chert. The lower 1.5 feet is almost chert free, but in the next 1.5 feet it increases in amount rapidly upward. The limestone is dark gray in the lower part but lightens upward to between medium olive gray and light brownish gray. The chert is light brownish gray to grayish brown and is in flattened nodular-branching forms mostly parallel to the bedding, but a few are crosswise. Beds average about 4 inches in thickness, and bedding joints are very irregular, winding in and out among the chert nodules. The chert contains some spicules. Much minute material present may be fossil fragments or poorly preserved foraminifera.	35	270	115–150
A thin section from 116 feet is composed of extremely fine grained, cloudy calcite containing much poorly preserved fossil debris, and a few recognizable foraminifera and spicules. One grain of a light green mineral has aggregate polarization and the appearance of glauconite.			
A thin section from 119 feet is similar except that fossil debris is more abundant.			
A thin section from 120 feet is an intimate mixture of very cloudy, extremely fine grained calcite, and silica composed of spicules and extremely small chert aggregates. Fossil debris is scarce and consists mostly of crinoid fragments.			
A thin section from 131 feet is similar to the above section, except for layers without chert, a few dolomite rhombs associated with the chert, and lack of fossils other than spicules.			
A thin section from 138 feet is similar to the above section except that dolomite is more common and chert more evenly distributed.			
A thin section from 145 feet is an intimate mixture of extremely fine grained, cloudy calcite and very fine grained, clear calcite, the latter being mostly finely comminuted fossil debris. Crinoid fragments and foraminifera are common.			
SHIFT downstream 700 feet in an east-southeast direction shifting across a fault using the top of reef at 115 feet. The reef is scrubbed clean upstream from the fault, and near the fault a knob on the reef extends 10 feet into the overlying cherty beds. The cherty beds in part drape over the knob and in part pinch out against it. Since the top of the reef fluctuates in level, other traceable horizons were used to substantiate the shift; namely, the top of the nodular chert zone at 155 feet and the top of a massive limestone at 181 feet. The top of the cherty zone substantiated the shift made on top of the reef. The massive limestone, however, thinned upstream 6 feet and showed evidence of solution in that direction. A few hundred feet farther upstream a large collapsed area is present in which the massive limestone appears to be absent.			
Reef limestone: 115 feet thick			
28. Limestone—extremely fine grained, medium olive gray ranging toward light brownish gray, massive, and having widely spaced, short bedding joints. The portion of the interval between 80 and 87 feet is poorly exposed; however, isolated outcrops along the strike are of the same rock. Some beds are rich in fossil debris consisting of crinoid fragments and poorly preserved microfossils. On the upstream side of the fault crinoid columnals are clustered in the reef as if derived from one animal. In one place brachials and a few calyx plates are present in	80	350	35–115

Description	*Thickness Interval*	*Thickness Cumulative*	*Feet above base*
addition to the columnals. Such occurrences suggest that currents were weak.			
A thin section from 40 feet is composed of extremely fine grained, pelleted, slightly cloudy calcite, and some very fine grained clear calcite. Abundant fossil debris is mostly crinoid fragments, shell fragments with little structure, rare calcite spicules, and a few foraminifera. A very small amount of chert is present.			
A thin section from 47 feet is composed of a layer of extremely fine grained, cloudy calcite containing some fossil debris between layers, one of which is composed almost entirely of foraminifera and shell debris, and the other apparently of the same composition but with the fossil material mostly unidentifiable. Poorly preserved ooids and rare calcite spicules are present.			
A thin section from 55 feet is composed mostly of fossil debris and foraminifera, including a few fusulinids.			
A thin section from 80 feet is a pelleted limestone in which the calcite of the pellets is extremely fine grained and the matrix is slightly coarser grained and clear. The pellets are mostly less than 0.2 mm in diameter, and similar sized calcite grains and rare ooids and foraminifera are present, suggesting that the whole is a limesand.			
A thin section from 100 feet is similar to the one from 40 feet except that there is less fine grained, clear calcite and fossil debris, and no chert.			
A thin section from 115 feet is composed of relatively clear pelleted areas, extremely fine grained cloudy areas, and areas composed mostly of fossil debris. Rare ostracods and spicules, a few foraminifera, some crinoid fragments and a great abundance of shell fragments composed the fossil material.			
29. Limestone—very fine grained, medium dark gray, and contains abundant grayish black chert. The interval is characterized by a nodular appearance caused by the horizontal lenses and plates of chert. The chert and limestone contain much crinoid debris. The chert weathers to a rough porous mass as if the crinoid debris were being dissolved.	11	361	24–35
A thin section from 28 feet is composed of bitumen stained, extremely fine grained calcite, a few areas of which are pelleted, intimately intermixed With silica, some of which is chert and some of which is spicules. Other fossil debris is mostly crinoid fragments, a few shell fragments, and a few very poorly preserved foraminifera.			
SHIFT about 50 feet eastward to slumped block.			
30. Limestone—extremely fine grained, medium olive gray ranging toward light brownish gray, and one massive bed. Crinoid debris is common.	20	381	4–24
A thin section from 7 feet is composed of extremely fine grained, cloudy to almost clear, pelleted calcite. The abundant fossil debris is mostly shell fragments with little structure, some crinoid fragments, spicules replaced by calcite, and a few foraminifera, some of which are well preserved. Some dark brown material is concentrated along a stylolite, and portions of fossils are missing where in contact with the stylolite.			
31. Limestone—very fine grained, hard, brittle, recessive, and dark gray at base to between medium dark gray and olive gray at top. Bedding joints are irregular, poorly developed, and contain very thin shale(?) films. Fossils are crinoid debris and foraminifera.	4	385	0–4
A thin section from 3 feet is mostly extremely fine grained, cloudy calcite and some fine grained, clear calcite, the latter replacing fossil fragments. A few liny dolomite rhombs are enclosed by skeletal chert. Much fossil debris is present including fragments of shells having diverse structure, crinoid fragments, numerous types of foraminifera, some of which are well preserved, and a few spicules.			
A thin section from the bottom of the Marble Falls section is composed of extremely fine grained, highly cloudy to extremely			

Description	*Thickness* *Interval*	*Cumulative*	*Feet above base*
cloudy calcite, the latter containing many specks of carbonaceous material. The section contains a large amount of crinoid, brachiopod, and other fossil debris. A few foraminifera and a few calcite spicules are also present. Much of the fossil debris is replaced by fine grained clear calcite. The bottom of the Marble Falls section is on the north side of Colorado River about three-quarters of a mile upstream from the Marble Falls dam and 400 feet north of the old Alexander dam, now demolished and flooded. The lower 25 feet of the section is on a slumped block which has subsided about 10 feet squeezing out the shale of the Barnett formation until only about a foot of it remains between the slump block and the Chappel limestone. The Chappel limestone is about 2 feet thick, is in beds 4 to 10 inches in thickness, and rests on dolomitic rocks of the Honeycut formation of the Ellenburger group, the contact being obscured by fallen blocks of Marble Falls limestone.			

Weighed crushed samples were digested in hydrochloric acid and the residues washed, weighed, and bottled. The residues are described below followed by a table showing the amount in each sample. The chert of the Marble Falls limestone is characteristically opaque to feebly translucent, and in the following description of the residues the light-transmitting properties are not mentioned unless they differ from the normal.

Description	*Feet above base*
Chert—mostly compact, medium dark gray, and composed of spicules and carbonaceous matter	365–385
Chert—mostly porous, light olive gray, and highly spiculiferous. Loose spicules are abundant. The sample from 345 to 350 feet contains a few translucent, white crusts of chalcedony, and the one from 360 to 365 feet contains a small amount of medium gray spicule chert	344–365
Chert—porous to highly porous and composed of spicules and carbonaceous matter. Loose spicules are abundant. From 325 to 330 feet the chert is medium gray and in the rest of the interval it is medium light gray. The sample from 340 to 344 feet contains some compact, light olive gray chert	325–344
Chert—compact to porous, light olive grey, and spiculiferous. Loose spicules are common	320–325
Carbonaceous matter—amounting to little more than a stain on the filter paper, plus a few spicules from 315 to 320 feet	310–320
Chert—mostly highly porous mass of spicules and loose spicules and light gray with an olive cast. The sample from 305 to 310 feet contains a few silicified foraminifera. Some of the porosity in the samples from 295 to 305 feet is caused by the solution of calcitic fossil debris	290–310
Chert—compact to porous, light olive gray, and mostly spiculiferous. Loose spicules are abundant. The porosity is mostly caused by the solution of calcitic fossil fragments	285–290
Chert—mostly porous from solution of calcitic fossil fragments and light olive gray ranging toward light gray from 270 to 285 feet. The sample from 275 to 280 feet contains in addition spiculiferous chert and many free spicules	260–285
Chert—compact to porous, medium olive gray, and highly spiculiferous. Loose spicules are abundant	255–260
Chert—compact to porous, light olive gray, some medium gray, and some between light olive gray and brownish gray, and all highly spiculiferous. Loose spicules are common	250–255
Chert—compact to porous, mostly between yellowish grey and light olive gray, and highly spiculiferous. Loose spicules are abundant. The sample from 240 to 245 feet is light olive gray and contains a few silicified bryozoa	230–250

Description	*Feet above base*
Chert—highly porous from 210 to 220 feet becoming more compact from 220 to 230 feet, light olive gray from 210 to 215 feet, and gray in rest of interval from combination of white spicules and black carbonaceous material. Loose spicules are abundant	210–230
Chert—compact to highly porous and mostly light olive gray to yellowish gray. The porosity is between spicules. Loose spicules are very abundant	205–210
Chert—compact to porous and olive gray to light olive gray. Some chalcedonic chert is present. The porosity in the sample from 195 to 200 feet is caused by the dissolving of calcitic fossil debris and that from 200 to 205 feet appears to be from the solution of calcitic spicules	195–205
Chert—compact to porous, medium olive gray to light olive gray, and spiculiferous Some chalcedonic chert and poorly silicified foraminifera are present being most abundant from 185 to 190 feet	185–195
Chert—porous, friable silica, and a little sand which may be a contaminant	180–185
Carbonaceous matter—amounting to a slight stain on the filter paper	175–180
Chert—porous friable silica which appears to be a fossil replacement type, and a small amount of pyrite	170–175
Chert—compact to highly porous, olive black, olive gray, and yellowish gray speckled by small white mostly unidentified objects. Some of the chert is highly spiculiferous, loose spicules are common, and from 165 to 170 feet chalcedonic chert and hollow ooids are common	160–170
Chert—compact to highly porous and yellowish gray. Loose spicules are abundant, and pyrite is common	155–160
Chert—compact to highly porous and mostly light olive gray speckled by small white objects, some of which are spicules, some are microfossils, and others are unidentified. Free spicules are present in some samples but are mostly rare. The sample from 115 to 120 feet is olive gray and contains some transparent, chalcedonic chert which appears to be joint and cavity fillings. The sample from 150 to 155 feet contains Some milky quartz fillings and some silty clay	115–155
Reef facies—	
Chert—porous, friable silica of fossil replacement type. The sample from 105 to 110 feet contains many bryozoa and one conical foraminifer	100–115
Carbonaceous material—amounting to films on filter paper, except for a small amount of porous, friable silica from 40 to 50 feet	35–100
Chert—compact to highly porous, olive gray, and contains impressions of crinoid columnals. A small amount of very light gray, chalcedonic chert is present from 25 to 30 feet. Loose spicules are common, bryozoa are rare, and some cylindrical objects from 25 to 30 feet in section may be crinoid columnals. Carbonaceous matter is common	20–35
Carbonaceous matter—amounting to a stain on the filter paper, except for a few grains of quartz from 15 to 20 feet	5–20
Chert and carbonaceous matter—the chert is porous, friable silica of the fossil-replacement type, bryozoa are common, and one brachiopod fragment was recognized Pyrite rods and ovals about 0.05 mm in diameter are numerous, and a few quartz crystals are present. Carbonaceous material is common	0–5

The amount of insoluble residue contained in the Marble Falls section is given in table 1. A bar-diagram (fig. 2) depicting the amount of residue is placed alongside a graphic representation of the Marble Falls limestone and shows well the correspondence between the spiculitic and cherty portions of the formation and the high residue areas on the bar-diagram.

The lower 115 feet of the Marble Falls limestone in the line of section is extremely massive reef except for a cherty limestone lens which extends a short distance in each direction from the section and a basal few feet of less massive, slightly impure, dark gray limestone.

The top 21 feet of the section is a massive calcareous spiculite unit that has wide distribution in the eastern part of the Llano uplift. Other spiculites lower in the type section are less massive and less siliceous. A basal spiculite unit at the same level as the reef in the type section is common in the outcrop area of the Marble Falls limestone throughout the region south of Marble Falls. In the eastern part of the

Llano uplift it is likely that spiculite may be found at any level in the Marble Falls limestone.

SMITHWICK SHALE

The Smithwick shale lies conformably upon the Marble Falls limestone, and in outcrops as much as 10 miles apart in southern Burnet County, the top of the Marble Falls limestone appears to be one bed bearing on its top surface distinctive plant(?) markings up to a foot in length in spiculite which displays on other bedding surfaces numerous caudigalli. The basal portion of the Smithwick shale is well exposed along Hamilton Creek 4 miles northeast of Marble Falls where 4 feet of black shale is followed upward by a thick section of medium gray shale.

A concretion-like mass 10 feet in length rests on top of the Marble Falls limestone, and similar 15 to 20-foot concretion-like masses are wrapped in the basal black shale about 4 miles southeast of Marble Falls. These masses are of spiculite entirely similar to the Marble Falls spiculite beneath, except that the caudigalli instead of being in one plane appear on all sides of the masses.

Sandstone beds are common in the upper portion of the Smithwick, but only thin lenses of sandstone and siltstone laminae were noted within the map area (fig. 1), indicating that only the lower portion of the Smithwick is present. Much of the Smithwick near the Colorado River is covered by alluvial material; however, good exposures are present in the southeastern portion of the map area.

QUATERNARY ALLUVIUM AND HIGH GRAVEL

The alluvium and high gravel are situated mostly in areas underlain by Smithwick shale, and only in two places on the Marble Falls limestone was a thin scattering of presumably high gravel seen. One of these is in the vicinity of the Askew—W. K. Heinatz—K. Heinatz common property corner; just north of the corner a solution crack in the Marble Falls limestone is filled by siliceous gravel in part derived from the pre-Cambrian of the Llano uplift.

The other scattering of high gravel is near the crest of the hill along U. S. highway No. 281 almost a mile south of Marble Falls. These occurrences were not examined in sufficient detail to preclude the possibility that the gravel might be residual from the Cretaceous Hensell sand.

ECONOMIC GEOLOGY

HIGH PURITY MARBLE FALLS LIMESTONE

The almost complete absence of insoluble residues between 5 and 20 feet and 35 and 115 feet above the base of the section suggested that the limestone is of high purity. Chemical analyses were therefore made of the limestone, combining samples into 20-foot intervals except for one 15-foot interval. Each individual sample was analyzed in the 15-foot interval, as well as the composite sample, to see if there is any significant variation of quality within the rather thick sample interval chosen. The analyses of the composite sample and of the component samples are very similar. The analyses are given in table 2.

In table 3, the analyses have been calculated into the theoretical carbonates present and then into the minerals calcite and dolomite. Actually dolomite may not be present as a discrete mineral.

The analyses show that the reef limestone is an exceptionally pure limestone comparing with the Mosheim of Virginia (Edmundson, 1945), the Kimmswick of Missouri (Hinchey, Fischer, and Calhoun, 1947), and exceeding in purity all the limestone of Illinois listed by Krey and Lamar (1925). Physical properties such as crushing strength, porosity, and hardness were not determined, but the impression is obtained that the stone, being compact, has a very low porosity and that the crushing strength is high.

A map of the area (fig. 1) shows the extent of the reef limestone, none of which is nearer than a mile to the Marble Falls terminus of the Southern Pacific Railroad. The portion of the reef south of the Colorado River is in the best position to be quarried, and due east of the E. L. Michel ranch house the reef is estimated to be about 75 feet thick. It is estimated that about 2½ million tons of stone could be recovered in this area With a minimum of stripping and that an additional 5½ mil-

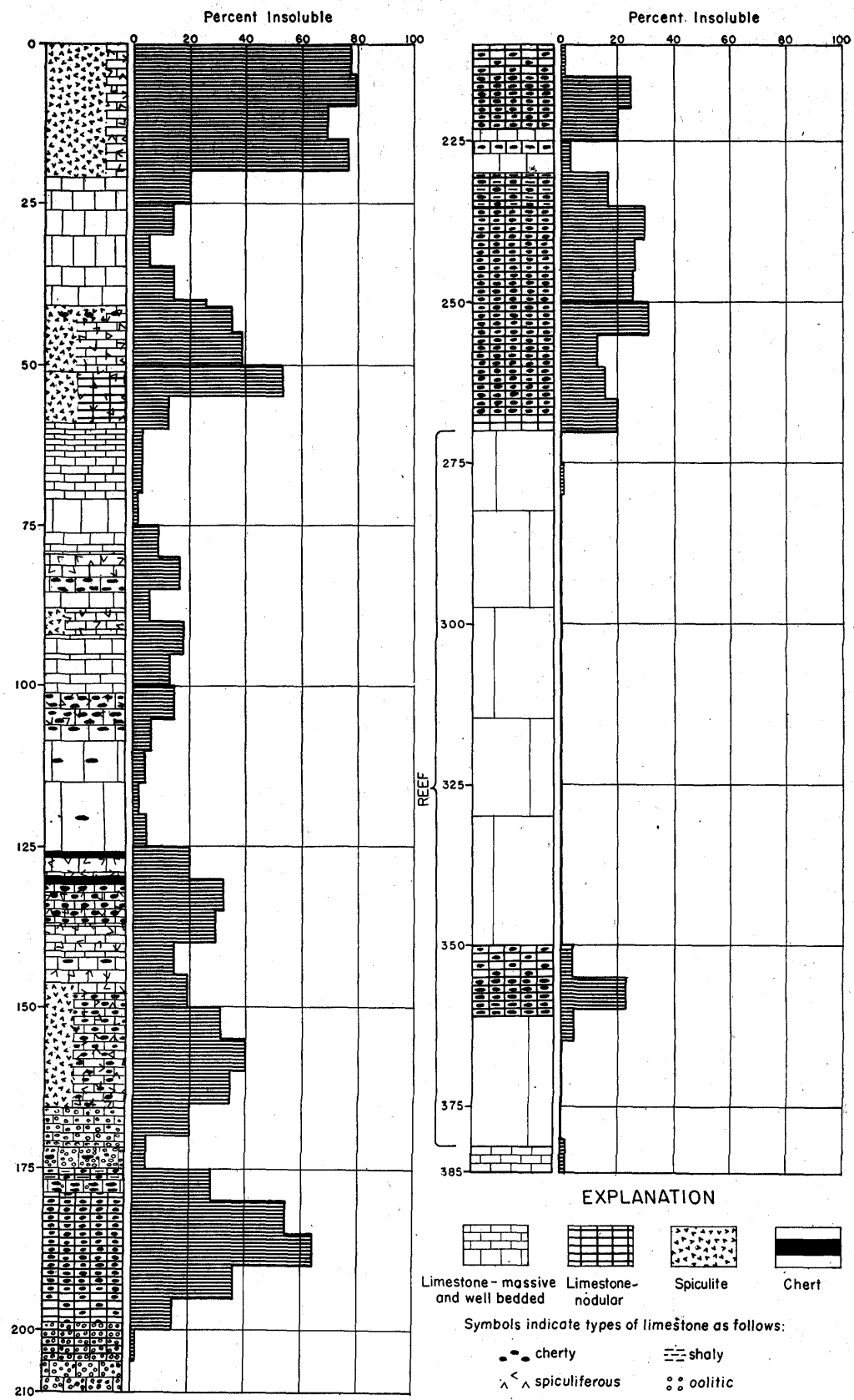


Figure 2. Lithology and insoluble residues of Marble Falls limestone in type section.

TABLE 1

Percent of insoluble residue in the type section of the Marble Falls limestone, Burnet County, Texas.

Feet above base	*Residue in percent*	*Feet above base*	*Residue in percent*
380–385	77.9	245–250	28.7
375–380	78.9	240–245	13.5
370–375	68.2	235–240	18.7
365–370	74.6	230–235	31.3
360–365	20.2	225–230	40.5
355–360	13.0	220–225	35.2
350–355	5.3	215–220	21.4
345–350	13.8	215–220	16.7
344–345	25.2	210–215	4.2
340–344	33.8	205–210	26.5
335–340	38.0	200–205	54.3
330–335	53.0	195–200	64.4
325–330	11.2	190–195	35.0
320–325	2.5	185–190	13.9
315–320	2.8	180–185	1.40
310–315	1.7	175–180	0.10
305–310	7.5	170–175	1.30
300–305	15.7	165–170	23.5
295–300	5.4	160–165	19.3
290–295	17.9	155–160	2.6
285–290	13.6	150–155	16.1
280–285	15.3	145–150	29.1
275–280	6.2	140–145	26.0
270–275	4.2	135–140	25.4
265–270	1.2	130–135	30.5
260–265	4.1	125–130	11.9
255–260	19.7	120–125	15.7
250–255	31.1	115–120	19.6
Reef facies			
110–115	0.35		
105–110	0.97		
100–105	0.30		
95–100	0.20		
90– 95	0.30		
85– 90	0.25		
80– 85	0.30		
75– 80	0.25		
70– 75	0.20		
65– 70	0.25		
60– 65	0.15		
55– 60	0.15		
50– 55	0.20		
45– 50	0.35		
40– 45	0.50		
35– 40	0.51		
30– 35	3.91		
25– 30	22.48		
20– 25	4.26		
15– 20	0.26		
10– 15	0.25		
5– 10	0.26		
0– 5	1.35		

lion tons could be obtained by stripping about 1,300,000 tons of cherty limestone.

The line of section north of the river is on a steep hill slope, and above the line of section is an additional 85 feet of mostly cherty limestone. A quarry in this area would soon encounter excessive overburden, and the reef may rapidly finger out northward. Some limestone could be quarried from the bottom portion of the reef to the east, but again overburden would soon become a problem, and eastward the reef soon fingers out.

The chemical analyses cited above represent the limestone in only one place and while furnishing an example which visually

TABLE 2

Chemical composition of reef in lower portion of Marble Falls limestone at type section.

Feet above base	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ignition loss	Total
95–115	0.16	0.07	0.24	0.12	54.33	0.97	43.80	99.69
75– 95	0.06	0.04	0.13	0.08	54.45	0.83	43.94	99.53
55– 75	0.09	0.03	0.08	0.05	54.45	0.84	43.91	99.45
35– 55	0.11	0.04	0.14	0.09	54.33	0.91	43.98	99.60
5– 20	0.08	0.03	0.12	0.09	54.21	1.05	43.96	99.54
15– 20	0.11	0.10	0.20	0.09	54.09	0.91	43.83	99.33
10– 15	0.04	0.03	0.16	0.10	54.45	0.89	43.93	99.60
5– 10	0.09	0.03	0.16	0.11	54.21	1.10	43.94	99.64
Average	0.10	0.04	0.14	0.08	54.35	0.93	43.92	99.56

TABLE 3

Recast of analyses in table 2 showing amount of carbonates present.

Feet above base	$CaCO_3$	$MgCO_3$	$FeCO_3$	Excess ignition loss	Calcite $[CaCO_3]$	Dolomite $[Ca, Mg(CO_3)_2 + FeCO_3]$	Total carbonate
95–115	97.01	2.03	0.18	—0.01	94.60	4.62	99.22
75– 95	97.23	1.84	0.11	0.16	95.04	4.14	99.18
55– 75	97.23	1.76	0.06	0.18	95.14	3.91	99.05
35– 55	97.01	1.90	0.13	0.26	94.75	4.29	99.04
5– 20	96.80	2.20	0.13	0.17	94.18	4.95	99.13
15– 20	96.59	1.90	0.13	0.29	94.33	4.29	98.62
10– 15	97.23	1.86	0.15	0.12	95.02	4.22	99.24
5– 10	96.80	2.30	0.16	0.09	94.07	5.19	99.26
Average	97.06	1.95	0.12	0.15	94.74	4.38	99.13

compares with the rest of the limestone mapped as reef does not mean that the rest of the limestone is as pure. The reef limestone should be extensively cored and many chemical analyses made before any quarrying operation for high purity limestone is attempted.

The lower portion of the Marble Falls limestone east of Slickrock Creek in the southwestern portion of the Granite Mountain quadrangle about 5.5 miles west of Marble Falls is almost white, massive, reef-like, and appears to be a high-grade limestone. The reef-like limestone is believed to be essentially coextensive with the outliers of Marble Falls limestone as mapped in figure 3. No attempt was made to map the reef-like limestone separately, and no estimate was made of its maximum thickness, but it was noted that there is little overburden and that a rather large tonnage is present.

It is likely that reef-like masses of limestone are present elsewhere in the Marble Falls limestone. These masses could be found by detailed surface mapping.

LIMESTONE IN HONEYCUT FORMATION

The 20-foot bed of limestone mapped in the Honeycut formation was not analyzed, but similar limestone from the Gorman formation has been analyzed (Cloud and Barnes, 1948, p. 381) and found to average about 2.5 percent insoluble residue for a 50-foot section. The magnesia is exceptionally low. If the Honeycut limestone is of similar composition, it could be used for many purposes where the highest grade limestone is not needed.

The best quarry site is west of Flatrock Creek extending south from the road to Marble Falls dam. The outcrop belt here is widest, and stripping is feasible to add to the amount that can be quarried. The same bed of limestone with its top near creek level continues to the small dam near the south border of the map. In this portion of the outcrop, cannonball chert becomes abundant, and lateral gradation from limestone to dolomite is prevalent, rendering the limestone valueless.

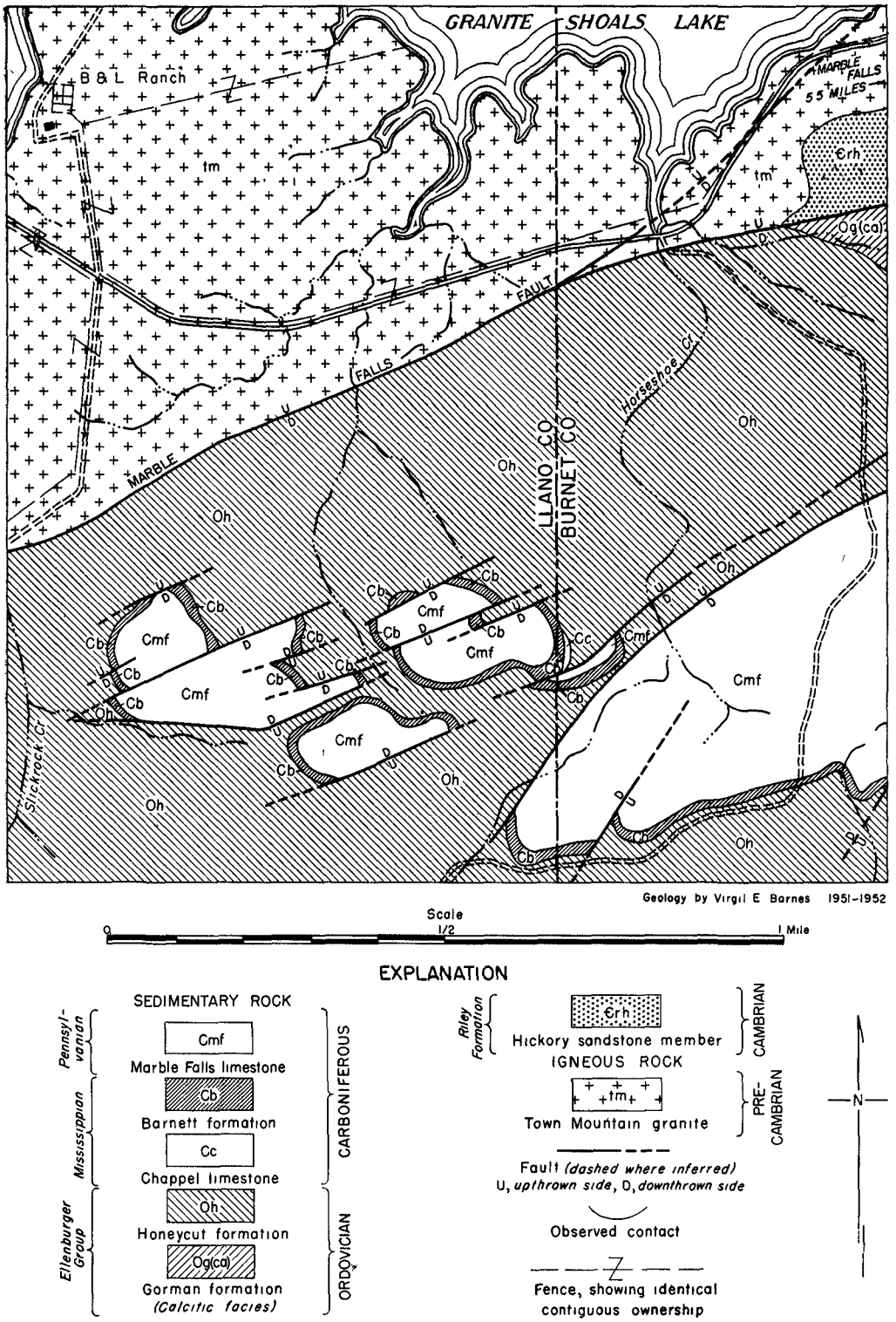


Figure 3. Geologic map of an area in the vicinity of Slickrock Creek, Llano and Burnet counties, Texas.

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