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

JOHN T. LONSDALE, Director

Report of Investigations—No. 23

Phosphorite in Eastern Llano Uplift of Central Texas

By

VIRGIL E. BARNES

April 1954

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

JOHN T. LONSDALE, Director

Report of Investigations—No. 23

Phosphorite in Eastern Llano Uplift of Central Texas

By

VIRGIL E. BARNES

April 1954

CONTENTS

ILLUSTRATIONS

Phosphorite in Eastern Llano Uplift of Central Texas

Virgil E. Barnes

Introduction and stratigraphy.—A deposit of phosphorite, estimated to be 11 feet thick, was found March 26, 1952, while the writer was mapping ancient sink fillings and collapse structures within the outcrop area of the Honeycut formation south of Marble Falls, Texas. The phosphorite is exposed in a road material pit on the eastern side of a Carboniferous outlier (fig. 1). It rests on shale typical of that in the Barnett formation of Mississippian age and is beneath spiculitic limestone at the base of the Pennsylvanian Marble Falls limestone. Geiger counter measurements, both in the road material pit and on the opposite side of the hill at the same stratigraphic level, gave values of about 100 counts per minute, the background count being about 40 per minute.

Another outlier about 500 feet to the northeast possibly contains a similar sequence. Limestone of the type found in the phosphorite in the road material pit occurs as float about this outlier indicating that the interbedded phosphorite may also be present. A Geiger counter examination failed to reveal any abnormal readings, but the phosphorite may be present and masked by soil. These outliers probably are in structural sinks because evidence of col-

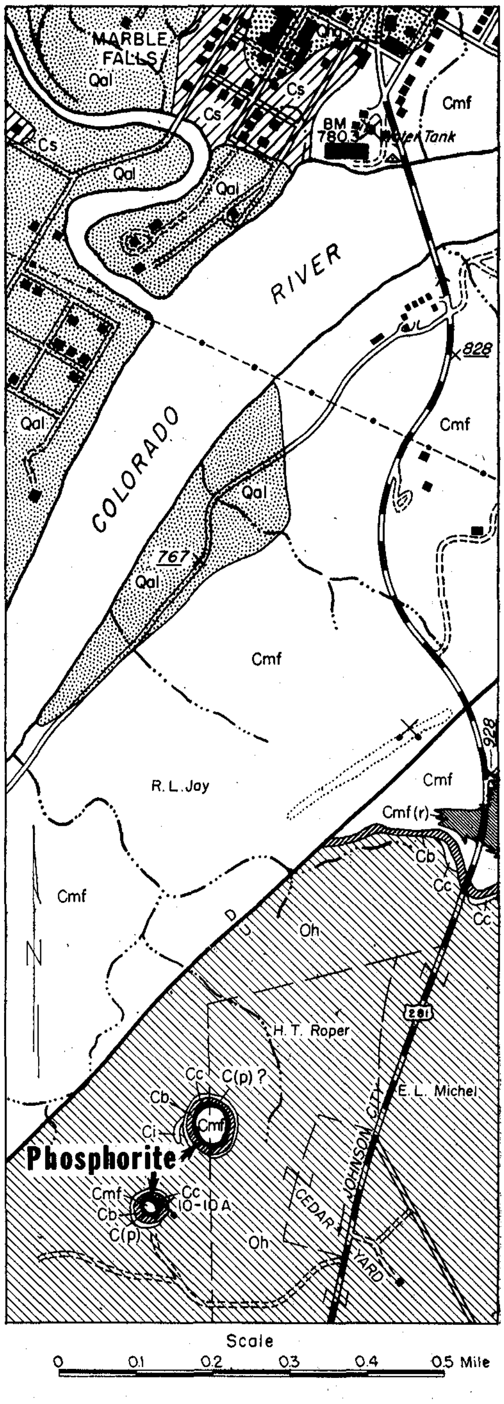

FIG. 1. Geologic map of an area south of Marble Falls, Texas, showing location of phosphorite deposit. Areas underlain by alluvium are indicated by the symbol Qal, and an area underlain by high gravel is indicated by the symbol Qhg. Both Pennsylvanian and Mississippian rocks of Carboniferous age are present. The Pennsylvanian rocks are indicated by symbol as follows: Cs, Smithwick shale; Cmf, Marble Falls limestone showing reef facies Cmf(r); and an unnamed phosphorite C(p). The Mississippian rocks are indicated by the following symbols: Cb, Barnett formation; Cc, Chappel limestone; and Ci, Ives breccia. Of the Ordovician rocks only the Lower Ordovician, Honeycut formation, Oh, is present. Base from U. S. Department of Agriculture, Soil Conservation Service, aerial photographs flown by Park Aerial Surveys, Inc., 1939–1940. Geology by Virgil E. Barnes, 1951–1952.

lapse is well displayed in the road material pit where both the Honeycut and Barnett formations dip steeply inward.

The position of the phosphorite suggests that in age it is between the Barnett formation and the Marble Falls limestone. From stratigraphic position alone it could be a unit of the Barnett formation not hitherto recognized or a basal unit of the Marble Falls limestone. However, conodonts from a limestone bed in the phosphorite and from phosphorite adhering to the bed have been identified by Dr. W. H. Hass of the United States Geological Survey as predominantly Lower Pennsylvanian in age, thus eliminating the possibility that the phosphorite is a member of the Barnett formation.

The possibility of the phosphorite being part of the Marble Falls limestone is not entirely ruled out, especially if rocks of Morrow equivalence are included with the Marble Falls limestone. Rocks of Morrow age collapsed through the Barnett formation into the Honeycut formation have been found in San Saba County (Cloud and Barnes, 1948, pp. 229–230) and in normal stratigraphic sequence in Honeycut Bend, Blanco County (p. 318). The phosphorite may be of Morrow age. This possibility is strengthened by the discovery of a few inches of phosphorite at the base of the sequence in Honeycut Bend. The exposure was made by the record-breaking 1952 Pedernales River flood. Another exposure downstream 1.25 miles, made by the flood, reveals 28 inches of phosphorite and limestone at the base of the sequence considered to be of Morrow age. Figure 2 is a graphic representation of the section measured at this point.

The soil-masked outcrop between the exposures on Pedernales River was examined with a Geiger counter, the probe being lowered into holes made by a round iron bar. Higher than normal values were observed in several places near the upper edge of the soil-covered bench between the Honeycut formation and the spiculite of the Marble Falls limestone, suggesting that the bench is occupied both by shale of the Barnett formation and by phosphorite similar to that shown in figure 2.

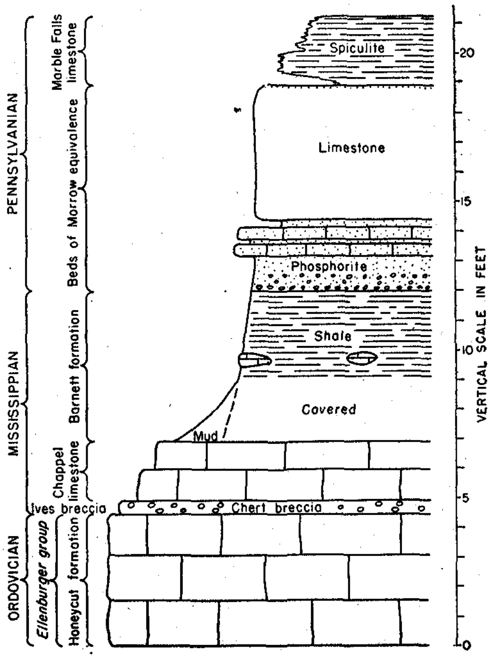

Fig. 2. Stratigraphic section 1.25 miles downstream from Honeycut Bend.

It is likely that phosphorite is also at locality 16T-2-33F (Cloud and Barnes, 1948, pl. 3). A meager conodont assemblage from that locality suggests a Pennsylvanian age. The sample from which the conodonts were obtained is mostly phosphatic pellets and glauconite grains. The locality is 2.25 miles northeast of Honeycut Bend, and the intervening area should be prospected for phosphorite. Additional possibilities for phosphorite may exist at Elm Pool, another 0.75 mile to the northeast.

Other thin phosphatic zones are known in the Llano uplift. One of these at the base of the Barnett formation has been reported by Cloud and Barnes (1948, p. 111). Another is the Ives breccia which in places contains a phosphatic matrix (Cloud and Barnes, 1948, pp. 46–47) and, in some areas, closely associated, thin beds of phosphatic, bone-bearing limestone (Barnes, Cloud, Warren, 1945, pp. 174–176; Cloud and Barnes, 1948, pl. 3, locality 16T-2-42 I). All of these occurrences yield abnormal values when tested with a Geiger counter, the most radioactive sample being a rock composed of conodonts (locality 16T-2-42I). The phosphatic zone at the base of the Marble Falls limestone mentioned by Cloud and Barnes (1948, p. 59) may be the one under consideration here.

The Llano uplift, at least from Honeycut through Marble Falls time, has had a very extensive solution and collapse history, of which only a small part is known. The area repeatedly received deposits which were subsequently removed except for remnants in collapse structures. The phosphorite probably represents such a cycle, being deposited on an erosional surface of the Barnett formation. During the emergence which followed, the phosphorite was removed, except for the small amount trapped by collapse. If the phosphorite is not of Morrow age, then at least two periods of submergence and emergence are indicated between the deposition of shale in the Barnett formation and the deposition of the Marble Falls limestone.

The Barnett formation beneath the phosphorite appears to be about the same thickness and typical of that exposed in three road material pits within a mile to the northeast. If this is true, the top of the Barnett upon which the phosphorite was deposited was not far from the top of the Barnett as now preserved, and it is possible that some phosphorite will be found in normal stratigraphic sequence in this portion of the Llano uplift. The phosphorite is difficult to recognize because of subdued exposure.

In mapping, the base of the Barnett formation is always carefully scrutinized to determine whether it is in contact with Honeycut rocks or is resting on one of the many other units common at this horizon. The upper contact has not received the same careful scrutiny, and possibly phosphorite in normal stratigraphic sequence has been overlooked. However, in the Marble Falls area, all good exposures at this contact have been examined, and in all, Marble Falls limestone lies directly upon shale of Barnett age.

Description of phosphorite.—The phosphorite is composed mostly of well-rounded grains between 0.1 and 0.6 mm in diameter, but some grains are larger and others are smaller. Most of the grains are ooids, a few appear to be structureless pellets, and others are portions of organisms. A basal reddish-brown conglomerate about 3 inches thick is composed of highly oolitic phosphatic nodules, the ooids having developed concentric structure, and a matrix of phosphatic material like that described above. The nodules range in color between pale yellowish brown and dark yellowish brown where least weathered to dark yellowish orange where weathered.

Phosphatic nodules of similar appearance are scattered throughout the rest of the deposit. Three beds of dark yellowish-orange, impure limestone range from about 4 to 6 inches thick and are situated approximately at 6 feet, 8.5 feet, and 9.5 feet above the base of the deposit. The lower limestone is highly fossiliferous in places, but the fossils are very difficult to break free. Brachiopods are most abundant, and gastropods, cephalopods, and corals are common. The upper two limestone beds are less fossiliferous and contain a few oolitic phosphate nodules.

In an attempt to free fossils by calcining, the rock lost considerable weight and turned wood-ash gray. The rock slaked in a period of about a week so that it could be easily pulled apart and the fossil molds exposed. Unfortunately as the shell material is all calcite, it completely disintegrates and the molds soon fall apart.

The deposit appears to be well bedded as indicated by the limestone beds and by parallel rows of phosphate nodules. No cross-bedding was seen, but caliche has destroyed minor bedding features. The caliche may be mostly reprecipitated calcium carbonate derived from within the deposit or mostly derived from outside the deposit. If it was introduced from the outside, the deposits may be richer in phosphate where not weathered. If the calcium carbonate was reworked *in situ,* there is a chance some calcium carbonate has been lost during weathering with an enrichment of the deposit, and if this is true the unweathered material probably is leaner.

Analytical and testing data.—Chemical analyses of phosphorite samples collected in the road material pit are as follows:

	1*	2*
SiO_2	8.72	7.01
Al_2O_3	10.73	11.25
Fe_2O_3	4.34	4.62
MgO	0.73	0.63
CaO	32.00	32.50
Na_2O	0.84	0.50
K_2O	0.68	0.86
Ignition loss	22.65	22.74
TiO_2	3.21	2.93
P_2O_5	13.92	15.18
F	1.37	1.39
Cr_2O_3	0.04	0.04
MnO	0.0x	0.0x
	99.23	99.65
Less O=F	0.58	0.59
Total	98.65	99.06

* Sample 1 extends from 3 inches to 5 feet above the base of the deposit: sample 2 extends from 5 to 8.5 feet above the base of the deposit.

Spectrographic analyses show traces of lead and silver.

The same samples were analyzed for phosphate by the Minnesota Rock Analysis Laboratory and the following results obtained: Sample No. 1 contains 14.42 percent P_2O_5, and sample No. 2, 15.36 percent P_2O_5.

A value for the U_3O_8 in the phosphorite was derived by comparison, using a Geiger counter, with an analyzed sample of phosphate rock containing 0.029 percent U_3O_8, obtained from the New Brunswick Laboratory of the Atomic Energy Commission. The phosphorite is indicated to contain about 0.017 percent U_3O_8, which is very near to the amount found (0.019 percent U_3O_8) in a very pure phosphorite collected by the writer from near Louis Gentil, French Morocco.

Tests by Mr. R. M. Wheeler indicate that the grade of the phosphate is not improved by screening. The phosphate content of the plus 100-mesh fractions is only slightly higher than that of the fines, showing that screening is of little value for producing a higher grade material. The results of these tests are as follows:

Mesh size of screen: Through	Retained on	Percent of sample	P_2O_5 in percent	Proportion of P_2O_5 in each fraction
20	40	38.1	14.53	5.54
40	60	20.8	15.14	3.15
60	100	18.05	14.14	2.55
100		23.05	9.22	2.12
				13.36
Bulk sample			13.73	

The grain density of the one measured specimen is 2.95 gm/cm^3, and the porosity is about 20 percent. An estimate of the tonnage of phosphorite can be made with these values, if the thickness of the phosphorite seen in the road material pit holds for the entire area of the two outliers. The estimated tonnages are 5,000 tons for the southwestern deposit and 35,000 tons for the northeastern deposit. As mentioned above, the Geiger counter gave a normal reading in the vicinity of the larger outlier, and possibly no phosphorite is present. These tonnage estimates naturally are tentative as they have not been based on sufficient thickness measurements and sufficient density data.

Conclusions.—The known phosporite deposits in the Marble Falls area are of low grade and small tonnage and of questionable commercial value. However, commercial phosphorite deposits may exist elsewhere at this stratigraphic position, especially in the eastern part of the Llano uplift. It is recommended that the interval between the Barnett formation and the Marble Falls limestone be thoroughly searched along its outcrop. A Geiger counter can be used as a rapid reconnaissance tool if holes are made through the masking soil cover and the probe lowered to the unweathered material. In addition to the Marble Falls area, another likely area to prospect is from Honeycut Bend northeastward about 3 miles. The rocks of Morrow equivalence alongside the S. Aylor ranch house (Cloud and Barnes, pl, 9, locality 205T-1-4A) should be checked for phosphorite.

REFERENCES

BARNES, V. E., CLOUD, P. E., JR., and WARREN, L. E. (1945) The Devonian of central Texas: Univ. Texas Pub. 4301, Jan. 1, 1943, pp. 163–177.

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

INDEX