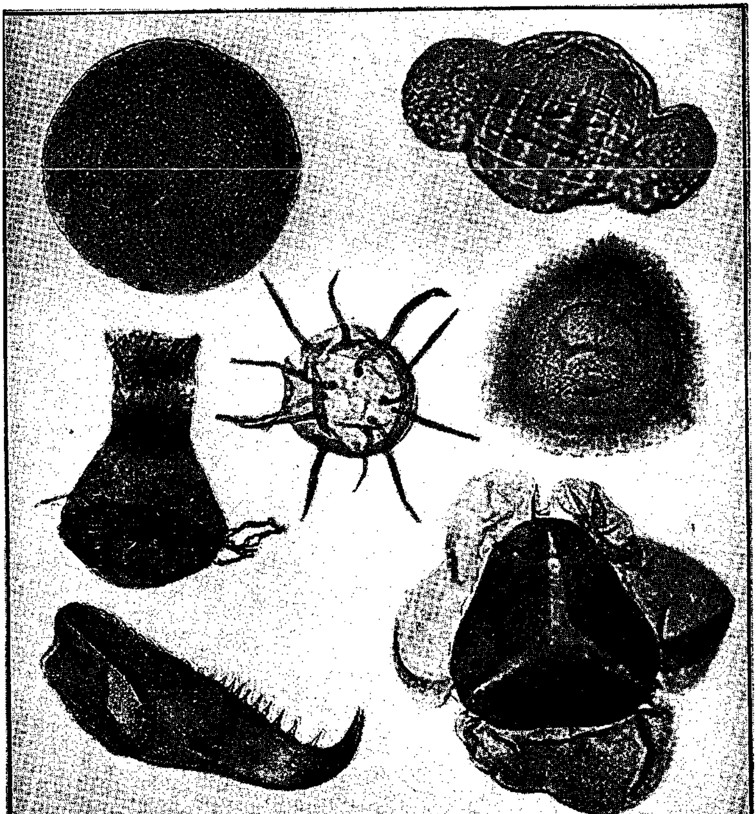
OKLAHOMA GEOLOGY NOTES



OKLAHOMA GEOLOGICAL SURVEY

NORMAN, OKLAHOMA

VOLUME 20, NUMBER 11
NOVEMBER, 1960

SUBSCRIPTION $2.00
SINGLE NUMBER $0.25

John Tipton Lonsdale (1895-1960)

John Lonsdale was born on November 8, 1895, at Dale, Iowa, son of John Dye and Eva Mary Connor Lonsdale. He received his Bachelor of Arts degree at the State University of Iowa in 1917, having been field assistant with the Iowa Geological Survey in 1914 and with the Colorado Geological Survey in 1915. He served as First Lieutenant in the U.S. Army from 1917 to 1919, then returned to Iowa as graduate assistant and received his Master of Science degree in 1921. On August 13, 1921, he married Gertrude Van Arnam. John then went to the University of Virginia as assistant professor and as assistant geologist on the Virginia Geological Survey. He earned his Doctor of Philosophy degree at Virginia in 1924.

Dr. Lonsdale came to The University of Oklahoma as assistant professor in 1924 and served as field geologist for the Oklahoma Geological Survey in the summers of 1924 and 1925. He wrote, with C. N. Gould, for this survey Bulletin 37, *Geology of Texas County, Oklahoma*, and Bulletin 38, *Geology of Beaver County, Oklahoma.*

From 1925 to 1927 he was associate geologist with the Texas Bureau of Economic Geology and geologist from 1927 to 1928. From 1928 to 1935 he was professor of geology and head of the department at Texas Agricultural and Mechanical College, and from 1935 to 1942 he held a similar position at Iowa State College. From 1942 to 1945 he was again an officer in the U. S. Army, as Lieutenant Colonel and Colonel, General Staff Corps, and he was a colonel in the U. S. Army reserve from 1945 to 1953, at which time he retired.

In 1945, Dr. Lonsdale became Director of the Texas Bureau of Economic Geology, a position he held at the time of his death. He had been feeling below normal physically for a few months and stayed away from the office on Monday and Tuesday. At 1:30 a. m. on Wednesday, October 5, his heart stopped beating.

Dr. Lonsdale wrote widely on mineralogy, on sedimentation, on ground water, on petrography, on economic geology, and on meteorites. He was a member of Sigma Xi, Gamma Alpha, Sigma Gamma Epsilon, and of Delta Tau Delta social fraternity. He was a fellow of the Geological Society of America, of the American Mineralogical Society, of the American Association for the Advancement of Science, of American Association of Petroleum Geologists, of American Institute of Mining, Metallurgical and Petroleum Engineers, of the American Geophysical Union, and of the Society of Economic Geologists. He was President-Elect of the Association of American State Geologists at the time of his death. A man of broad information and scientific ability and of personal warmth, he will be greatly missed by his colleagues and many friends.

—C. C. B.

CHLOROX USED IN PREPARATION OF BLACK SHALE FOR CLAY MINERAL ANALYSIS

M. M. CASSIDY AND C. J. MANKIN

During research upon the composition of the Excello member of the Senora formation (a black shale of Middle Pennsylvanian age) in Oklahoma, the problem arose of removing the organic matter from this black shale without altering the clay mineral constituents. Organic matter will in many cases mask the important (001) diffraction peaks of the clay minerals, and for this reason it is necessary to remove most of the organic constituents in order to evaluate the clay mineralogy.

There are several methods available for the destruction of organic matter. Some of the less rigorous are: heating in a stream of oxygen (Strahl, 1958); treatment with a solvent or a series of solvents (Krumbein and Pettijohn, 1938); treatment with H_2O_2 in order to oxidize the organic material to CO_2. The first method, heating, may alter or even destroy some of the clay minerals depending upon which are present. For example, a temperature in excess of 100°C may alter montmorillonite so as to render it indistinguishable by means of X-ray diffraction.

Treatment with solvents is less destructive (depending upon the solvent) but is sometimes ineffectual because organic material is extremely difficult to dissolve. If successful at all, the treatment commonly requires several solvents applied in series. After such treatment elaborate methods must be used in order to collect and re-purify the solvents because of their cost. In addition, the organic solvents may enter into the structure of the expandable clays by filling an unspecified number of the exchange positions.

The oxidation by H_2O_2 is probably the best of the above listed methods. The low temperature at which the oxidation is carried out does not materially affect the basic structure of the clay minerals. It readily destroys the organic constituents and products (mostly CO_2) which are liberated from the system and do not contaminate the sample. Unfortunately, 30 percent H_2O_2 is expensive and in order to clean any number of samples the cost is prohibitive. Consequently, a less expensive chemical oxidizer is desirable. Use of Chlorox (sodium hypochlorite solution) was considered as a possible technique. This laundry bleach has been used by paleontologists and zoologists to clean the tissues from recent invertebrates in order to study the hard parts. (Pennak, 1953, p. 737), and for macerating spore and pollen samples (Hoffmeister, 1960, p. 34).

The method, as it has been developed for the treatment of black shale, consists of placing in a beaker two grams of shale and 250 ml of a solution of five percent by weight of sodium hypochlorite (Chlorox). This can be heated at 70°C in a drying oven for three days or boiled for three hours on a hot plate. In the three-day treatment a plastic beaker must be used because the ultimate concentration of the sodium hypochlorite will react with the glass and dissolve the beaker. Consequently this method, although ideally suited for the destruction of the organic material, is not desirable in clay studies because the clay is also affected. Boiling the sample for about three hours is the desirable method even though all the organic material is not destroyed. A sufficient amount is decomposed so that an easy and accurate analysis of the clay minerals can be made. The main precaution that must be exercised when using this method is to prevent over-concentration of the solution by boiling. A gentle boiling should be used and the solution will concentrate to about one-fifth the original volume. Bleach solution and/or water is added if necessary to prevent further concentration. The results of this method should be a suspension of clay that is either brown, reddish-brown, or white, depending upon which constituents are present. The residue is then diluted with distilled water, filtered, and thoroughly washed. Slides for X-ray diffraction studies may then be made by the usual procedure of suspending the sample in distilled water and sedimenting a thin film of the suspended material upon a glass slide.

After it was found that this method would destroy the organic material in black shales, several series of tests were made to determine the effect of length of time in treatment of the Excello shale (fig. 1), the effectiveness of the method in cleaning several different black shales (figs. 2, 3), and the effect of the treatment on various clays and other minerals (fig. 4).

The results of these tests show that illite, chlorite, and vermiculite are unaffected by sodium hypochlorite treatment. Some montmorillonites, gibbsites, and some kaolinites are destroyed if the treatment is severe. If the boiling time is kept to three hours or less and the concentration of the sodium hypochlorite is not excessive, most of the clay minerals are unaffected. It has been found that the treatment will alter Ca-montmorillonite to Na-montmorillonite by ion exchange. This would be expected, however, because of the high concentration of the Na ions in the sodium hypochlorite solution. Prolonged treatment of kaolinite and montmorillonite will cause these minerals to be broken down into a product which gives prominent diffraction peaks at approximately 6.3 A and 3.64 A. This product is currently under investigation. Fortunately, if the sample contains an appreciable amount of either kaolinite or montmorillonite and if the treatment causes either to be broken down, the 3.64 A diffraction peak is strongly developed and therefore is an internal indication of any damage to the clays.

Because some kaolinites and montmorillonites are affected by NaClO, it was considered desirable to study the nature of this alteration. It was found that solutions of sodium hypochlorite are strongly basic with high capacities. The pH value for a five percent solution of sodium hypochlorite, uncorrected for the Na ion effect, is 12.1. This high basicity is a result of reversable reactions of sodium hypochlorite and water.

$$NaClO + 2H_2O \rightleftharpoons Na^+ + OH^- + HClO + H_2O$$

$$H_2O + 2HClO \rightleftharpoons Cl_2 + O^{--} + 2H_2O$$

The result of this reaction is the formation of hypochlorous acid, a weak acid, and sodium hydroxide, a strong base. The presence of the sodium hydroxide is the reason for the high basicity of the solution.

Correns (1949) shows, with a pH-solubility diagram, that Al_2O_3 and SiO_2 are both soluble in basic solutions and that Al_2O_3 is much more soluble than SiO_2 at pH values in excess of 10. In order to test the hypothesis that pH is the important factor, gibbsite and hectorite were treated with sodium hypochlorite. These two minerals were selected because gibbsite is essen-

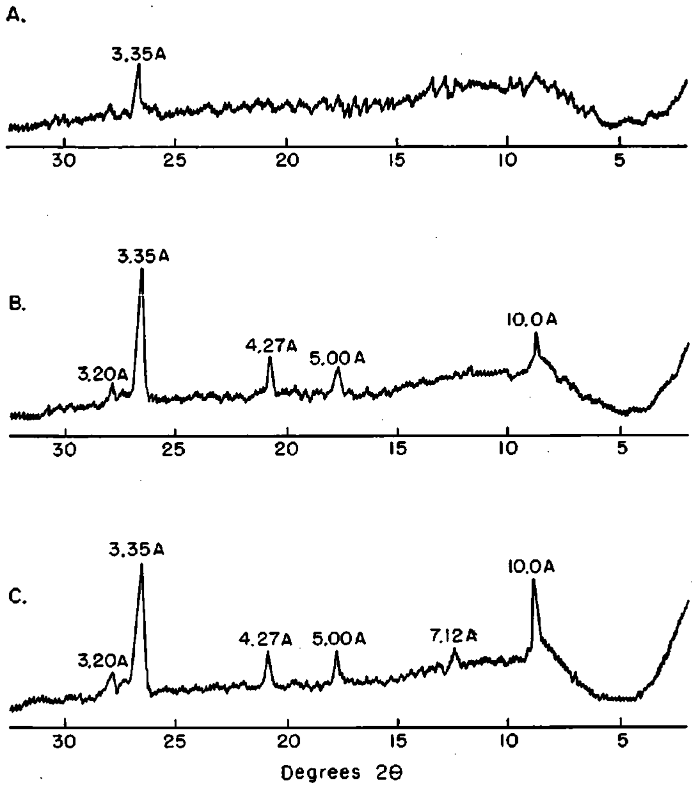


FIGURE 1. X-ray diffractograms of samples of the Excello shale showing effect of length of time of treatment by a solution of sodium hypochlorite (Cu radiation; Ni filtered at a setting of 35 kv and 18 ma).

A. Untreated sample
B. Sample boiled for one hour in five percent solution of sodium hypochlorite
C. Sample boiled for 2.5 hours in five percent solution of sodium hypochlorite

tially an aluminum hydroxide, $Al(OH)_3$, and hectorite contains no appreciable alumina in its structure, $(OH)_4Si_8(Mg, Li)_6O_{20}$. X-ray diffractograms obtained after the sodium hypochlorite treatment show that the gibbsite was destroyed and the hectorite was unaffected (fig. 4). From the above statements it would seem that pH is the important consideration. If this is correct then the octahedral layers of the clay minerals are being destroyed preferentially to the tetrahedral layers because in most kaolinites and montmorillonites the octahedral layer is composed of aluminum in six-fold coordination with oxygen (and hydroxyls) and the tetrahedral layer is composed of silicon in four-fold coordination.

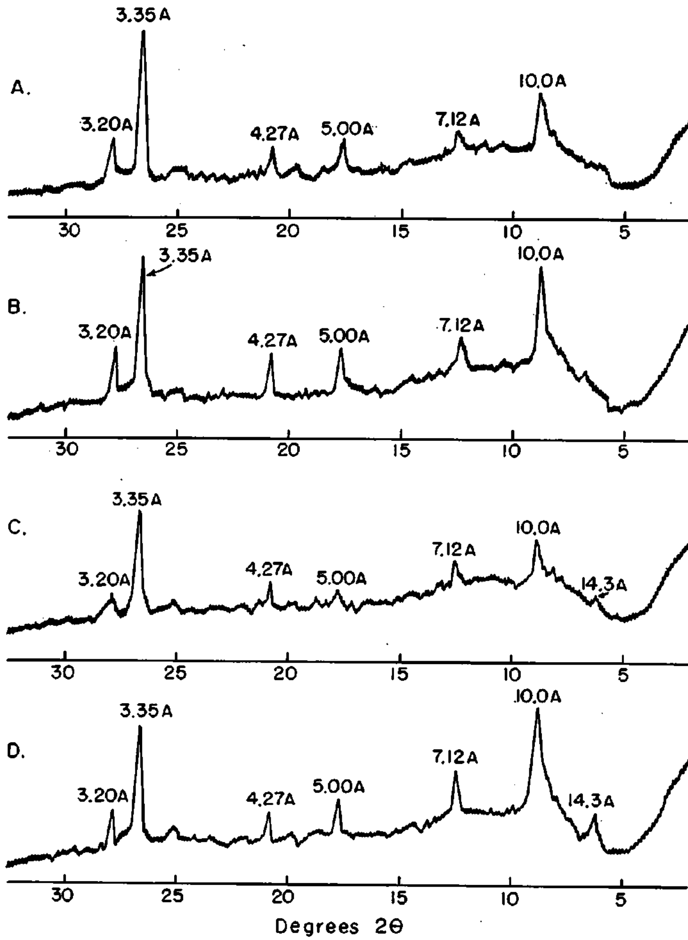


FIGURE 2. X-ray diffractograms of Chattanooga and Little Osage shales showing effect of boiling for 2.5 hours in five percent solution of sodium hypochlorite (Cu radiation; Ni filtered at a setting of 35 kv and 18 ma).

A. Untreated sample of Chattanooga shale
B. Treated sample of Chattanooga shale
C. Untreated sample of Little Osage shale
D. Treated sample of Little Osage shale

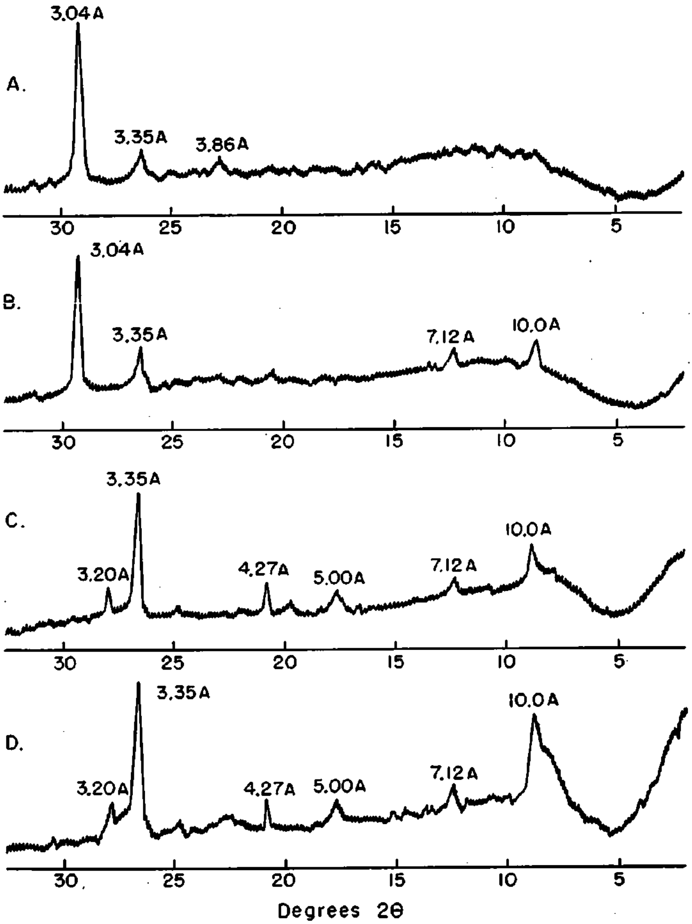


FIGURE 3. X-ray diffractograms of Nelly Bly and Stark shales showing effect of boiling for 2.5 hours in five percent solution of sodium hypochlorite (Cu radiation; Ni filtered at a setting of 35 kv 18 ma).

A. Untreated sample of Nelly Bly shale
B. Treated sample of Nelly Bly shale
C. Untreated sample of Stark shale
D. Treated sample of Stark shale

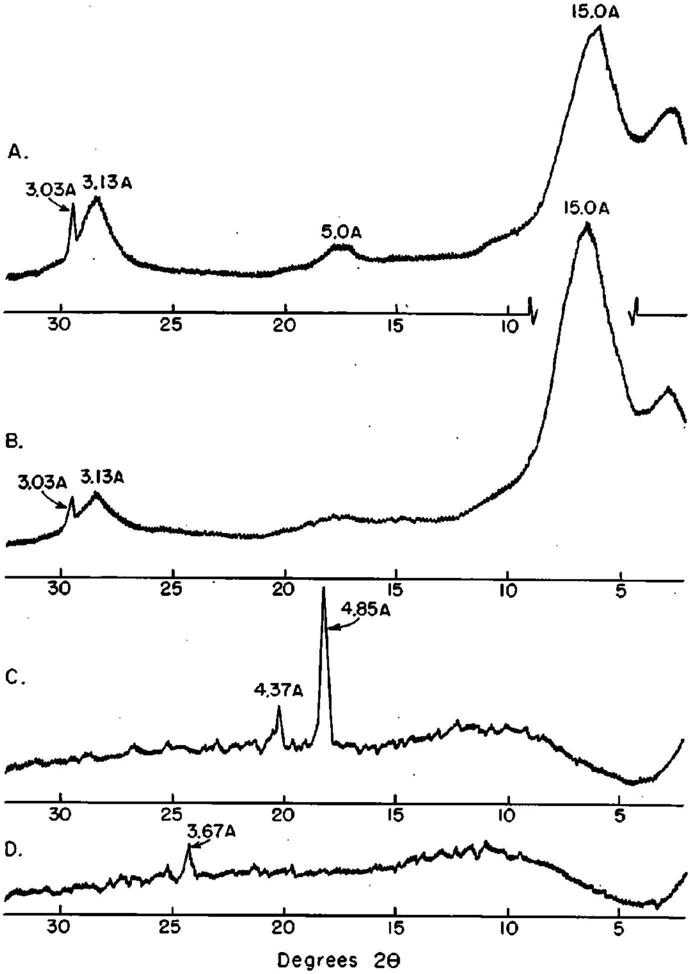


FIGURE 4. X-ray diffractograms of hectorite and gibbsite showing effect of treatment of five percent solution of sodium hypochlorite heated to 70°C for three days. (Cu radiation; Ni filtered at a setting of 35 kv and 18 ma).

A. Untreated sample of hectorite
B. Treated sample of hectorite
C. Untreated sample of gibbsite
D. Treated sample of gibbsite

The effect of sodium hypochlorite upon other minerals has been limited to a check on weight loss (or gain) of treated samples of pure pyrite, hematite, magnetite, siderite, apatite, limestone, quartz, and Na-feldspar. None of these minerals lost more than five percent by weight. The pyrite and siderite were oxidized to iron oxides and both had significant weight gains. An X-ray diffractogram of the siderite sample following treatment showed the formation of beta iron oxide hydrate. The alteration of various other minerals by sodium hypochlorite treatment is currently under investigation.

The organic material from black shale is at first partly decomposed and partly dispersed. This can be demonstrated by boiling the black shale and sodium hypochlorite for 2± hours and then decanting the hot, still black, liquid phase. The residue in the bottom of the beaker is the clay fraction, commonly brown, gray, or white. The black elutrate is a fine colloidal suspension because it cannot be separated in the ultracentrifuge even at a setting of 9,000 G for three hours. Yet this same material will not go through a #50 Whatman filter paper, indicating its fine colloidal nature. Continued boiling of the black elutrate in sodium hypochlorite will eventually destroy the colloidal organic material leaving a liquid faintly colored by iron and other insoluble contaminants. The reaction of the sodium hypochlorite with the organic material can be explained by reaction of the excess oxygen with the complex hydrocarbon chains. In this reaction at least some of the carbon is removed from the system in the form of CO_2.

The Chlorox method has certain limitations in that some clay minerals are affected if the treatment is severe, but indication of damage to the clay structure is inherent in the method. Pyrite and siderite are attacked and, if the solution is left to evaporate in glass beakers, serious damage can result to the beakers. But with the understanding of its limitations, this is a good, inexpensive method for cleaning black shales for clay mineral studies.

References Cited

Correns, C. W., 1949, Einführung in die Mineralogie: Berlin, Springer-Verlag, 414 p.

Hoffmeister, W. S., 1960, Sodium hypochlorite, a new oxidizing agent for the preparation of microfossils: Okla. Geol. Survey, Okla. Geology Notes, vol. 20, p. 34-35.

Krumbein, W. C. and Pettijohn, F. J., 1938, Manual of sedimentary petrography: New York, Appleton-Century-Crofts, Inc., 549 p.

Pennak, R. W., 1953, Fresh water invertebrates of the United States: New York, Ronald Press Co., 769 p.

Strahl, E. O., 1958, An investigation of the mineralogy and petrography of uranium-bearing shales: U. S. Atomic Energy Commission, NYO-7908, 155 p.

OKLAHOMA CEMENT COMPANY OPENS NEW PLANT NEAR PRYOR

George G. Huffman

Introduction—In July 1960, the Oklahoma Cement Company began operation in a new 8-million-dollar plant located five miles east and two and one-half miles south of Pryor, Mayes County, Oklahoma. The plant (fig. 1) is capable of processing 1,000 to 1,200 tons of raw material per day, and the operators expect to produce 1,000,000 barrels of cement per year. The plant, when operating at full capacity, will employ nearly 100 persons with an annual payroll of $700,000 and will have an estimated annual gross production valued at $3,250,000.

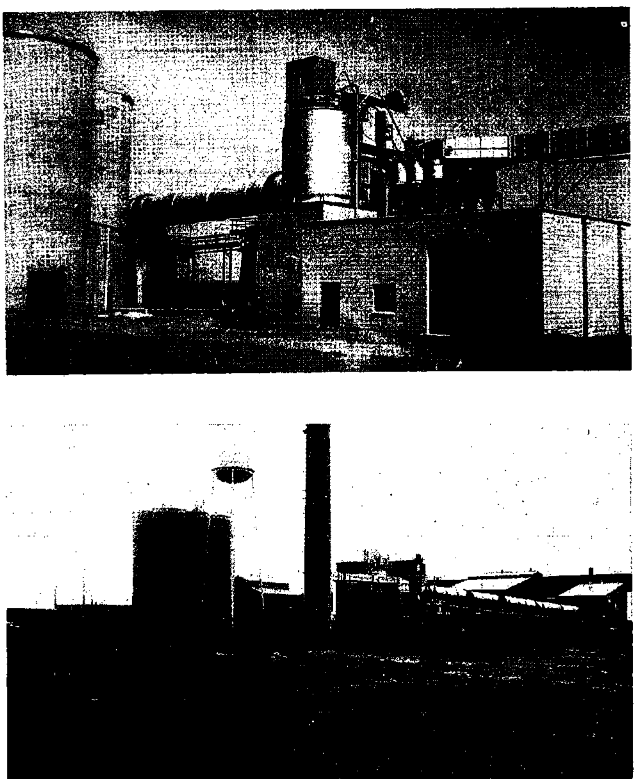


Figure 1. Two views of the newly completed Oklahoma Cement Company Plant near Pryor, Oklahoma.

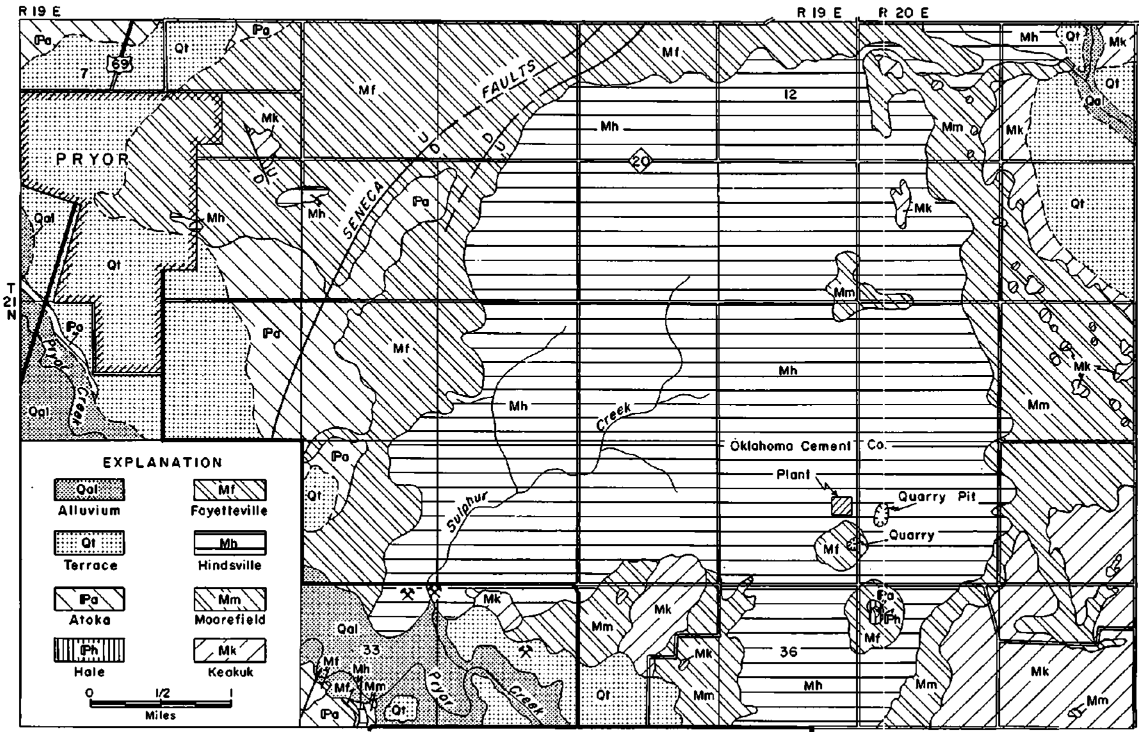


FIGURE 2. Geologic Map of the Pryor area showing location of new plant and quarries in respect to the regional geology.

The plant is located near the center of the east half of sec. 25, T. 21 N., R. 19 E. The surface rock in the vicinity of the plant is the Hindsville limestone and a small outlier of Fayetteville shale is located immediately to the south of the plant. Materials from the Hindsville and the Fayetteville are to be utilized in the manufacture of the cement.

Geologic Setting of the New Plant—Rocks in the Pryor area dip gently toward the west from the Ozark uplift at the rate of 25 to 50 feet per mile. Local steepening of dip is associated with such features as the Seneca fault zone and the small fault which bounds the Pryor Cemetery Hill on the west (fig. 2).

The oldest stratigraphic unit exposed in the area is the Keokuk chert of Early Mississippian age. Succeeding units include the Moorefield, Hindsville, and Fayetteville formations of Mississippian age and the Hale and Atoka formations of Pennsylvanian age. These are overlain locally by terrace and alluvial deposits.

Keokuk formation: The Keokuk consists of massive, white to buff and gray-mottled, fossiliferous chert and irregular masses of blue-gray, fine-grained limestone. Locally reefs or bioherms of coarsely crystalline, crinoidal limestone are present as in the roadcut at the Pryor Cemetery. The cherty facies is typically brecciated and weathers tripolitic.

Thickness ranges from 30 to 125 feet in the Pryor area. It unconformably overlies the Reeds Spring formation and is unconformably overlain by the Moorefield formation. Poorly preserved molds and casts of fossils are common. Typical forms are *"Dictyoclostus" crawfordsvillensis* (Weller), *Spirifer logani* Hall, *Spirifer keokuk* Hall, and *Werriea (Orthotetes) keokuk* (Hall).

Moorefield formation: The Moorefield formation in southern Mayes County includes three members or facies: (1) gray, lithographic, cherty Bayou Manard limestone; (2) gray, thick-bedded, coarse-grained, chert-pebble-bearing Lindsey Bridge limestone; and (3) blue-gray to yellow, calcareous Ordance Plant siltstone and shale. Thicknesses of individual members are variable and the total thickness of the Moorefield ranges from 0 to approximately 100 feet.

The Moorefield formation is abundantly fossiliferous, with brachiopods, gastropods, pelecypods, and trilobites present. Diagnostic forms include *Aviculopecten batesvillensis* Weller, *Griffithides pustulosus* Snider, *Leiorhynchus carboniferum* Girty, *Moorefieldella eurekensis* (Walcott), and *Spirifer arkansanus* Girty.

Hindsville formation: The Hindsville is a gray, medium-crystalline, thick-bedded, oolitic, fossiliferous limestone. The base, in the Pryor area, is marked by a thick bed of limestone containing abundant plates of a small crinoid, *Agassizocrinus*. The uppermost beds are gray and lithographic, resembling the limestones in the lower part of the Fayetteville formation.

The thickness of the Hindsville formation is variable because the top has been eroded throughout most of the area. Exposed thickness ranges from 10 feet to 35. The Hindsville lies unconformably upon the Moorefield and locally upon the Keokuk chert.

Fossils are abundant. Diagnostic forms include the crinoid *Agassizocrinus*, a small blastoid of the genus *Pentremites*, and numerous brachiopods such as *Diaphragmus cestriensis* (Worthen), *Spirifer leidyi* Norwood and Pratten, and *Stenoscisma cestriense* Snider.

Fayetteville formation: The Fayetteville includes a lower sequence of gray to black, lithographic limestones in beds 6 to 8 inches thick, separated by green and black shale, and an upper unit of black, fissile shale. The lower limestone and shale facies has a maximum thickness of approximately 70 feet and the overlying black shale ranges from 30 to 50 feet in thickness.

The Fayetteville lies conformably on the Hindsville formation but locally overlaps the Hindsville and rests upon remnants of the old Keokuk surface. It is succeeded unconformably by the Hale and Atoka formations.

Black shales in the Fayetteville are essentially barren of fossils. The limestones are abundantly fossiliferous with the spiral bryozoan *Archimedes* and the brachiopods *Brachythyris ozarkensis* Snider, *Chonetes chesterensis* Weller, *Diaphragmus cestriensis* (Worthen), *"Marginifera" adairensis* (Drake), and *Werriea kaskaskiensis* (McChesney).

Hale formation: The Hale formation is a gray to brown, sandy limestone which weathers pitted and fluted. Laterally it grades into cross-bedded, calcareous sandstone composed of coarse, frosted, subrounded quartz grains.

The Hale is poorly developed in the Pryor area where its thickness ranges from 0 to 16 feet on Timbered Hill, sec. 31, T. 21 N., R. 20 E. Fossils include numerous corals, brachiopods, and a plant, *Lepidodendron*.

Atoka formation: The Atoka formation consists of sandstones, shales, and a few thin beds of limestone. The sandstones are brown, thick-bedded, and fine-grained. The shales are brown to black and fissile. Limestones are brown, medium-crystalline, arenaceous, and glauconitic. The thickness ranges from zero to a few feet. The Atoka lies with unconformity upon the Hale and Fayetteville formations.

Terrace and alluvial deposits: Thick beds of well-rounded, waterworn gravels are widely distributed in the Pryor area. The town of Pryor is located on an extensive terrace deposit which parallels Pryor Creek. Other gravels are present along the southern boundary of the map area as well as in the northeastern corner in secs. 8 and 17, T. 21 N., R. 20 E. These gravels have been quarried extensively for road surfacing material.

Deposits of Recent alluvium floor the major stream valleys and are especially well developed along the floodplain of Pryor Creek.

CHEMICAL ANALYSES OF HINDSVILLE AND FAYETTEVILLE FORMATIONS—The following chemical analyses of the Hindsville and Fayetteville formations have been furnished by the Oklahoma Cement Company, Pryor, Oklahoma.

1. *Fayetteville formation—SE¼ sec. 25, T. 21 N., R. 19 E. (July 23, 1960).*

	Raw	*Ignited*
SiO_2	21.18	30.29
Fe_2O_3	2.60	3.71
Al_2O_3	8.58	12.28
CaO	35.69	51.04
Ignition loss	30.07	
	98.12	97.32

2. *Fayetteville formation—SE¼ sec. 25, T. 21 N., R. 19 E. (Aug. 5, 1960).*

	Raw	Ignited
SiO_2	21.84	31.14
Fe_2O_3	2.63	3.75
Al_2O_3	9.05	12.90
CaO	34.50	49.19
MgO	1.37	1.95
Ignition loss	29.85	
	99.24	98.93

Calculated $CaCo_3$ 60.66 percent

3. *Hindsville limestone—upper 8 feet in quarry, west side sec. 30, T. 21 N., R. 20 E. (July 23, 1960).*

	Raw	Ignited
SiO_2	5.60	9.44
Fe_2O_3	1.02	1.73
Al_2O_3	1.80	3.03
CaO	50.57	85.31
Ignition loss	40.72	
	99.71	99.51

4. *Hindsville limestone—upper 8 feet in quarry, west side sec. 30, T. 21 N., R. 20 E. (August 5, 1960).*

	Raw	Ignited
SiO_2	5.84	9.83
Fe_2O_3	1.01	1.69
Al_2O_3	2.05	3.46
CaO	49.72	83.68
MgO	.90	1.51
Ignition loss	40.49	
	100.01	100.17

Calculated $CaCo_3$ 89.5 percent

Selected References

Huffman, G. G., 1958, Geology of the south and west flanks of the Ozark uplift, northeastern Oklahoma: Okla. Geol. Survey, Bull. 77, 281 pages, 5 maps.

Hurt, T. W., 1951, Geology of the Pryor area, Mayes County, Oklahoma: unpublished Master of Science thesis, University of Oklahoma, 83 pages.

McBryde, T. J., 1952, Areal geology of the Locust Grove area, Mayes County, Oklahoma: unpublished Master of Science thesis, University of Oklahoma, 57 pages.

RUSSIAN STRATIGRAPHIC NAMES

MAXIM K. ELIAS AND CARL C. BRANSON

In current Russian literature there is no summary in familiar languages, and few of us can do more than transliterate titles of papers and of journals, names of geographic localities, and of stratigraphic units. In Russian usage the categories of stratigraphic nomenclature, as formalized by a commission of the All-Union Scientific-Research Geological Institute (translation by John Rodgers, *International Geology Review*, vol. 1, no. 2, p. 22-38, 1959), are:

Rock divisions		Time divisions	
ГРУППА	GRUPPA	ЭРА	ERA
СИСТЕМА	SISTEMA	ПЕРИОД	PERIOD
ОТДЕЛ	OTDEL	ЭПОХА	EPOKHA
ЯРУС	YARUS	ВЕК	VEK
ЗОНА	ZONA	ВРЕМЯ	VREMYA

Rock stratigraphic units of regional or local occurrence are:

СЕРИЯ	SERIYA
СВИТА	SVITA
ПОДСВИТА	PODSVITA
ПАЧКА	PACHKA

American units are not precise equivalents in concept. The Russian "group" has no established English equivalent. The Russian division (otdel) is of the order of our Mississippian, Pennsylvanian, or Comanchean. The stage (yarus) appears to correspond to our series. The Russian term series is similar both to our group and our series; the suite to some of our formations; the subsuite is like some formations; the packet like a member. The Russian term ГОРИЗОНТ (GORIZONT) is a separate concept similar to many American formations and members, but is not considered as a rank in the rock classification.

Stratigraphic names of foreign origin are rendered in Russian without endings of gender in most cases. Such names when of Russian origin take the gender of the name of the unit; that is, sistema is feminine. The Pliocene series can be rendered as ПЛИОЦЕН, as ПЛИОЦЕНОВЫЕ ОТЛОЖЕНИЯ (Pliocene deposits) in the neuter plural, or as ПЛИОЦЕНОВЫЙ ЯРУС (Pliocene stage), masculine. The words ЭРА (era), СИСТЕМА (system), СВИТА (suite) are feminine. The word ОТЛОЖЕНИЕ (deposit) is neuter singular, and ОТЛОЖЕНИЯ is neuter plural. ОТДЕЛ (division), ЯРУС (stage), ГОРИЗОНТ, and ПЕРИОД (period) are masculine: example—ЮРСКИЙ ПЕРИОД.

The Russian general stratigraphic column given in Russian, in transliteration, and in English is as follows:

Russian	Transliteration	English
КАЙНОЗОЙСКАЯ	KAINOZOY	CENOZOIC
ЧЕТВЕРТИЧНАЯ	CHETVERTICHNAYA	QUATERNARY
ГОЛОЦЕН	GOLOCENE	HOLOCENE
СОВРЕМЕННЫЙ	SOVREMENNEYE	RECENT
ПЛЕЙСТОЦЕН	PLEYSTOTSEN	PLEISTOCENE
ТРЕТИЧНАЯ	TRETICHNAYA	TERTIARY
НЕОГЕН	NEOGEN	NEOGENE
ПЛИОЦЕН	PLIOTSEN	PLIOCENE
МИОЦЕН	MIOTSEN	MIOCENE
ПОНТ (ИЧЕСКИЙ)	PONT	Pontian
САРМАТ (СКИЙ)	SARMAT	Sarmatian
ТОРТОН (СКИЙ)	TORTON	Tortonian
ГЕЛЬВЕТ (СКИЙ)	GEL'VET	Helvetian
АКВИТАН (СКИЙ)	AKVITAN	Aquitanian
БУРДИГАЛЬ (СКИЙ)	BURDIGAL'	Burdigalian
ПАЛЕОГЕН	PALEOGEN	PALEOGENE
ОЛИГОЦЕН	OLIGOTSEN	OLIGOCENE
ЭОЦЕН	EOTSEN	EOCENE
ПАЛЕОЦЕН	PALEOTSEN	PALEOCENE
МЕЗОЗОЙСКАЯ	MEZOZOY	MESOZOIC
МЕЛОВАЯ	MELOVAYA	CRETACEOUS
СЕНОН (СКИЙ)	SENON	Senonian
МААСТРИХТ (СКИЙ)	MAASTRICHT	Maestrichtian
КАМПАН (СКИЙ)	KAMPAN	Campanian
САНТОН (СКИЙ)	SANTON	Santonian
КОНЬЯК (СКИЙ)	KON'YAK	Coniacian
ТУРОН (СКИЙ)	TURON	Turonian
СЕНОМАН (СКИЙ)	CENOMAN	Cenomanian
АЛЬБ (СКИЙ)	AL'B	Albian
АПТ (СКИЙ)	APT	Aptian
БАРРЕМ (СКИЙ)	BARREM	Barremian
ГОТЕРИВ (СКИЙ)	GOTERIV	Hauterivian
БАЛАНЖИН (СКИЙ)	BALANZHIN	Valanginian
НЕОКОМ (СКИЙ)	NEOKOM	Neocomian
ЮРА (ЮРСКАЯ)	YURA	JURASSIC
ТИТОН (СКИЙ)	TITON	Tithonian
КИМЕРИДЖ (СКИЙ)	KIMERIDZH	Kimmeridgian
ОКСФОРД (СКИЙ)	OKSFORD	Oxfordian
КЕЛЛОВЕЙ (СКИЙ)	KELLOVEY	Callovian
БАТ (СКИЙ)	BAT	Bathonian
БАЙОС (СКИЙ)	BAYOS	Bajocian
ААЛЕН (СКИЙ)	AALEN	Aalenian
ТОАР (СКИЙ)	TOAR	Toarcian
ТРИАС (ОВАЯ)	TRIAS	TRIASSIC
ПАЛЕОЗОЙСКАЯ	PALEOZOY	PALEOZOIC
ПЕРМЬСКАЯ	PERM'SKAYA	PERMIAN
ТАТАРСКИЙ	TATARSKIY	Tatarian
КАЗАНСКИЙ	KAZANSKIY	Kazanian
КУНГУРСКИЙ	KUNGURSKIY	Kungurian

Russian	Transliteration	English
АРТИНСКИЙ	ARTINSKIY	Artinskian
КАМЕННОУГОЛЬНАЯ	KAMENNOUGOL'NAYA	CARBONIFEROUS
САКМАРСКИЙ	SAKMARSKIY	Sakmarian
УРАЛЬСКИЙ	URAL'SKIY	Uralian
ГЖЕЛЬСКИЙ	GZHEL'SKIY	Gschelian
МОСКОВСКИЙ	MOSCOVSKIY	Moscovian
НАМЮР (СКИЙ)	NAMYUR	Namurian
ВИЗЕ (ЙСКИЙ)	VIZE	Visean
ТУРНЕ (ЙСКИЙ)	TURNE	Tournaisian
ДЕВОН (СКАЯ)	DEVON	DEVONIAN
ФАМЕН (СКИЙ)	FAMEN	Famennian
ФРАН (СКИЙ)	FRAN	Frasnian
ЖИВЕТ (СКИЙ)	ZHIVET	Givetian
ЭИФЕЛЬ (СКИЙ)	EYFEL'	Eifelian
КОБЛЕНЦ (СКИЙ)	KOBLENTS	Coblenzian
ЖЕДИН (СКИЙ)	ZHEDIN	Gedinnian
СИЛУР (ИЙСКАЯ)	SILUR	SILURIAN
ЛУДЛОВ (СКИЙ)	LUDLOV	Ludlovian
ВЕНЛОК (СКИЙ)	VENLOK	Wenlockian
ВАЛЕНЦ (СКИЙ)	VALENTS	Valentian
ОРДОВИК (СКАЯ)	ORDOVIK	ORDOVICIAN
ЛЛАНДЕЙЛ (СКИЙ)	LLANDEYL	Llandeilian
АРЕНИГ (СКИЙ)	ARENIG	Arenigian
ТРЕМАДОК (СКИЙ)	TREMADOK	Tremadocian
КЕМБРИЙ (СКАЯ)	KEMBRIY	CAMBRIAN
ДОКЕМБРИЙ	DOKEMBRIY	PRECAMBRIAN
ПРОТЕРОЗОЙ	PROTEROZOY	PROTEROZOIC
АРХЕЙ	ARKHEY	ARCHEOZOIC

The word for Upper is ВЕРХНИЙ (VERKHNIY), for Middle СРЕДНИЙ (SREDNIY), Lower НИЖНИЙ (NIZHNIY). Many of the rock terms are similar to English words:

ПЕСОК	PESOK	sand
ГЛИНА	GLINA	clay
ГАЛЕЧНИК	GALECHNIK	gravel
АЛЛЮВИЙ	ALLYUVIY	alluvium
СЛАНЕЦ	SLANETS	shale
ПЕСЧАНИК	PESCHANIK	sandstone
ИЗВЕСТНЯК	IZVESTNYAK	limestone
КОНГЛОМЕРАТ	KONGLOMERAT	conglomerate
ГЛАУКОНИТ	GLAUKONIT	glauconite
КАМЕННАЯ СОЛЬ	KAMENNAYA SOL'	rock salt
ГИПС	GIPS	gypsum
АНГИДРИТ	ANGIDRIT	anhydrite
УГОЛЬ	UGOL'	coal
ДОЛОМИТ	DOLOMIT	dolomite
МЕРГЕЛЬ	MERGEL	marl

Dr. Robert Vlach, Department of Modern Languages, The University of Oklahoma, kindly assisted in the preparation of the manuscript.

WHAT LIES BENEATH THE LUKFATA SANDSTONE?

WILLIAM D. PITT

The oldest exposed rock unit of the Ouachita Mountains in Oklahoma is the Lukfata sandstone. This unit crops out in the central part of the Choctaw anticlinorium in southeastern Oklahoma and is probably Ordovician in age (fig. 1). In outcrop, it consists of approximately 145 feet of massive, well-sorted, dolomitic sandstone, with thin, dark beds of shale, siltstone, and limestone. An intriguing question to be answered is: How thick is the Lukfata formation and what kinds of sedimentary rocks underlie it? Estimates of thickness range from 500 to more than 20,000 feet (Tomlinson, C. W., 1954, personal communication; Lyons, 1950; Ham, 1959). The thickness of sedimentary rock beneath the oldest exposed rocks in the Choctaw anticlinorium (and in the entire Ouachita Mountains) remains a compelling question that can be answered only by drilling.

The kind of rock beneath the oldest exposed rock in the central Choctaw anticlinorium, or "core" area, also remains an interesting question. The Crystal Mountain sandstone and older rocks exposed in the Ouachita Mountains have been correlated either with sandstones of the Simpson group or with the underlying Arbuckle limestone. The upper part of the Arbuckle limestone is more sandy in the eastern part of the Arbuckle Mountains than in

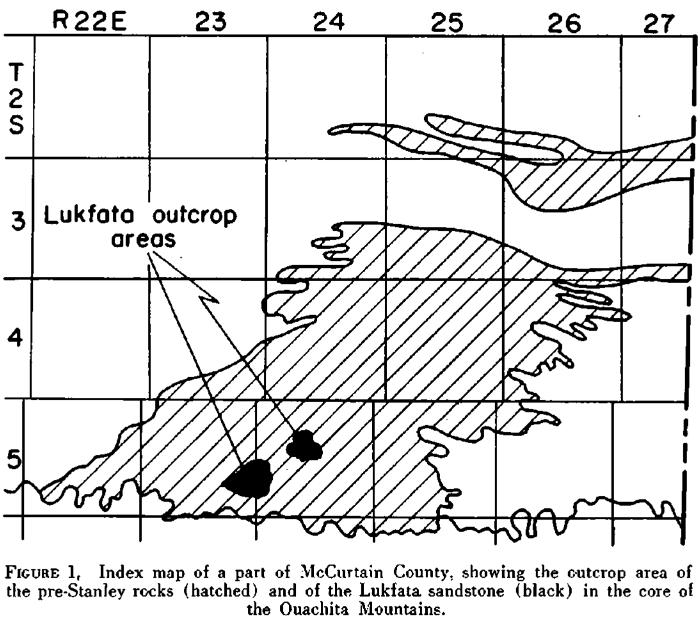


FIGURE 1. Index map of a part of McCurtain County, showing the outcrop area of the pre-Stanley rocks (hatched) and of the Lukfata sandstone (black) in the core of the Ouachita Mountains.

the western part. If this trend continues eastward from the Arbuckle Mountains, the Arbuckle equivalent in the Ouachita Mountains must be more clastic and presumably more porous than that unit farther west.

In addition to answering the questions of the kind and thickness of the sedimentary rock beneath the Lukfata sandstone, drilling in this area could lead to the discovery of new oil and gas reserves. The area is a good prospect for the following reasons:

Structure: Perhaps the most attractive thing about the core area as an oil or gas prospective area is its size. The anticline covers more than 200 square miles, and if the crest of it yields oil or gas, oil and gas might also be found far down the flanks. The crest of the anticline is a low-dip area, one that is essentially unfaulted. Hence, structurally, the area is quite promising.

Oil potential: The oldest rock exposed in the core area is the only clue we have to the nature of the underlying rocks. This rock, the Lukfata sandstone, is largely a clastic formation, containing nearly 50 percent sandstone or siltstone. Certainly if there is more than 10,000 feet of this kind of rock beneath the surface, thick sections of reservoir rock seem almost assured.

Oil shows: Two wells that are less than 10 miles south of the core area have had oil shows in Paleozoic beds. One is the Seahy Oil Co. No. 2 Harmon (NE¼ sec. 5, T. 8 S., R. 23 E.), which is bottomed in a fairly soft oil sand below a chert bed (Davis, L. V., personal communication, 1958). The fact that the oil is found below a bed of chert suggests that it is indigenous to the Paleozoic rocks in which it is found. The age of the oldest stratum penetrated in this well is not known, but its degree of induration and the presence of a chert bed indicate that it belongs to the Paleozoic Ouachita facies.

References Cited

Ham, W. E., 1959, Correlation of pre-Stanley strata in the Arbuckle-Ouachita Mountain region, *in* The geology of the Ouachita Mountains, a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 71-85.

Lyons, P. L., 1950. A gravity map of the United States: Tulsa Geol. Soc., Digest, vol. 18, p. 33-43.

Selected References

Branan, C. B., Jr., and Jordan, Louise, 1960, Recent exploration in the Arkoma basin and Ouachita province, southeastern Oklahoma, Okla. Geol. Survey, Okla. Geology Notes, vol. 20, p. 140-146.

Chenoweth, P. A., 1959, Is there oil and gas in the Ouachita Mountains?: Okla. Geol. Survey, Okla. Geology Notes. vol. 19, p. 198-208.

Goldstein, A., Jr., and Flawn, P. T., 1958, Oil and gas possibilities of Ouachita structural belt in Texas and Oklahoma: Amer. Assoc. Petroleum Geologists, Bull., vol. 42, p. 876-881.

Honess, C. W., 1923, Geology of the southern Ouachita Mountains of Oklahoma: Okla. Geol. Survey, Bull. 32, 355 p.

Howell, J. V., and Lyons, P. L., 1959, Oil and gas possibilities of the Ouachita province, *in* The geology of the Ouachita Mountains, a symposium: Dallas Geol. Soc. and Ardmore Geol. Soc., p. 57-61.

Pitt, W. D., 1955, Geology of the core of the Ouachita Mountains of Oklahoma: Okla. Geol. Survey, Circ. 34, 34 p.

THE TYPE SPECIES OF GLOBOBLASTUS HAMBACH

ROBERT O. FAY

The type species for *Orbitremites* Austin and Austin 1842 is *Pentremites derbiensis* Sowerby 1825, from the Lower Carboniferous limestone of England. This species is characterized as a globular blastoid with linear ambulacra, with 4 spiracles and 1 anispiracle in raised areas at the adoral tips of the 5 extremely elongate deltoids, small side plates covering only the abmedial one-half of the lancet, and one hydrospire fold on each side of an ambulacrum terminating in a hydrospire plate alongside the lancet plate. This description is radically different from that of *Pentremites norwoodi* Owen and Shumard 1850, the type species for the genus *Globoblastus* Hambach 1903.

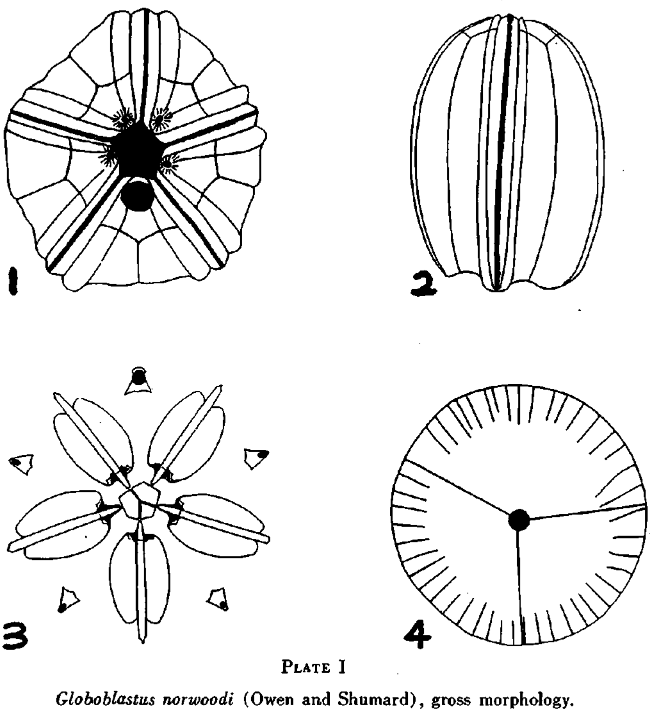


PLATE I

Globoblastus norwoodi (Owen and Shumard), gross morphology.

FIGURE 1. Oral view, x4.7, K. U. coll. 4197.
FIGURE 2. Left posterior radial view, x3.5, K. U. coll. 4197.
FIGURE 3. Plate layout, anal side toward top, x1.1, K. U. coll. 1385.
FIGURE 4. Stem impression on basal, x25, K. U. coll. 1385.

Genus Globoblastus Hambach 1903 (emended)

Plates I - IV

Calyx ellipsoidal: ambulacra linear; spiracles 5, raised, with anispiracle between an epideltoid and a hypodeltoid plate; deltoids 4, short, confined to summit; side plates large, completely covering the lancet plate; hydrospires 2 on each side of an ambulacrum, terminating laterally in a hydrospire plate; radial plate long, with radial limbs overlapping deltoids.

Plate II

Globoblastus norwoodi (Owen and Shumard). Detail of peristomal area, anal side down, x13, Univ. Ill. 500.

Type species GLOBOBLASTUS NORWOODI (Owen and Shumard) 1850

Characteristics same as those of genus. Special internal morphologic features are shown on plate IV. The oral opening (O), of which the mouth was a part in the living animal (arrow pointing to black space), is pentagonal, surrounded on four sides by deltoid lips (DL) and on the fifth (anal) side by an epideltoid plate (ED). The anal opening (A), of which the anus was a part in the living animal (arrow pointing to black space), is pentagonal, epideltoid and hypodeltoid (HD) plates, coalesced internally with two adjacent hydrospire canals (HC). Each spiracle (S) bifurcates internally into two hydrospire canals (HC); with a deltoid septum (DS) between, connecting the deltoid lip (DL) with the deltoid body (D). The first adoral pore (P) appears to have two small poral canals leading internally to the hydrospire canal. The deltoid plate infolds internally into two hydrospire folds (H) on each side beneath the radial plates near the radiodeltoid suture, continuing aborally with similar infolds of the radial plates (pl. III, figs. 4, 7). It is presumed that water entered the pores into the hydrospires and passed upward through the hydrospire canals, coming out of the spiracles.

Surrounding the oral opening is the circumesophageal ring (CE), a double set of pentagonal canals that lead directly to the radial canal (RC). The radial canal extends through the center of each lancet plate and appears to be composed of two canals for a short distance alongside the deltoid plate. Two small coelomic canals (CC) appear to branch internally through the base of the lancet plate from the main radial canal, a short distance from the adoral end of the radial canal. The main radial canal of each ambulacrum bifurcates adorally and the branches penetrate the center of the deltolancet sutures on either side so as to meet the canal of an adjacent ambulacrum at

---

EXPLANATION OF PLATE III

Globoblastus norwoodi (Owen and Shumard), gross morphology.

Bp—brachiolar pit	L—lancet
D—deltoid	MF—main food groove
DL—deltoid lip	P—pore
DS—deltoid septum	Psp—primary side plate
ED—epideltoid	R—radial
H—hydrospire	RC—radial canal
HD—hypodeltoid	SF—side food groove
HP—hydrospire plate	SP—side plate

Ssp—secondary side plate

FIGURE 1. Peristomal area, anispiracle toward base, x6.4, K. U. coll. 1385.

FIGURE 2. Peel section below spiracles, anispiracle down, x7.5, K. U. coll. 7449.

FIGURE 3. Same as figure 2, deeper near radiodeltoid suture, showing suture between epideltoid and hypodeltoid, x5.5.

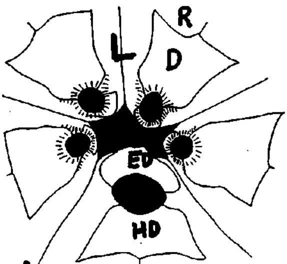
FIGURE 4. Same as figure 3, deeper, showing right anterior deltoid overlapped by radial limbs, with anterior lancet on left, x8.9.

FIGURE 5. Peristomal area showing accessory oral plates, x16, Univ. Ill. 500.

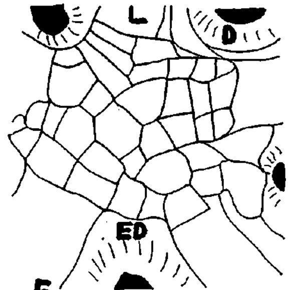
FIGURE 6. Details of one-half of an ambulacrum, x41, mouth toward top, K. U. coll. 7449.

FIGURE 7. Cross-section of an ambulacrum, x22, K. U. coll. 2697.

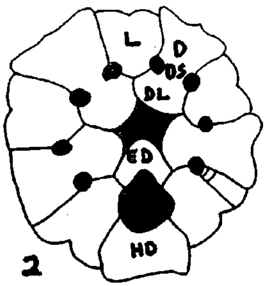
PLATE III



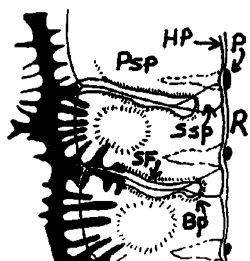
1



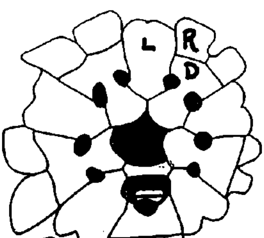
5



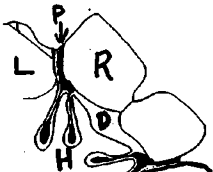
2



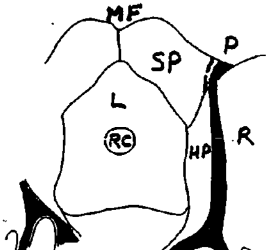
6



3



4



7

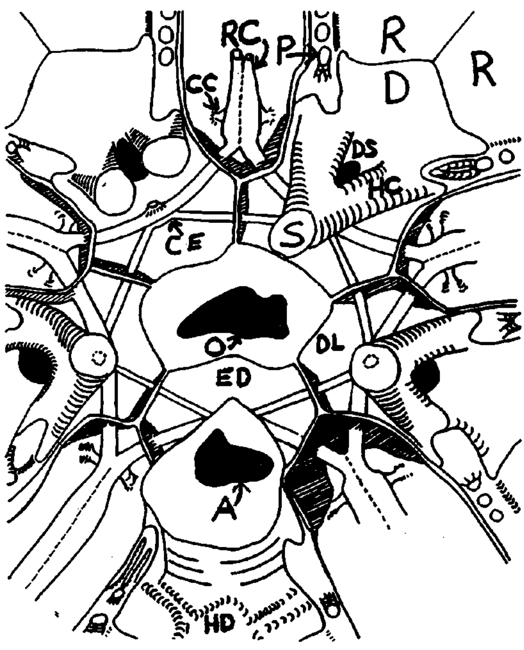
the center of the base of a deltoid septum, which is the point of lateral bifurcation of this septum. At the junction of canals is an additional set of smaller canals which forms an inner pentagonal ring around the esophageal opening, each canal of this inner ring penetrating the center of the outer pentagonal ring at the junction with the inward abaxial portion of the deltoid septum. The inner ring is slightly proximal to and inward from the outer ring to which it is connected. Of primary importance is the presence of small tubes extending distally from the outer ring toward the base of each

---

EXPLANATION OF PLATE IV

Globoblastus norwoodi (Owen and Shumard). Internal mold showing detailed internal morphology, x13 (photograph) and x14.7 (line drawing), Univ. Ill. coll. 518.

A—anal area
CC—coelomic canal
CE—circum-esophageal ring
D—deltoid
DL—deltoid lip
DS—deltoid septum
ED—epideltoid
HC—hydrospire canal
HD—hypodeltoid
O—oral area
P—pore
R—radial
RC—radial canal
S—spiracle



deltoid septum and seemingly connecting with the spiracles (pl. IV arrow at CE). The entire structure has essential characteristics of the esophageal ring and associated radial canals of living echinoderms. The stone canal and polian vesicles are comparable to the small canals which seemingly reach to the base of each spiracle, and the madreporite is comparable to a spiracle. These observations and interpretations suggest that the lancet plate is built by secretion around a radial canal and that water entered such canal by diffusion from the hydrospires. It is significant that in all Silurian and Devon-

PLATE IV

ian blastoids, as well as in many later ones, the lancet plate is almost entirely concealed by side plates, denoting complete disuse of the lancet plate as primary support of a food groove. In other words, the lancet plate is not part of the ambulacral food gathering system but probably belongs to the respiratory system and only in later specialized forms is found to have taken on structural functions in relation to the ambulacral food grooves. Thus *Globoblastus*, with lancet covered by side plates, is more primitive than *Orbitremites* which has the medial part of the lancet exposed.

The side plates (SP) are roughly trapezoidal, when considered together. The primary side plate (Psp) is actually referred to as the side plate and is trapezoidal, with the secondary side plate (Ssp) resting upon the bevelled adoral margin of the primary side plate and being triangular in outline (pl. III, fig. 6). A brachiolar pit (Bp) occurs near the admedial tip of the secondary side plate (medial referring to the line of the main food groove). The side food groove leads from the brachiolar pit to the main food groove (MF), with about three side food-groove sockets on either side. Each hydrospire pore corresponds in position with the middle portion of each primary side plate each of which has an elongate depression leading toward the pore. There are about 10 side plates in 3 mm.

The basals are three, small, in basal concavity, similar to other globular or ellipsoidal blastoids. The stem is round, about 1.6 mm in diameter, with about 46 crenellae extending about one-fourth the way toward the center from the periphery (pl. I, fig. 4) The oral area or peristome is commonly covered with many small accessory oral plates (pl. III, fig. 5; pl. II).

Remarks—*Globoblastus* Hambach 1903 is here resurrected as a valid generic name, distinct from *Orbitremites* Austin and Austin 1842. *Globoblastus*, with short deltoids, an epideltoid and hypodeltoid with anispiracle between, two hydrospire folds on each side of an ambulacrum, and large side plates completely covering the lancet plate, is here considered the primitive ancestor to *Orbitremites*, with the following trends toward the latter. The short deltoids extended aborally into elongate deltoids, the epideltoid and hypodeltoid fused to form one anal deltoid, the two hydrospire folds atrophied to one, and the lancet plate migrated outward to receive the food groove of *Orbitremites*. These trends are common in many blastoid lineages. Of the known elliptical spiraculate blastoids with hydrospire plates, these are the only two genera whose species contain 5 raised spiracles. *Globoblastus* was probably derived from a primitive type of *Mesoblastus* with an epideltoid and hypodeltoid plate on the anal side.

Repository—The whereabouts of Owen and Shumard's type specimens is unknown. The Owen collection, presumably containing Owen and Shumard's types, at Indiana University, was destroyed by fire in 1883 (Blatchley, 1917, p. 116). The original specimens were collected from the Burlington limestone, at Burlington and Augusta, Iowa, and Oquawka, Illinois. The characteristics of my figured specimens agreed with those of Owen and Shumard's description. *Plesiotypes*: University of Illinois, Geology Department, 518, chert in upper part of Burlington limestone, either Louisiana or Curryville, Missouri (pl. IV); 500 or 830 or 25-D17, lower part of Burlington limestone, Louisiana, Missouri (pl. III, fig. 5; pl. II). University of Kansas, Geology Department, 1385 (pl. I, figs. 3-4; pl. III, fig. 1) Pike County, 2697 (pl. III, fig. 7) Pike County, 4197 (pl. I, figs. 1-2) Louisiana, 7449 (pl. III, figs. 2-4, 6) Sweeney Quarry at Clifton City, all from the Burlington limestone, Missouri.

References Cited

Austin, T., and Austin, T., Jr., 1842, Proposed arrangement of the Echinodermata particularly as regards the Crinoidea, and a subdivision of the class Adelostella (Echinidae): Annals and Magazine of Natural History, vol. 10, p. 111.

Blatchley, W. S., 1917, A century of geology in Indiana: Ind. Acad. Science, Proc., 1916, p. 89-177 (p. 116).

Hambach, G., 1903, Revision of the Blastoideae, with a proposed new classification, and description of new species: St. Louis Acad. Science, Trans., vol. 13, p. 46.

Owen, D., and Shumard, B. F., 1850, Descriptions of fifteen new species of Crinoidea from the sub-Carboniferous limestone of Iowa, collected during the U. S. Geological Survey of Wisconsin, Iowa, and Minnesota in the years 1848-1849: Philadelphia Acad. Nat. Sciences, Jour., new series, vol. 2, pt. 1, p. 64, pl. 7, figs. 13a-c.

Sowerby, G., 1825, Note on two genera and several species of Crinoidea; note on the foregoing paper, together with a description of a new species of *Pentremites*: Zoological Journal, vol. 2, no. 7, p. 317, pl. 11, fig. 3.

New Theses Added to O. U. Geology Library

The following Master of Science theses were added to The University of Oklahoma Geology Library during the month of September, 1960:

Distribution of Layton sandstone (Pennsylvanian), Logan County, Oklahoma, by G. L. Bross.

Surface geology of the Jumbo Quadrangle, Pushmataha County, Oklahoma, by H. C. Burrough.

The economic geology of the petroleum and iron ore deposits south of Jacksonville, Texas, by D. L. Norton.

Broken Bow Area Mapped

The most recent Oklahoma topographic map issued by the U. S. Geological Survey is that of the Broken Bow area in east-central McCurtain County. It is a 15′ quadrangle, mapped on the scale of 1:62,500 with 10- and 20-foot contour intervals. The limits of the area are latitudes 34°—34°15′ and longitudes 94°30′—94°45′. The area is the SE¼ of the U. S. G. S. Lukfata, Okla., 30′ topographic quadrangle, edition of 1902.

Key Wolf (1886-1960)

Key Wolf died on October 12, 1960, at his home in Davis, Oklahoma. He is survived by his widow, Mrs. Euline Capshaw Wolf, formerly of Norman, and by their three daughters and four sons.

Key Wolf, half Scotsman and half Chickasaw, came to The University of Oklahoma as a student in 1905. He was one of the star football players of Bennie Owen's earlier teams and he played in all 45 games of the 1905 to 1909 seasons. Key received his Bachelor of Arts degree in geology in 1910 and worked as field assistant for the Oklahoma Geological Survey, first in mapping the Wapanucka limestone across Coal, Atoka, Pittsburg, and Latimer Counties in 1908 and later that year working with C. A. Reeds in the Arbuckle Mountains. In 1909 he was in D. W. Ohern's party in northeastern Oklahoma. He taught in and later was superintendent of an Indian academy at Wagoner, South Dakota. In the thirties he returned to a farm at Davis and in that city he coached and taught in the school system.

—C. C. B.

Mailing List for the Notes

The mailing list for the Oklahoma Geology Notes is being revised. For that purpose we are enclosing an address verification card with this issue. If you wish to continue receiving this publication, please return the enclosed card immediately with your correct address. We must remove from the list the names of those who do not reply.