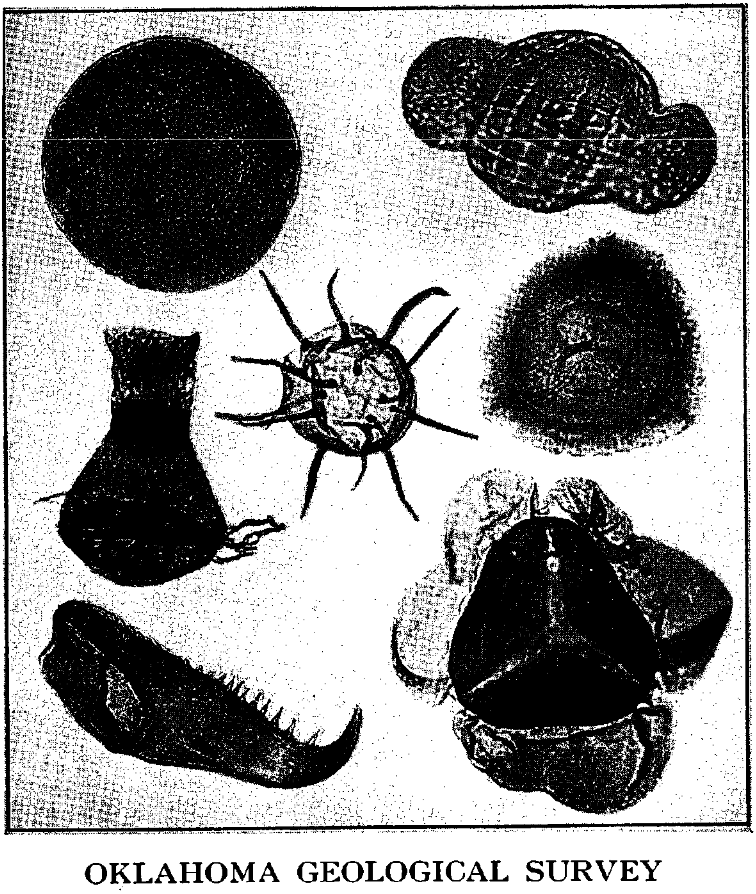
OKLAHOMA GEOLOGY NOTES



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RECOVERY OF LIME AND SULFUR FROM GYPSUM AND ANHYDRITE

ALBERT L. BURWELL

An article entitled "Reductive decomposition of gypsum by carbon monoxide," written by T. D. Wheelock and D. R. Boylan, Iowa State University, was published in the March, 1960, issue of *Industrial & Engineering Chemistry* (p. 215-218). The products from this newly devised process are lime and sulfur dioxide, thus providing a new route to the manufacture of sulfuric acid from gypsum.

It is interesting to compare the new process of Wheelock and Boylan with that developed by the present writer (U. S. Patent 2,740,691, April 3, 1956). In the new process the gaseous products are SO_2 and CO_2. whereas in the older process the gaseous products are H_2S and CO_2. Both processes involve the separation of the CO_2 from the sulfur-bearing gas. The SO_2 from the new process would be marketed as such or converted to sulfuric acid by conventional means. The H_2S of the older process could be converted to sulfur or to SO_2. The sulfur could be marketed in either solid or liquid form. As a matter of fact, the mixed gases passing off from the older process are comparable in most respects to a "sour natural gas" from which sulfur is now produced in competition with natural sulfur. After removal of H_2S and CO_2 the residual excess natural gas might be recycled or returned to the natural-gas pipe line.

TABLE I.—CALCULATED EQUILIBRIUM CONSTANTS AND HEATS OF REACTION

		$Log_{10}K$			ΔH_r Cal/Mole
		1200°K	1400°K	1600°K	1400°K
(1)	$CaSO_4 + CO = CaO + SO_2 + CO_2$	0.31	1.48	2.28	43,400
(2)	$CaSO_4 + 4CO = CaS + 4CO_2$	7.92	6.69	5.66	-48,400

Table I gives the calculated equilibrium constants and heats of reaction of the two principal reactions of the new process as given by Wheelock and Boylan. They say, "The principal reaction (Reaction 1) is endothermic and is therefore favored by high temperatures. Reaction 2 ... is exothermic and is favored by low temperatures and high carbon monoxide partial pressures."

Since our process operates at considerably lower temperature and the products are obtained in more salable form, the fixed investment should be less and the market would be broader.

Announcement

It has been the policy of the Survey to publish no new paleontologic or stratigraphic names in the *Oklahoma Geology Notes*. With the publication in this issue of Dr. Harris' article on Arbuckle octracodes, the policy is relaxed. The Survey now distributes the *Notes* to all state, provincial and national geological surveys, to 200 universities over the world, and to 500 individuals and oil companies. The circulation is sufficiently wide to warrant publication of an occasional new name.

AN INDEX OSTRACODE FROM THE ARBUCKLE LIMESTONE, OKLAHOMA

REGINALD W. HARRIS

The ceratopsid ostracode described herein is one of the more numerous and diagnostic of a dozen species recovered from uppermost Arbuckle limestone (West Spring Creek) on the south flank of the Arbuckle Mountains. Relatively large size, distinctive spine, common occurrence, and limited stratigraphic range place this speecies among classic index Ostracoda.

This ostracode constitutes the second such crustacean to be reported from the Arbuckle group. Frederickson (1946, p. 578, text-figs. 1-3) described *Eoleperditia (Leperditia) harrisi* from the Upper Cambrian Honey Creek formation of the lower Arbuckle limestone of the Wichita Mountains. In a future issue of the Journal of Paleontology will appear a more comprehensive report regarding upper Arbuckle Ostracoda associated with the ceratopsid form described herein.

Topmost Arbuckle and basal Simpson outcrops were sampled on the south side of the Arbuckle Mountains from a section paralleling and fifty yards west of U. S. Highway 77, in NE¼ SE¼ SE¼ sec. 24, T. 2 S., R. 1 E. The beds strike N30°W and dip 55°SW.

The Arbuckle-Simpson contact in the section under consideration is regarded tentatively as being at the top of a two-foot-thick dolomitic, conglomeratic, *Hormotoma*-bearing limestone bed located fourteen feet down slope (southward) from a similar more resistant conglomeratic Arbuckle limestone bed containing *Hormotoma* in greater abundance. The two-foot-thick conglomeratic contact bed contains reworked limestone and a few small chert pebbles, as well as evidence of oxidation in the form of red and pink discoloration with traces of red claystone. A few Arbuckle Ostracoda were recovered from the twenty-foot-thick limestone and calcareous shale section overlying the two-foot contact bed. Additional search in this twenty-foot section and along the strike must determine whether such Ostracoda are in situ in twenty feet of additional topmost Arbuckle section, or in the basal twenty-foot Simpson section, either as reworked Arbuckle forms, or as actual Simpson forms of late Arbuckle origin.

CERATOLEPERDITIA n. gen.

Genotype: *Ceratoleperditia arbucklensis* n. sp.

Relatively large, simple leperditian forms with subcentral, subalate spine or knoblike process projecting obliquely downward and outward from lower part of carapace. Smooth to punctate, reticulate, papillose, or otherwise conservatively sculptured surface may display, in addition, an eye tubercle with or without faint sulcate depression, muscle scars, occasional secondary node or depression, or marginal thickening, rim, or beading. Straight hingement is apparently in simple contact. Right valve is larger and overlaps left about free margins, with maximum overlap along venter.

Range: Upper Canadian and lower Champlainian (Chazyan-Blackriveran).

Relationships: The genus is assigned to the Family Leperditiidae Jones, as described by Ulrich and Bassler (1923, p. 294), Bassler and Kellett

(1934, p. 13), and Swartz (1949, p. 311). The genus will thus be included among genera listed by Henningsmoen (1953, p. 274), members of Subfamily Leperditiinae Jones, of the Family Leperditiidae Jones.

Remarks: The characteristic subcentral spine appears to be an expanded development of the ventral body proper, not simply a surficial ornamentation. In the genotype the lateral slope of the carapace continues its gently expanding curvature through the oral surface of the spine without significant break or channeling at the base of the spine. Ventrally the adult ceratopsid process is undercut and obliquely pendant.

A slight antero-ventral near-marginal inflation of the carapace is present before and below the ventral spine of the genotype; such inflation is considered to be a specific characteristic. Again, definite post-dorsal thickening was observed on many adult left valves of the type species. Such thickening is characteristic of the genus *Leperditia* Rouault and some species of *Eoleperditia* Swartz. The related leperditian genera *Herrmannina* Kegel and *Chevroleperditia* Swartz do not display post-dorsal inflation of the left valve. Incidentally, post-dorsal thickening or "roll" was observed on other leperditian associates of the new form in topmost Arbuckle strata.

No distinct sulcus was observed on the Arbuckle genotype, though on some specimens a faint, short, narrow sulcus is suggested immediately behind the eye tubercle. A faint sulcus may characterize some undescribed species of the genus. However, ceratopsid leperditians with distinct sulcus, as *Eoleperditia ? perplexa* Harris (1957, p. 134, pl. 1, figs. 8a, 8b), originally described from the so-called McLish "Birdseye" limestone of the Criner Hills of Oklahoma, should not be included in this genus. Such forms with sulcus and essentially outward-projecting (not obliquely-projecting) lateral spine apparently appeared in younger strata; late Arbuckle *Ceratoleperditia* being a more primitive, less ornate forerunner.

A smoothly finished, indistinct, ovate muscle scar lies diagonally immediately behind and below the eye tubercle of the genotype. Surficial pores were observed about the scar, but none upon it, the wall appearing here denser and smoother. No papillose structure nor radiating venose lines were observed in association with the scar. Swartz (1949, p. 306-308) recorded such a subocular chevron mark in the genera *Leperditia*, *Herrmannina*, and *Chevroleperditia* of the Family Leperditiidae.

The new genus differs from *Ceratocypris* Poulsen (1934, p. 38) in several respects. The new form is larger (6.0 mm versus 0.5-1.5 mm); its belly is not inflated, nor does it overhang the ventral contact; its subcentral (not post-ventral) spine is somewhat flattened at the base (not cylindrical), and the spine is directed obliquely downward and outward (not directly posteriorly in a horizontal line).

Again, were some species of ventrally inflated *Pinnatulites* Hessland (1949, p. 198) discovered with ceratopsid peripheral spine, such forms would not be referable to *Ceratoleperditia* because of its inflated belly overhanging the ventral contact.

Two established leperditian species are assigned to the new genus and a third is tentatively assigned to it. *Isochilina kentuckyensis* Ulrich (1891, p. 179, pl. 11, figs. 11a-d), from Middle Ordovician "Birdseye" (Lowville) limestone of Kentucky, closely resembles the genotype in convexity, eye tubercle, and pendant ceratopsid spine. A peripheral flange and ventral pits are features of the Kentucky form not observed on the Oklahoma species. *Leperditia* *armata* Walcott (1883, p. 7, pl. 17, fig 10), from Middle Ordovician upper Blackriveran, "Birdseye" (Lowville) and "Black River" (Chaumont) formations, from Russia, New York, five miles southeast of Trenton Falls, agrees with the new genus in relatively large size, leperditian outline, and possession of somewhat flattened, subcentral, ceratopsid process. Differences involve apiculate cardinal angles and longer and more curving ceratopsid spine on the New York species. Incidentally, the spine of Walcott's species is recurved posteriorly, not "... curved toward anterior extremity," as stated. These two established species are not considered synonymous herein, as was the case with Ulrich and Bassler (1915, p. 672), and Bassler and Kellett (1934, p. 337). *Leperditia tuberculata* Kolmodin (1879, p. 135, pl. 19, figs. 1a-b) is tentatively assigned to the new genus.

Isochilina armata (Walcott) var. *pygmaea* Ruedemann (1901, p. 72, pl. 7, figs. 19-25), from middle Trentonian (lower Sherman Fall) Rysedorph conglomerate, of eastern New York, should not be included in the new genus. Though possessing mucronate cardinal angles, as in *Ceratoleperditia armata* (Walcott), Ruedemann's form differs from *Ceratoleperditia* in at least three essential aspects: 1) smaller size (1-2 mm versus 6 mm); 2) a pair of vertical furrows or primary and secondary sulci extending the height of the carapace; 3) the rod-like (not nodular or subalate) spine is located postventrally and projects somewhat posteriorly, more in the fashion of *Ceratocypris longispina* Hessland (1949, p. 196, pl. 4, figs. 7-12; pl. 15, fig. 9) than that of *Ceratoleperditia arbucklensis* n. sp.

Ceratoleperditia arbucklensis n. sp.

Plate I, figures 1a, b—4a, b

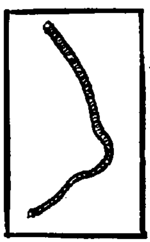
Large, subovate, leperditian carapace, length exceeding 6 mm in adult, maximum height through post-central point approximating two-thirds maximum length through near-median longitude (greater than two-thirds in instars); length of straight hinge line approximates the height of carapace; dorsal margin is essentially straight except for slight umbonation or peripheral "roll" on posterior shoulder of adult left valve; cardinal angles are distinct, the anterior more sharply angled than the posterior; from the more sharply rounded and higher near-median anterior nose the ventral margin gracefully curves in a retral swing through the lower and more broadly rounded and produced posterior end (ventral profile of smaller left valve is a flatter curve); right valve overlaps the left along free margins, with maximum overlap at mid-venter; dorsal half of carapace is moderately convex, gradually expanding into inflated lower body (carapace wedge-shaped in end profile). On the instars the ceratopsid extension of the subcentral lower body is a bluntly rounded knob; on the adult it is a slightly undercut subalate spine projecting obliquely downward and outward, though not beyond the ventral border. The ventral surfaces of some adult carapaces are locally expanded and flattened by a slight inflation or semikeel situated near the margin before and below the ceratopsid process; small rounded eye tubercle well removed from the cardinal angle; an indistinct, smooth, nonperforate, ovate muscle chevron scar lies diagonally behind and below the eye tubercle, no papilli were observed within the chevron nor radiating venose lines about it; thick, lamellate shell wall is distinctly perforate, otherwise smooth, except for umbonate inflation or rolled-edge effect at post-dorsal shoulder of adult left valve.

The holotype and three paratype instars are illustrated on plate I, figures 1-4. All specimens are from a sandy, dolomitic, gray limestone horizon 30 feet below top of Arbuckle limestone on south side of Arbuckle Mountains, 50 yards west of U. S. Highway 77, NE¼ SE¼ SE¼ sec. 24, T. 2 S., R. 1 E.

Range: The species occurs commonly in the uppermost 35 feet of the Arbuckle limestone (West Spring Creek formation).

Remarks: Freshly fractured limestone surfaces exhibit many well-preserved specimens of this upper Arbuckle index fossil. With hand lens the species is readily identifiable by its large size, polished brown surface, and characteristic ventral spine (text-fig. 1). Cardinal angles and spine are usually broken off in the rock matrix; however, perfect specimens can be obtained only by careful and tedious preparation with a needle.

The ceratopsid spine is apparently a development of the lower body (not merely a surficial feature), the oral surface of the spine being essentially a continuation of gentle convexity of the upper carapace body. Ventrally, however, the adult ceratopsid process is undercut and obliquely pendant. In instars (pl. I, figs. 2-4) and in the adult (pl. I, fig. 1) there is little incision or channeling defining the upper contact of the spine with the body proper. Superficially the adult spine appears horizontally attached, but in most specimens scrutiny reveals it to be in oblique attachment, subparalleling the ventral margin, thus effecting a slight downward and backward inclination of the spine.



TEXT-FIGURE 1. Typical profile of *Ceratoleperditia arbucklensis* n. sp.

A practical aspect of the ceratopsid process of *C. arbucklensis* involves recognition of the topmost Arbuckle section in which the species occurs. So numerous is the form in its limited vertical range that even in limestone cuttings and fragments containing it one may observe and recognize it by its characteristic sectional profile, involving simple arc with submedian nodose to spinose extension (text-fig. 1). Such a characteristic, irregular profile may be observed in spite of any warping or deformation that the fossil might have undergone.

In relative size, wedge-shaped anterior profile, subcentral location of spine, and small eye tubercle well removed within the cardinal angle, the Arbuckle species closely resembles *Ceratoleperditia (Isochilina) kentuckyensis* (Ulrich) (end views of the two forms are practically identical). The Kentucky form displays, however: 1) more slender, elongate outline; 2) relatively longer hinge line and, accordingly, less produced terminal noses; 3) less pronounced retral swing; 4) smaller and sharper ceratopsid process.

The Arbuckle species differs from *C. (Leperditia) armata* (Walcott) in: 1) smaller size (6.1 mm versus 8.5 mm); 2) absence of distinct cardinal spikes; 3) shorter, duller, and much less conspicuous ceratopsid process that does not project beyond the ventral border.

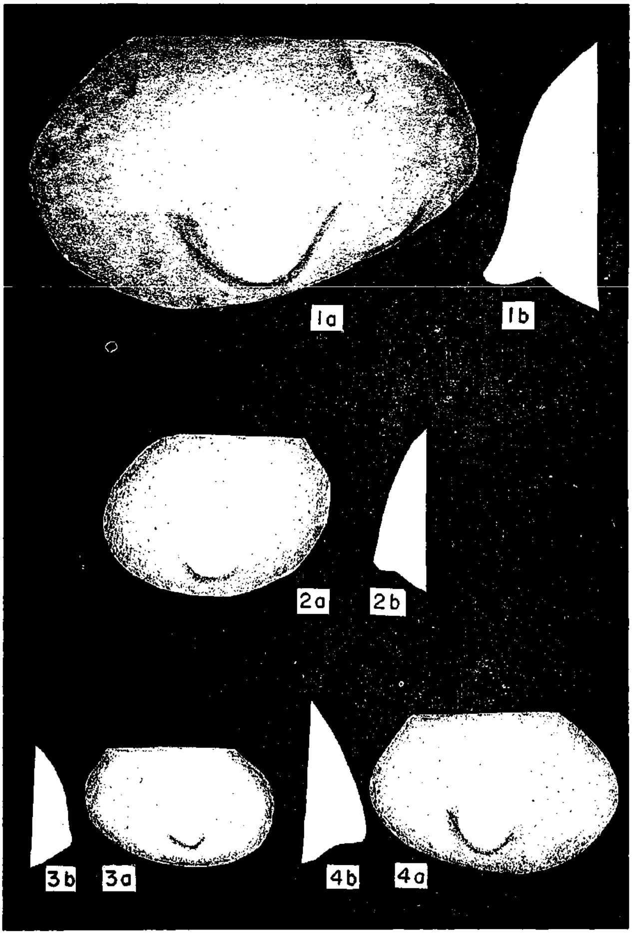


PLATE I

Ceratoleperditia arbucklensis n. sp., x12

FIGURE 1. Holotype No. OArb 001; length 6.1 mm, height 3.5mm: a—right valve, b—anterior profile.

FIGURE 2. Paratype No. OArb 002; length 3.1 mm, height 2.0 mm: a—right valve, b—anterior profile.

FIGURE 3. Paratype No. OArb 003; length 2.3 mm, height 1.5 mm: a—left valve, b—anterior profile.

FIGURE 4. Paratype No. OArb 004; length 3.5 mm, height 2.3 mm: a—left valve b—anterior profile.

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Ouachita Mountains Bulletin Issued

Oklahoma Geological Survey Bulletin 85, *Stratigraphy of the Late Paleozoic rocks of the Ouachita Mountains, Oklahoma*, by L. M. Cline, was issued in August 1960. The document consists of 113 pages, 45 figures. and two plates, including a colored geologic map of the western part of the Lynn Mountain syncline, Pushmataha County.

The document may be purchased from the Survey office for $3.25, cloth bound or $2.50, paper bound. The map may be purchased separately for $1.00.

DEVELOPMENT OF PALEOBOTANY IN OKLAHOMA*

L. R. Wilson

The academic study and the application of paleobotany to stratigraphic problems in Oklahoma began while the area was still known as the Indian Territory. It is not known when the first fossil plants were observed in Oklahoma, but probably the first observers were the Indians who are known to have used fossils as ornaments. Jules Marcou, the geologist and mining engineer of the Mississippi River to the Pacific Ocean Survey of 1853-1854, reported finding "imprints of *Sigillaria* [*Stigmaria?*] and of *Equisetum* [*Calamites*]" near Scullyville, Le Flore County, and "stalks of *Sigillaria* [*Stigmaria?*]" in northern Pittsburg County on July 19, 1853, and August 7, 1853, respectively. This may be the earliest record of fossil plants being recognized and used stratigraphically by one trained in paleobotany.

The first paper describing a fossil flora in Oklahoma was published by Dr. Charles David White in 1899, *Report on fossil plants from the McAlester coal field, Indian Territory, collected by Messrs. Taff and Richardson in 1897.* Seven years before, I. C. White had published a list of the fossil plants from the Wichita or Permian beds of Texas. In the subsequent fifty years other papers were published, but, because plant fossils in that period were not as valuable stratigraphically as the invertebrates and also because Oklahoma's coal beds are nearly devoid of concretions containing well-preserved plant tissues, relatively few studies were made of Oklahoma's fossil floras. Since the development of palynology, paleobotanical studies have increased markedly. Palynology deals with fossil spores and pollen grains and with other microscopic organisms, some of which are animals. This new approach to paleobotanical studies has become an important exploration tool of the oil industry during the last decade. Several major oil companies in Oklahoma maintain palynology laboratories and a larger number outside the State are also investigating Oklahoma's geology with paleobotanical techniques. The University of Oklahoma has developed an active program in the field and at present has six Ph. D. candidates and as many M. S. candidates writing theses on paleobotanical subjects.

In the 107 years of Oklahoma's paleobotanical investigations, approximately 85 publications have appeared reporting its fossil plants and describing the techniques of study. Of this number, 25 have been printed in the last three years. These studies may be divided into four groups. Each succeeding group represents new interests and new advances in techniques.

In the first group are studies of megascopic fossils such as leaves, stems, and "fruit" impressions, compressions, casts, molds, and petrified woods. These studies represent the older paleobotanical investigations and most of the investigators in the United States were men trained primarily in geology as were Charles David White, C. N. Gould, and E. W. Berry. Megascopic fossils lend themselves well to field identification and many are good stratigraphic markers.

The second group consists of morphological studies which deal with structural features, primarily of petrified remains. Such studies require tedious laboratory techniques and microscopic examination. The investi-

* Preliminary report of one study being conducted under National Science Foundation Grant No. G6589.

gators must have an extensive knowledge of plant morphology and most of this work is done by those whose backgrounds are primarily botanical. Morphological studies have been conducted in other parts of the United States and in Europe for more than a century, but the first paper to be published about Oklahoma material appears to be that of Winifred Goldring in 1921.

The third group of studies deals with algal masses and their fruiting structures. Many fossil algae are diagnostic and stratigraphically restricted. The porosity and permeability of algal rocks and, in many cases, the strategic relation of fossil algae to petroleum source and reservoir rocks have caused the petroleum industry to be interested in these plants. Many species are identified by their growth forms but others require microscopic examination in thin sections. Geologists and botanists have both contributed to our knowledge of the fossil algae. The former have best described the field relations of the fossils and the latter the morphological details.

The fourth and most recent group of paleobotanical studies is that of palynology. Paleobotany has been revitalized mainly because of palynology. Fossil spores and pollen have essentially the same use in the petroleum industry as do the Foraminifera and Ostracoda. However, because they occur in both continental and marine deposits, they are in many cases the best fossils for the resolution of stratigraphic and paleoecological problems. The approach of palynology is both geological and botanical. The geologist is equipped with an understanding of time and space problems but frequently he lacks the essential knowledge of plant morphology, phylogeny, and ecology. His identification of species tends to follow a size-shape system and, unfortunately, he lacks an understanding of the natural relationships and the ecological inferences of spores and pollen. The botanist who attempts stratigraphic work in palynology is handicapped by a lack of a geological understanding, although he can contribute much to paleoecology and to an understanding of natural plant relations. Palynology is still young and it is evident that it is a science which emphasizes geology and botany equally. The future palynologist will be thoroughly trained in both fields.

The following bibliography of Oklahoma's paleobotanical literature is not complete because newspaper articles, trade-journal items, unpublished theses, and abstracts have not been included. Where the information has been significant it normally has also appeared in a scientific journal. If omissions are noted in the bibliography, a reference to them will be appreciated by the writer.

The arrangement of the following literature is first by geologic era, then by grouping into the four categories described above, and then by authors in alphabetical order. Those papers written in Oklahoma which deal with techniques of paleobotanical study are listed at the end.

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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 July, 1960:

Areal geology of northeastern Cherokee County, Oklahoma, by J. M. Starke.

Areal geology of northeastern Caddo County, Oklahoma, by Sherill D. Howery.

Dakota group of the northeast flank of the Canon City embayment, Colorado, by Charles F. Blackwood.

Microfossils of the Sylvan shale (Ordovician) of Oklahoma, by Richard W. Hedlund.

Microfossils of the Woodford shale (Devonian) of Oklahoma, by James B. Urban.

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

One doctoral dissertation, *Geology of Wagoner County, Oklahoma*, by Raymond W. Govett, was also added to the library.

PETROGRAPHY OF THE SPAVINAW GRANITE

C. A. Merritt

Introduction—Five small granite exposures, the largest only 200 x 300 feet, occur near Spavinaw, Mayes County, Oklahoma (fig. 1). These have been described by several writers and the reader is referred to Ireland (1930) and Huffman (1958, p. 15-18) for the geology and for a summary of the literature. For many years there was a controversy regarding the age of the Spavinaw granite, the question being whether it is a buried hill of Precambrian igneous rock or an intrusion into the adjacent Ordovician Cotter dolomite. This problem was reviewed by Ham and Dott (1943) who furnishd new data which strongly support the Precambrian assignment.

Data on the mineralogical and chemical character of the granite recorded in the literature are neither detailed nor complete. Drake (1898) gave a brief description of the mineralogy and later investigators have added little to these original data. He also gave a chemical analysis of the rock which is

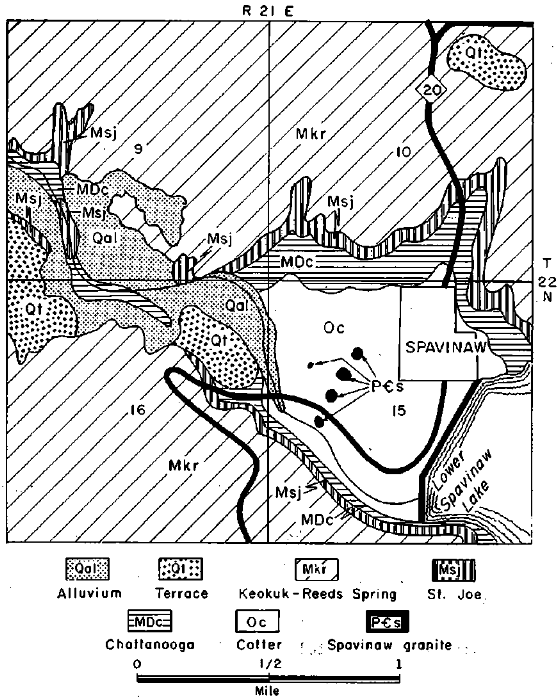

Figure 1. Geologic map showing outcrops of Spavinaw granite near Spavinaw, Mayes County, Oklahoma.
(Modified from Huffman, 1958)

incomplete inasmuch as it does not separate ferric oxide from ferrous oxide or alumina, nor does it separate soda from potash.

The writer obtained a chemical analysis of the Spavinaw granite with funds granted him by The University of Oklahoma Alumni Development Fund to assist in his study of the igneous rocks of Oklahoma. It is the purpose of this note to make this analysis available and to give a detailed microscopic description of the rock.

MICROSCOPIC DESCRIPTION—The Spavinaw granite is typically a uniform, medium to coarse-grained rock with a brownish-red color. The easily recognized minerals in a hand specimen are reddish feldspar, 5 to 10 mm in length, quartz, and hornblende. Specks of a black, opaque mineral, which proved to be titaniferous magnetite, are disseminated throughout the rock. In thin section the feldspar is identified as a mixture of oligoclase, orthoclase and microperthite.

A large amount of oligoclase is present as anhedral to subhedral grains, generally 2 to 5 mm in length, though a few individuals are larger. Part of the plagioclase is fresh and part is altered to clay and sericite. Many small epidote grains are scattered through the oligoclase and have apparently replaced the host mineral. The feldspar shows well-developed albite and minor pericline twinning.

The chief constituents of the rock are orthoclase and microperthite. These commonly are highly altered to clay and sericite and in some grains it is difficult to determine which of the two was the original material. The microperthite is mainly the string type with a minor amount of the patch variety. Some grains show Carlsbad twinning. The constituent minerals are orthoclase and sodic plagioclase. The latter is too highly altered or too minute to determine its exact composition. It probably is albite formed by exsolution from sodic orthoclase on cooling.

The microperthite is normally intergrown with quartz to form a micropegmatite which occurs as a mantle on one or more sides of the oligoclase grains. The micropegmatite rim around part of the plagioclase is a striking mircoscopic feature of the Spavinaw granite (figs. 1, 2), and comprises approximately half of the rock. The micropegmatite is later than the oligoclase and may be the result of eutectic crystallization of sodic orthoclase and quartz. Further cooling developed the microperthite from the orthoclase.

The quartz of the micropegmatite is much smaller than the host feldspar and the grains are usually less than 1 mm in diameter. It forms irregular and finger-like patterns, some of the latter being semi-radiating, in the host feldspar. The quartz is optically continuous in an individual microperthite fragment. A small amount of free quartz, not part of an intergrowth, is present.

Hornblende occurs as prismatic grains, most less than 1 mm in length. It is considerably altered to chlorite and epidote. The chlorite is mainly in minute fibers which replace the amphibole. Epidote occurs as small grains in hornblende, as minute grains in feldspar and as larger ones, up to 0.5 mm, along the contacts between the various minerals. Chlorite and epidote are interpreted as late hydrothermal alterations of hornblende.

Titaniferous magnetite is abundant. It ranges in size from minute grains to 0.5 mm in width, and it is partially altered to leucoxene.

Apatite is more abundant than in ordinary granite and occurs as prisms or irregular grains. Pyrite is present in some thin sections and is commonly

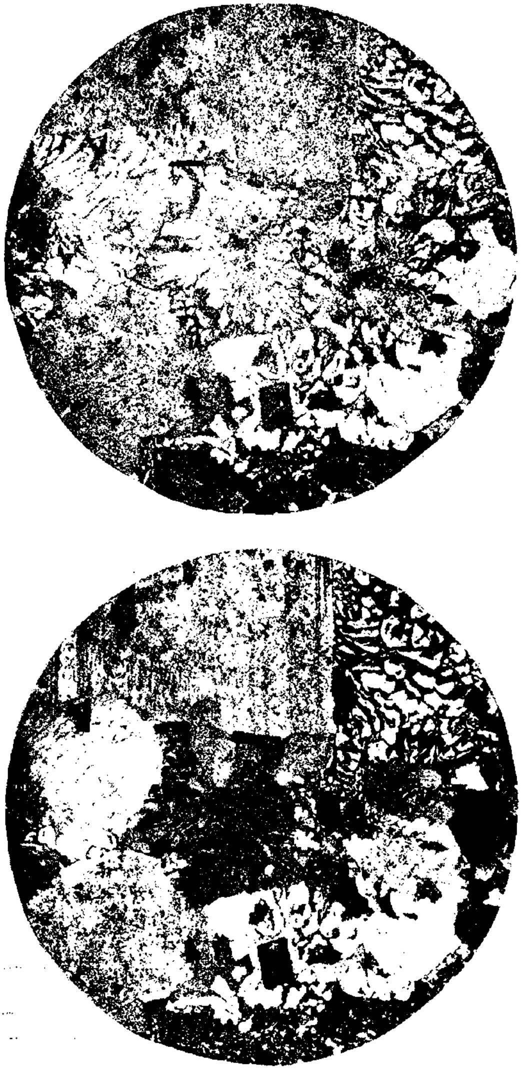

FIGURE 2. Photomicrographs of a thin section of Spavinaw granite showing mantle of micropegmatite around oligoclase and free quartz. Diameter of field, 4 mm.
Above: Ordinary light.
Below: Crossed nichols.
(Photographs by R. E. Denison)

altered to limonite along the edges. Prisms and anhedral grains of zircon are present in minute amounts.

The Spavinaw granite outcrops are rather uniform though there are local phases which differ in texture and color. Some of these phases are only a few inches wide, are dark-colored and have a higher iron-oxide and hornblende content than the normal granite of the outcrop. In thin section there is a trace of augite, which is an unusual mineral in granite. The small, dark phases of the granite are interpreted as altered xenoliths of basic country rock picked up at depth by the intruding magma.

Locally there are pink, finer grained phases of the granite which approach aplite in texture. Microscopically these have a higher microperthite content and considerably less micropegmatite than the typical Spavinaw granite. Probably they are facies of the granite and the result of more rapid crystallization of the magma, perhaps a border phase.

CHEMICAL AND MINERALOGICAL ANALYSES—A chemical analysis and the computed norms of one sample and a modal analysis of three thin sections are presented in table I.

TABLE I.—CHEMICAL AND MINERALOGICAL ANALYSES
SPAVINAW GRANITE

Chemical analysis[1] *M-14*		*Norms*[2]		*Approximate Mode*[3] *(Percent by weight)*	
SiO_2	66.44	Quartz	19.56	Quartz	22.0
Al_2O_3	14.27	Orthoclase	28.91	Microperthite	
TiO_2	.82	Albite	31.96	and orthoclase	37.0
Fe_2O_3	2.21	Anorthite	7.51	Oligoclase	26.0
FeO	2.27	Hypersthene	5.16	Augite	trace
MnO	.07	Magnetite	3.25	Hornblende	
MgO	1.64	Ilmenite	1.52	and chlorite	8.0
SrO	.03	Apatite	.67	Epidote	2.0
CaO	1.91	Normative		Magnetite	
Na_2O	3.79	plagioclase	Ab_{81} An_{19}	and ilmenite	4.0
K_2O	4.85			Apatite	1.0
Rb_2O	.03			Zircon	trace
BaO	.12			Sphene	trace
P_2O_5	.28			Pyrite	trace
H_2O+	.77			Modal	
H_2O-	.08			plagioclase	Ab_{80} An_{20}
Total	99.58				

1 Chemical analysis by the Rock Analysis Laboratory, University of Minnesota. Analysts: C. O. Ingamells and Doris Thaemlitz, 1959.

2 Normative mineral percentages computed from the chemical analysis according to the widely used quantitative classification of Cross, Iddings, Pirsson, and Washington.

3 Average of Rosiwal analyses of three thin sections. The mineral percentages by volume obtained by this method were computed into percentages by weight to facilitate comparison with the norms.

The feldspar percentages include considerable amounts of alteration products of clay and sericite. The perthite is too highly altered to permit determination of the percentages of the constituent orthoclase and sodic plagioclase. The composition of the free plagioclase and the types of twinning were determined by the Turner (1947) method with the universal stage.

Most of the quartz occurs in micropegmatitic intergrowths with perthite or orthoclase, but the quartz is sufficiently coarse to allow estimation of its percentage.

Hornblende is partially altered to chlorite and it was impossible to determine the amounts of these two minerals separately. Hornblende also is altered to epidote but this latter mineral occurs as discrete grains sufficiently large to permit percentage determination.

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New Topographic Maps

Now available are 15-minute topographic maps (scale approximately one inch to one mile) of three quadrangles: Heavener in Le Flore County; Cove in Arkansas and in McCurtain County, Oklahoma; and Apache, in Caddo and Comanche Counties. The Apache area was previously covered by the Boone, Apache, Richards Spur, and Elgin 7½ minute sheets. Issued also is a revised set of 15-minute sheets of the Wichita Mountain area, which is also covered by 7½-minute maps. The new sheets are dated 1956 and are revisions of the 1949 maps. The sheets are Cooperton, Snyder, Saddle Mountain, Cache, Lawton, Cement, and Nellie.

In prospect for early publication are the Page, Bethel, Smithville, and Broken Bow quadrangles in southeastern Oklahoma. The Golden quadrangle has been issued recently.

Topographic maps are made and printed by the U. S. Geological Survey, Topographic Branch, and Oklahoma maps are obtainable for 30 cents each from the Federal offices in Washington and in Denver or from Oklahoma Geological Survey.

Soil Surveys in Oklahoma

The United States Department of Agriculture, Soil Conservation Service, has now completed and published soil surveys for 36 Oklahoma counties. The two latest surveys to be issued (June 1960) are for Logan and Harper Counties.

The Logan County report is *Soil Survey of Logan County, Oklahoma*, Series 1948, No. 7. It contains 60 pages of text, 68 aerial-photograph soil maps, and a soil association map.

Soil Survey of Harper County, Oklahoma, Series 1956, No. 8, consists of 59 pages of text, 120 aerial-photograph soil maps, and a soil association map.

In each document the soil maps are on the scale of 3 inches to the mile, and the soil association maps are on the scale of 1¼ inches to 4 miles.

The reports may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

PROPOSED AMERICAN STANDARD OF EARLY PERMIAN (?) ROCKS, A CENTURY-OLD CONTROVERSY

CARL C. BRANSON

THE PERMIAN CONTROVERSY—Not all scientists are objective all of the time. The Cope-Marsh war over priority in collecting and describing fossil vertebrates drove one good man (Joseph Leidy) from the field and their subsequent diatribes at each other left effects even now evident. The ridiculous argument of Hitchcock and Deane over priority in finding fossil tracks in the Connecticut River valley sullies early American geologic literature. The Sedgwick-Murchison quarrel was notable, and there have been some more recent emotional outbursts.

The southwest was virtually unknown geologically at the middle of the nineteenth century. In 1853, Jules Marcou casually stated that near the Little Colorado River he had found rocks corresponding to the Magnesian limestone of England (a Permian formation). In 1858 D'Archiac claimed the discovery of Permian rocks west of the Mississippi for Marcou.

Marcou was fortunate that the rock he suggested might be Permian actually is of that age. He merely observed redbeds, which he assumed were the "New Red," above dolomite. At most places in the area the redbeds themselves are Permian. Marcou was severely criticized by Dana (1858) and he published a lengthy reply in 1859.

On February 22, 1858, a letter from G. C. Swallow was read to a meeting of the St. Louis Academy of Science. The letter contained an announcement of the finding of Permian rocks and fossils in the Cottonwood River valley of Kansas.

On March 2, 1858, F. B. Meek read a paper to the Albany Institute (published in 1864) by means of which he and Hayden announced that fossils collected by Major Hawn from the Smoky Hill River valley in Kansas indicated a Permian age for the rocks. At the March 8 meeting of the St. Louis Academy of Science, Dr. B. F. Shumard stated that he had examined fossils from the White limestone of the Guadalupe Mountains of New Mexico, and that these fossils are Permian in age. This is the first credible announcement of the discovery of Permian rocks in North America. The locality is actually in Texas and the White limestone is Capitan reef rock. The rocks and fossils studied by Swallow and those studied by Meek and Hayden are Sakmarian, not then considered Permian, and even now only reservedly accepted as Permian by many geologists, not so accepted by others.

Meek was perturbed by the fact that he was eight days later than Swallow in announcing the recognition of Permian rocks, and he began a long series of published claims. At his friends' solicitation, Swallow gave his version of the facts in May 1858 (p. 220) and in September 1858. Meek appended a note to his Albany Institute paper, read in 1858, but published in 1864, giving his version of the facts. Major Hawn, who had collected both the fossils described by Swallow and those described by Meek and Hayden, gave the facts as he understood them (1858, p. 1-3). According to Hawn, he had intended to send his Cretaceous fossils to Meek and his Upper Carboniferous ones to Swallow. He had, however, some fossils from Smoky Hill Fork, and sent some to each (to Swallow in June, to Meek in July). Meek wrote that they might be Triassic or Permian, although perhaps of the Upper Coal Measures.

Swallow refused to examine the Smoky Hill Fork fossils when he learned that Meek had some. Instead Swallow studied and described the fossils of the Cottonwood River valley, and identified them as Permian.

Hayden gave a biased account of the recognition of Permian rocks (1858). On January 10, 1859, Dr. Wislizenus read to the meeting of the St. Louis Academy of Science the annual report of the president, B. F. Shumard, who had left St. Louis to become state geologist of Texas. In this report Shumard mentions Swallow's paper, his own paper, and the April statement of Norwood that there is Permian in Illinois. Shumard noted Meek and Hayden's claim as well. Swallow gave further accounts of his version in 1858 and 1859 in two journals.

Hayden revived the controversy in 1867, and differed with Marcou and Geinitz, who had described Permian rocks and fossils in Nebraska (only two of their localities contain rocks as young as Sakmarian). Swallow felt it necessary to defend himself and wrote at length in April 1868. The final cannonade was Meek's reply in July 1869, published privately in a 9-page brochure, probably the most inane writing of the entire series. He seems to have argued that Swallow was wrong because there is no Permian in Kansas.

Marcou's identification of Permian rocks in Arizona was correct only by chance and was unsupported by evidence. Swallow was incorrect, as were Meek and Hayden, in that the rocks and fossils they called Permian are Sakmarian, then considered Permian by no one. Geinitz was in error on the Nebraska Permian. The gentlemen involved should have realized that they had made no great discovery, that they were not certain of their facts, and that their printed comments, ranging down to diatribes, only detracted from their own scientific reputations.

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Permian in Oklahoma—Permian rocks were first recognized in Oklahoma quite casually. Cragin (1897) wrote of the Cimarron series as extending into the State. Drake (1898) showed a broad belt of Permian rocks on his maps, but most of them are Marmaton, Missourian, or Virgilian, and some part of the area is underlain by Sakmarian rocks. Beede had stated (p. 46) that fossils collected by C. N. Gould at Whitehorse Springs from the Red Bluff formation of Cragin (now Doe Creek member of the Marlow formation) had been determined as Permian, and that Schuchert concurred. Adams in 1901 announced the recognition of Permian rocks in Oklahoma and gave valid evidence (fig. 1).

Gould reported on Permian fossils from Oklahoma redbeds later in 1901. Beede described the fossils in the first biennial report of Oklahoma Terri-

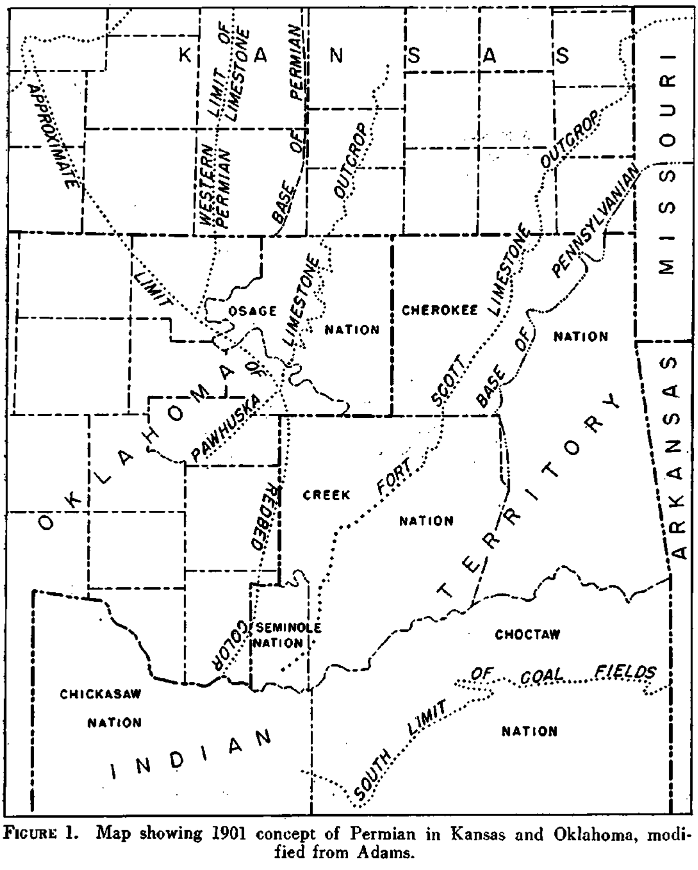

Figure 1. Map showing 1901 concept of Permian in Kansas and Oklahoma, modified from Adams.

TABLE I.—GENERALIZED GEOLOGIC COLUMN OF LATE PALEOZOIC ROCKS IN OKLAHOMA

System	*Series*	*Group*	*Formation*
PERMIAN	Ochoa		Quartermaster fm. Cloud Chief fm.
PERMIAN	Guadalupe	Whitehorse	Rush Springs ss. Marlow fm.
PERMIAN	Guadalupe	El Reno	Dog Creek sh. Blaine fm. Flowerpot sh.
PERMIAN	Leonard		Hennessey sh. Garber ss. Wellington fm.
PERMIAN(?)	*Lyon*	*Chase*	*Herington ls.* *Odell sh.* *Winfield ls.* *Doyle sh.* *Ft. Riley ls.* *Matfield sh.* *Wreford ls.*
PERMIAN(?)	*Lyon*	*Council Grove*	*Garrison sh.* *Cottonwood ls.* *Eskridge sh.* *Neva ls.* *Roca sh.* *Red Eagle ls.* *Johnson sh.* *Foraker ls.*
PERMIAN(?)	*Lyon*	*Admire*	*Admire fm.*
PENNSYLVANIAN	Virgil	Wabaunsee	Vanoss fm.
PENNSYLVANIAN	Virgil	Shawnee	Pawhuska ls.
PENNSYLVANIAN	Virgil	Douglas	Kanwaka sh. Oread ls. Vamoosa fm.

torial Geology and Natural History Survey, the other manuscripts for which were destroyed in the fire that consumed the building, but Beede's report was issued as "advance bulletin" (1902).

Recognition of Permian rocks in Oklahoma was slow in occurring, but was unaccompanied by personal claims to fame.

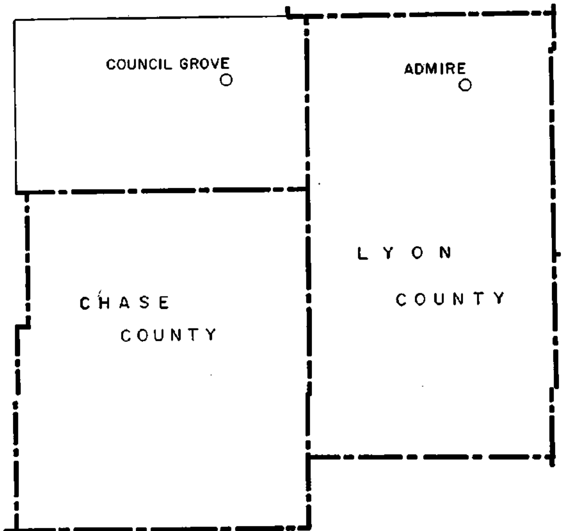

FIGURE 2. Index map showing geographic relationships of type-name localities of the early Permian(?) rocks in Kansas.

PERMIAN STANDARD IN NORTH AMERICA—Had Marcou, Meek, Hayden, Swallow, and Geinitz been more objective and less emotional, the Permian rocks of Kansas and Nebraska might have been recognized as the American standard section. As it is, the section in the Glass Mountains of West Texas, largely a reef-rock section with fossils of reef-dwelling organisms, has been so recognized by many geologists. This development is particularly unfortunate in respect to the Sakmarian equivalent, the Wolfcamp, which may or may not be Permian. The type Wolfcamp section is incomplete, its basal contact is not well known, and the hostility of many of the land owners in the Glass Mountains area restricts investigation.

Ross (1959) has emphasized the unsuitability of the Wolfcamp as a standard by naming the Wolfcamp of the western Glass Mountains the Lenox-hills formation, by naming the upper part of the eastern Wolfcamp the Neal-ranch formation, and by removing the "gray limestone" of the Wolfcamp of King to the Gaptank formation.

The Kansas section of rocks of Sakmarian age (Admire, Council Grove, and Chase groups) is complete, is richly fossiliferous, and is well exposed over a wide and accessible area, including parts of Oklahoma and Nebraska.

The name Wolfcamp series and the time term Wolfcampian should not be used in Kansas, Oklahoma, and Nebraska. A name should be selected for the unit (Big Blue series included Wellington, and the form Big Blueian is undesirable), and that name should be applied to what is truly the American standard Sakmarian section.

An examination of the map of Kansas suggests the possibility of the use of the name Lyon series (Lyonian epoch) for Sakmarian rocks of the area. The name is that of Lyon County, site of the type localities of the Admire group and of the Americus limestone. Council Grove is a few miles west of the county, and Chase County is adjacent on the west. Thus the type localities of the three groups which comprise the series are in or near Lyon County (fig. 2). No other name of an important city or stream or of a county seems available or, if available, seems euphoneous. The Lyon series would include the rocks from the top of the Brownville limestone to the top of the Herington limestone; that is, it would consist of the Admire, Council Grove, and Chase groups. Faunally, it would include the zone of *Pseudoschwagerina*, of primitive *Schwagerina*, and of advanced *Triticites;* the zone of *Peritrochia* and *Properrinites.*

In Oklahoma, the Lyon series would include, in Pawnee County, the seven mapped units of the Chase group, the eight of the Council Grove group, and the Admire shale. In Lincoln County it would include the undivided shale and sandstone sequence below the Fallis sandstone, the Red Eagle limestone, the Johnson shale, the Foraker limestone, and the Admire formation (table I).

The suggested name is to be submitted to the Kansas and Nebraska geological surveys for their consideration, and for possible agreement on this or some other name by the surveys of the three states involved.

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THE TYPE OF NUCLEOCRINUS CONRAD

ROBERT O. FAY

The type specimen of *Nucleocrinus elegans* Conrad 1842, type species for the genus *Nucleocrinus*, is on deposit at the American Museum of Natural History, Catalogue Number 5039/1. This is the specimen figured by Conrad (1842, p. 280, pl. 15, fig. 17), with the short description: "This genus differs from *Pentremites*, Say, in having only one perforation at top, which is central. Found by Mr. Hall in the western part of New York, in Upper Silurian shale." Hall (1862, p. 147-148, pl. 1, figs. 14-15) described the specimen in detail and stated: "The larger of these specimens before me is the one from which the original figure and description of Mr. Conrad was made."

The illustrations of Conrad (1842) and Hall (1862) are lithographs and therefore the type specimen is here illustrated by photographs (Plate I). Hall mentioned that this species was named *Nucleocrinus halli* by Vanuxem (1842, p. 163) in a faunal list that preceded Conrad's publication and that Conrad actually published in 1843 although the date 1842 appears on the publication. Hall stated that he collected the specimen illustrated and several others from the shales of the Hamilton group, Moscow, Livingston County, New York. There are three specimens on deposit at the American Museum; the largest, which is the holytype, is in a glass vial with the other two specimens.

The type specimen and holotype is 12 mm wide and 11 mm high, with maximum width in side view slightly adoral of center. The anal opening and 10 separate spiracles are confined to the summit of the ventral surface, not seen in side view. The anal opening is broadly quadrangular, between the adoral middle one-third of the tip of the hypodeltoid plate and the adanal portions of the adjacent epideltoid plates. The deltoids are 4 in number, elongate, broadly triangular, extending to within 3 mm of the base, notched with two spiracles each along the adambulacral margins near the adoral tip. The spiracles are hemielliptical, about 0.4 mm in length, with the long dimension parallel to the adambulacral margins. On the anal side there are 3 deltoid plates, a large central triangular hypodeltoid with bluntly rounded adoral surface, with two epideltoids, one on either side, extending adorally beyond the hypodeltoid plate. The epideltoids each have one spiracle in their adambulacral margins similar to the other 8 in size, shape, and position. The epideltoids extend aborally the length of the hypodeltoid, to within about 2 mm of the base, with regular nodose ornamentation, each node corresponding in size and position with each side plate, aligned obliquely (about 105 degrees) to the food groove. The hypodeltoid has a sharply triangular central portion with chevron-shaped striae parallel to the adjacent aborally disposed radial limbs. The lateral margins of the hypodeltoid have elongated striations, sub-

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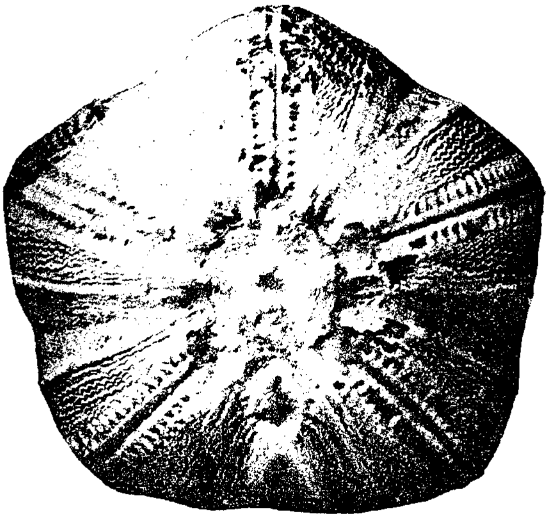
EXPLANATION OF PLATE I

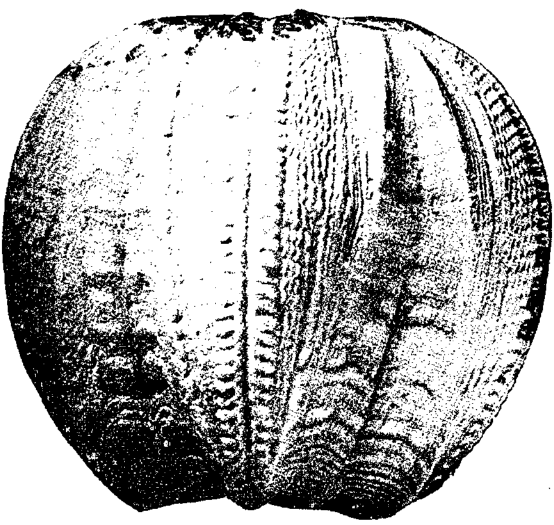
Nucleocrinus elegans Conrad, 1842, x7.2

Above: Oral view of the holotype with the anal side toward the bottom of the page. American Museum of Natural History, Catalogue No. 5039/1.

Below: Left posterior radial view of the same specimen with anal deltoids on right.

Plate I





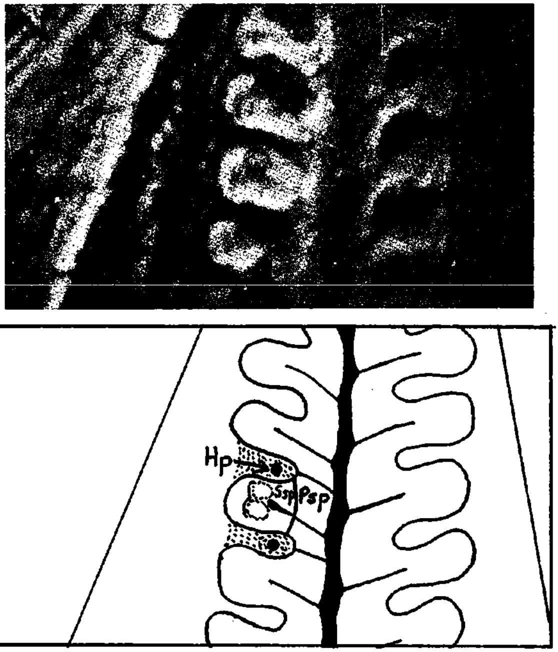


FIGURE 1. Details of an ambulacrum of the holotype of *Nucleocrinus elegans.*

Above: View of right posterior ambulacrum near aboral tip. Direction of oral opening toward bottom of picture. x45.

Below: Line drawing showing outline of side plates and main food grooves, with details in one side-plate area. Hp— hydrospire pore; Psp— primary side plate; Ssp— secondary side plate, with brachiolar facets dotted and brachiolar pit and side food groove shown in black.

divided into two distinct sets; one is a broadly triangular set with base parallel to adambulacral margins and apex near midlength of specimen, with one part of one striation parallel to margins of aboral half of adjacent hypodeltoid central portion and the other half of the striation extending from the apex adorally to the sharp corner of the hypodeltoid; the second set of striations is parallel to the latter line described above, converging at a low angle with the adoral half of the central portion of the hypodeltoid. The ornamentation of each deltoid plate is the same as that of the anal deltoids except for vertical striations which are absent on the deltoids. The radials are short, confined to the dorsal one-fourth of the calyx, with limbs about 3 mm long except for the two on the anal side, which are about 2 mm long.

It was impossible to section the type and therefore internal features cannot be determined. It is presumed that this specimen contains two hydrospire folds on each side of an ambulacrum, which is normal for *Nucleocrinus*. There are about 48 to 49 side plates the length of one side of an ambulacrum, with about 10 side plates in 3 mm. The details of an ambulacrum are shown in figure 1. The openings of the hydrospire pores between adjacent side plates are large and rounded, giving a lobed outline to each side plate. Each side plate is broadly quadrangular, almost covering the lancet plate, with large secondary side plates on their bevelled abmedial margins. The secondary side plates are broadly rounded along their abmedial margins, medial referring to the line of the food groove. A faint bifaciculate brachiolar muscle scar is present on the outer surface of the abmedial half of some secondary side plates, with a brachiolar pit admedial to the scar, terminating admedially in a secondary or side food groove. The side food groove forms an oblique angle of about 105 degrees with the main food groove, measured from the oral direction.

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Bear Creek and Cowskin Creek

Decision List No. 5904, April 1960, of the United States Board on Geographic Names, records two decisions which are of interest to Oklahoma. These decisions define Bear Creek and Cowskin Creek in Pawnee County.

Bear Creek is defined as "stream about 7.3 miles long, heading in sec. 32, T. 21 N., R. 8 E., flowing southeastward for about 4.5 miles, then northeastward to the Arkansas River about 1.9 miles west of the village of Prue..."

Cowskin Creek is defined as "stream about 4.1 miles long, heading in sec. 9, T. 20 N., R. 8 E., and flowing southeastward for about 1.5 miles, then northeastward to Bear Creek..."

This stream system appears on the U. S. Geological Survey, Hominy, Okla., 30-minute topographic quadrangle (Edition of May 1915) where Cowskin Creek, as defined above, and that portion of Bear Creek downstream from its junction with Cowskin Creek are labeled as Cowskin Creek. The upper portion of Bear Creek is unnamed.

The more recent U. S. Geological Survey Keystone Dam., Okla., 7½-minute topographic quadrangle (1958) shows the lower part of Bear Creek correctly labeled.

LIGNITE IN THE RED BRANCH MEMBER, WOODBINE FORMATION, OKLAHOMA

NEVILLE M. CURTIS, JR.

The occurrence of lignite in the Upper Cretaceous of Oklahoma has been previously reported from Cimarron County (Rothrock, 1925) and southern McCurtain County (Davis, 1960). Bullard (1925, 1926) did not report the occurrence of lignite in his geologic study of the Cretaceous in Love and Marshall Counties, nor did Gibbs (1950) record any lignite deposits in eastern Choctaw County. Stephenson (1919) does report a lignite exposed on the south bank of Red River opposite Bryan County. This lignite is in the Woodbine formation and may be part of the Red Branch member.

The lignite found in Cimarron County crops out in Tps. 3 and 4 N., R. 1 E. Rothrock placed the lignite near the top of the Purgatoire formation whereas Schoff and Stovall (1943) placed it in the overlying Dakota sandstone. The lignite is impure, 12 to 18 inches thick, and has been mined for local use.

Trumbull (1957, p. 361) wrote the following relative to the Cimarron County lignite:

> Though the lignite occurs at about the same horizon in each of these five exposures, it has not been traced from one to another and may be present only in small lenses.

Bergquist (1949, sheet 2) divided the Woodbine formation in Cooke, Grayson, and Fannin Counties, Texas, into four members which are in descending order:

Woodbine formation—
- Templeton member
- Lewisville member
- Red Branch member
- Dexter member

He stated (sheet 2) that the thickness of the Red Branch member is 60 to 70 feet and is characterized by:

> . . . lenticular beds of cross-bedded tuffaceous sandstone or ferruginous sandstone containing abundant leaf prints, carbonaceous shale, and locally beds of lignite. The beds of Red Branch member may be chiefly tuffaceous sandstone or at places may be all carbonaceous shale with nontuffaceous sandstone layers.

From information on a field sheet of the Oklahoma State Mineral Survey an outcrop of Cretaceous lignite was located in NE¼ SE¼ SE¼ sec. 17, T. 7 S., R. 10 E., Bryan County, Oklahoma. The outcrop is in the Red Branch member of the Woodbine formation, which is Upper Cretaceous in age. Considerable difficulty was encountered in attempting to map the lignite zone in Bryan County because of slumping and vegetation cover. The outcrops in all cases are in creek banks and roadcuts or ditches along roads.

The following measured sections are in the Red Branch member of the Woodbine formation in Bryan County. The locations are shown in figure 1.

1.—NE¼ SE¼ SE¼ sec. 17, T 7 S., R. 10 E., on west bank of creek and approximately 0.15 miles north of section-line road.

		Feet
8.	*Lignite*, brownish-black, blocky	0.5
7.	Shale, lignitic, black, platy and crumbly	4.0
6.	*Lignite*, black, blocky	0.2
5.	Shale, carbonaceous, black	0.5
4.	*Lignite*, black, blocky	0.2
3.	Shale, carbonaceous, black	1.6
2.	*Lignite*, black, blocky	0.3
1.	Shale, carbonaceous, black	3.5

2.— SE¼ SE¼ sec. 16, T. 7 S., R. 10 E., in creek bank approximately 200 feet west of road and 0.2 miles north of section-line road.

		Feet
4.	*Lignite*, brown, shaly with yellowish-brown and purplish-brown clay with 2-5% subangular, fine-grained, clear to frosted quartz grains	1.2
3.	Shale, carbonaceous, purplish-gray, compact, ½ to 1 inch black *lignite* in upper part	2.4
2.	*Lignite*, black	0.5
1.	Shale, carbonaceous, purplish-gray, approximately 15% carbonized plant material	2.0

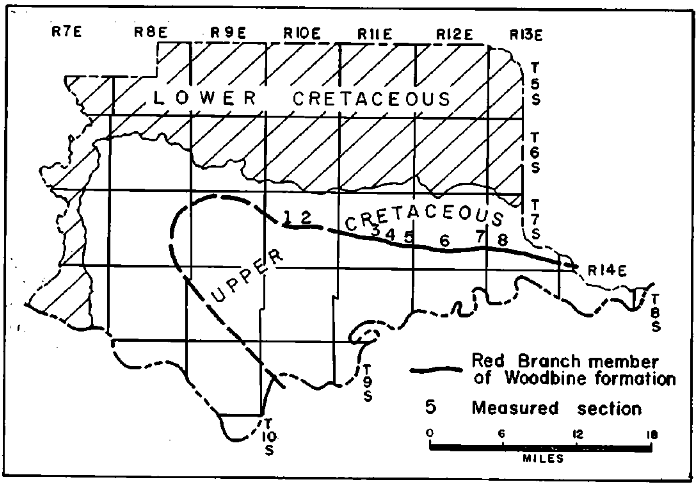

FIGURE 1. Outcrop map showing distribution of lignite zone in the Woodbine formation, Bryan County, Oklahoma.

3.—SW¼ NW¼ NW¼ sec. 22, T. 7 S., R. 11 E., roadcut approximately 100 feet north of hilltop.

		Feet
8.	Sandstone, brownish-orange, medium-grained, limonite cement, blocky, with thin (1/8") shale partings; sandstone blocks are ¼ to 2 inches in diameter, selenite crystals present	5.0
7.	Shale, gray, silty, with 1/8-inch layers of gray platy shale	3.6
6.	Shale, purplish-brown, containing black plant material	1.4
5.	*Lignite*, black	0.6
4.	Shale, purplish-gray, containing black plant material	3.8
3.	Sand, grayish-brown, limonite streaks	0.6
2.	Covered, sand and shale	6.0
1.	Shale, purplish-gray	0.5

4.—NW¼ NE¼ SW¼ sec. 23, T. 7 N., R. 11 E., on east bank of creek, approximately 0.4 mile north of section-line road and 0.25 mile east of west edge of section 23.

		Feet
17.	Shale, purplish-gray, less than 5% black carbonized wood; shale is compact with yellow clay along partings	3.3
16.	*Lignite*, black, blocky	0.4
15.	Shale, same as bed 17	4.0
14.	Shale, dark purplish-brown, crumbly, with 20-30% black carbonized plant material	1.1
13.	Shale, purplish-gray, 5% black carbonized plant material and thin (¼ inch) seam of shiny black *lignite* in upper part	1.9
12.	Sandstone, reddish-brown, fine-grained, pelecypod impressions and 2% black carbonized plant material; sandstone forms a resistant ledge which pinches out northward on the outcrop	0.2
11.	Shale, brownish-purple	2.5
10.	Sandstone, dark-brown, forms resistant ledge	1.5
9.	Clay, brownish-gray	1.7
8.	Sandstone, brown, limonite cement, forms resistant ledge	0.2
7.	Silt, grayish-brown	0.6
6.	Silt, light-gray	1.9
5.	Clay, grayish-brown	0.8
4.	*Lignite*, black	0.5
3.	Clay, purple in upper part and gray in lower part	1.4
2.	Sandstone, gray, fossiliferous (pelecypods), forms resistant ledge	0.2
1.	Sandstone, greenish-gray, fine-grained, abundant pelecypod shells	2.0

5.—NE¼ NE¼ NE¼ sec. 25, T. 7 S., R. 11 E., on west side of roadcut at section corner.

		Feet
2.	*Lignite*, brownish-black	0.5
1.	Shale, brownish-purple, 10-20% plant material	3.0

6.—NW¼ NW¼ NE¼ sec. 28, T. 7 S., R. 12 E., on east bank of Sulphur Creek approximately 0.5 mile east of section-line road.

		Feet
7.	Sandstone, brown, blocky, massive, coarse- to medium-grained	12.0
6.	*Lignite,* black, blocky, and carbonaceous shale, black	2.8
5.	*Lignite,* black, blocky	0.5
4.	Shale, light-gray	0.1
3.	Shale, carbonaceous, black	1.0
2.	*Lignite,* black, blocky	0.6
1.	Shale, carbonaceous, brown	1.0

7.—NW¼ SE¼ sec. 24, T. 7 S., R. 12 E., exposed in 30-foot bluff which faces east.

		Feet
5.	*Lignite,* black and carbonaceous shale	1.4
4.	Shale, black, carbonaceous	10.0
3.	*Lignite,* black	0.7
2.	Shale, dark-gray, carboniferous, 10-20% plant impressions	1.0
1.	Clay, carbonaceous, brown	0.8

8.—SW¼ NW¼ NW¼ sec. 29, T. 7 S., R. 13 E., east bank of creek 0.5 mile west of north-south road in section 29.

		Feet
5.	*Lignite,* brownish-black, blocky	0.5
4.	Shale, purplish-brown	1.0
3.	Clay, dark-gray	1.4
2.	Shale, purplish-brown, 10-20% black carbonized wood fragments	1.0
1.	Shale, black to gray, carbonaceous with 5% black carbonized wood fragments	2.4

The above described sections occur in the same horizon and are similar in that they contain lignite, carbonaceous shale, and purple to purplish-gray shale. Although they are all in the Red Branch member it would be difficult to correlate any one lignite across the area. In all probability the lignites are present as lenses in the Red Branch member. It may be noted that the above sections occur in the central and eastern part of Bryan County. It is not intended to infer that the lignite zone does not extend into the western part of the county. Lignite float does occur in the SE¼ sec. 2, T. 8 S., R. 8 E., on the west side of Coal Creek and also in the NE¼ NE¼ NE¼ sec. 27, T. 7 S., R. 8 E., in a stream bed. Black carbonaceous shale and purplish-brown shale crop out in the NE¼ NE¼ NE¼ sec. 13, T. 7 S., R. 9 E.

The lignite found in the Red Branch member in Bryan County is of no economic value although it has been used locally in the past for heating homes and in a blacksmith shop in Bennington, Oklahoma.

One sample of lignite from the Red Branch member has been examined for spores and pollen by Dr. L. R. Wilson of the Oklahoma Geological Survey. Richard Hedlund (graduate student at The University of Oklahoma) has started work on the spores and pollen in the Red Branch member. Hedlund's work is to be used as his doctoral dissertation at The University of Oklahoma.

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Recent U. S. G. S. Documents

Although the Great Uranium Rush is now over, there is still a vast amount of unpublished material concerning the occurrence and origin of uranium. It is to be expected that much of this material will make its appearance in print during the coming years. Two such documents were recently issued by the U. S. Geological Survey.

One is Bulletin 1087-G, *Uranium content of ground and surface waters in a part of the central Great Plains*, by E. R. Landis. The area of study of this report includes two Oklahoma counties, Cimarron and Texas, and parts of the states of Kansas, Colorado, and New Mexico. The data from Oklahoma include discussion and analyses of 20 water samples.

The second document is Miscellaneous Geologic Investigations Map I-299, *Epigenetic uranium deposits in the United States*, by W. I. Finch, I. S. Parrish, and G. W. Walker. It consists of three maps of the United States, each showing the distribution of epigenetic uranium deposits. In addition, sheet 1 shows the distribution of continental sedimentary rocks; sheet 2, the distribution of igneous and metamorphic rocks of pre-Late Cretaceous age; and sheet 3, the distribution of igneous rocks of Late Cretaceous and Cenozoic age. In Oklahoma, the maps show 13 occurrences of U_3O_8 which have assayed 0.01 percent or more.