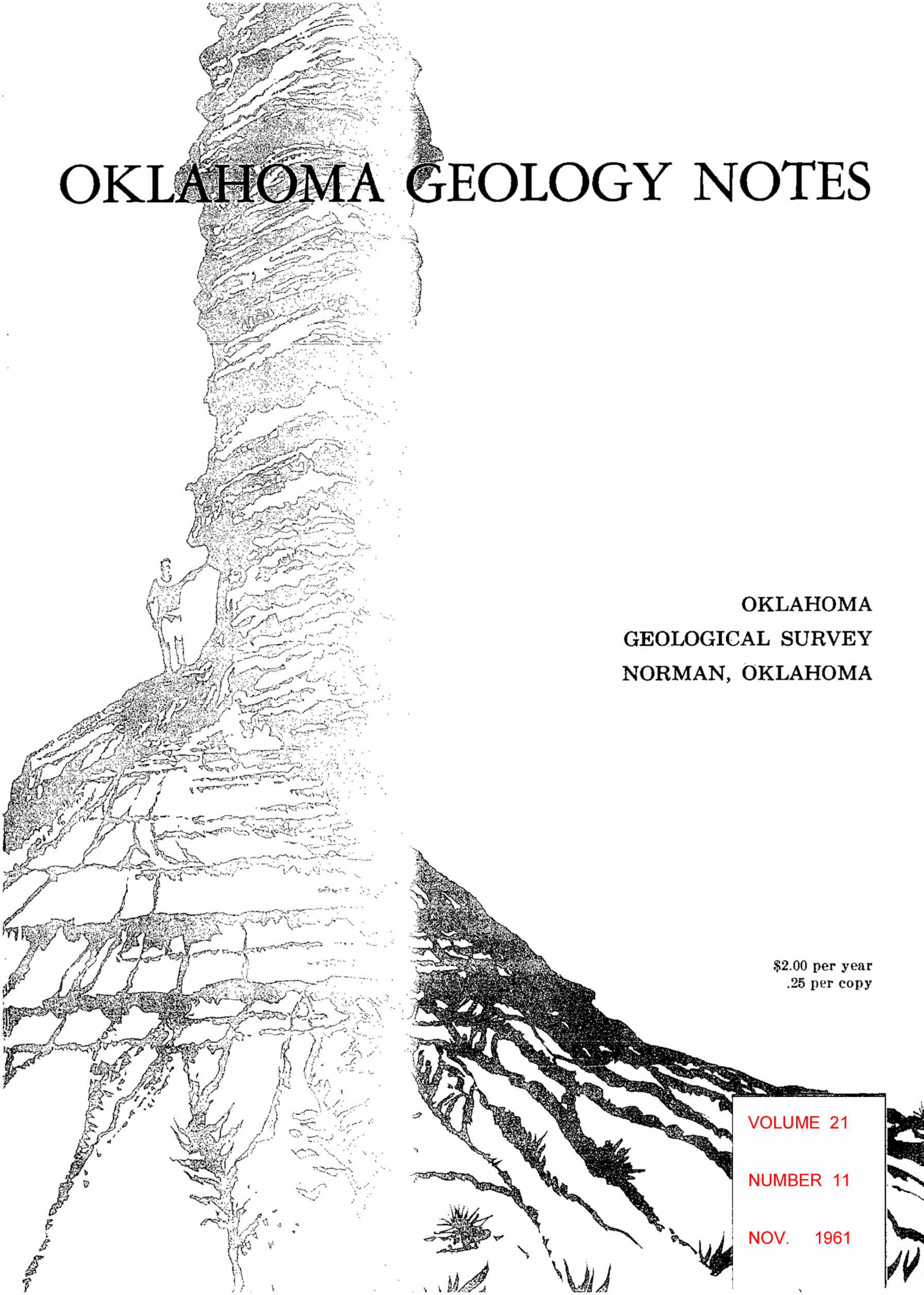
OKLAHOMA GEOLOGY NOTES



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The Mineral Industry of Oklahoma in 1960*

Robert B. McDougal** and Peter Grandone**

Fourteen minerals and 5 mineral fuels produced in 76 of Oklahoma's 77 counties in 1960 were valued at a total of $777.9 million, $12.5 million more than in the previous year, according to the Bartlesville, Oklahoma, office of the Bureau of Mines, U. S. Department of the Interior. Nationally, Oklahoma ranked fourth as a producer of crude petroleum and third as a producer of natural gas and natural gas liquids. Total construction (residential, nonresidential, and public works), which utilizes large amounts of nonmetals, increased 5 percent over 1959 as a result of a sharp gain in the fourth quarter. Interest in the Anadarko and Arkoma basins, as sources of petroleum and natural gas, continued to run high throughout the year. In the Anadarko basin, Kingfisher County was the Nation's busiest single drilling locality. Here, prolific, multizone completions highlighted the rapid development of Mississippian and Pennsylvanian reservoirs. Southeastern Oklahoma's Arkoma basin was emerging as a big new source of gas.

Mineral Fuels

Coal.—Output of coal declined 11 percent in Oklahoma. Part of this decline was due to the closing of Lone Star Steel Co.'s coal mining facilities in Pittsburg County during August.

Helium.—The new helium plant, operated by the Federal Bureau of Mines at Keyes, extracted 293.6 million cubic feet of helium from natural gas.

Natural Gas.—Oklahoma marketed 898 million cubic feet of natural gas in 1960, an 11 percent increase over 1959. Searching for more reserves, the industry completed 434 gas wells of 4,802 wells of all types drilled, as reported by The Oil and Gas Journal. Proved recoverable natural gas reserves at year end were estimated at 17.3 trillion cubic feet.

Natural Gas Liquids.—Natural gas liquids, recovered by 68 natural gasoline plants and 4 cycling plants, reached a record 1,294 million gallons. Increased output, mostly in LP gases (propane and butane), was due to increased processing of commercial gas from productive gasfields in the Panhandle area and more separation of LP gases from plant liquids to meet rising demand. On December 31, proved recoverable reserves of natural gas liquids were estimated at 338 million barrels.

Petroleum.—Crude petroleum produced in Oklahoma amounted to 192.3 million barrels, a 3 percent decline from the previous year. Estimated recoverable reserves of petroleum totaled 1.8 billion barrels at

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*This report, U. S. Bureau of Mines, Mineral Industry Surveys Area Report IV-127, has been prepared under a cooperative agreement for the collection of mineral data, except mineral fuels, between the Bureau of Mines and the Oklahoma Geological Survey, Dr. William E. Ham, geologist.

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yearend. Petroleum from 83,594 wells was reported from 64 counties, of which Osage, Stephens, Carter, Garvin, and Creek Counties led as producers in order named. Although in 1960 major interest in drilling was directed to field wells, several counties continued to attract attention for exploratory drilling. In the south-central section, Cleveland and McClain Counties yielded 20 oil wells out of 58 exploratory tests; in the northeastern section, Osage and Kay Counties yielded 13 oil and 3 gas wells out of 85 exploratory tests; in the central section, Lincoln and Kingfisher Counties yielded 22 oil and 8 gas wells out of 58 exploratory tests; and west of the Arbuckle Mountains, Stephens County yielded 6 oil and 2 gas wells out of 31 exploratory tests. Oklahoma had 15 refineries with a total daily capacity of 401,680 barrels of crude oil and 151,375 barrels of cracked gasoline.

NONMETALS

Cement.—Cement produced in Oklahoma decreased 20 percent from the previous year. Shipments of cement into the State decreased about 13 percent.

Clays.—Clay production was used primarily in manufacturing brick and tile and, to a lesser extent, in manufacturing portland cement and other clay products. Plants in Oklahoma and Rogers Counties expanded clay for lightweight aggregate. Bentonite, produced in Dewey County, was used for filtering and as an absorbent.

Gypsum.—Output of gypsum was 13 percent below the previous year. Most of the crude gypsum was produced in Blaine County, where United States Gypsum Co. operated quarries and a plant at Southard to manufacture wallboard and plaster products. Lesser quantities of gypsum were produced in Caddo and Washita Counties for use in soil conditioning and portland cement.

Lime.—Lime, produced by St. Clair Lime Co. in Sequoyah County, declined 21 percent from the previous year and was used mostly by chemical plants at Pryor and by municipal water plants.

Salt.—Salt, produced in Woods and Harmon Counties, gained more than 55 percent over 1959, and was used principally for stock food and recharging of water softeners. Minor uses included herbicides on ranches and salinity control of oil-well drilling fluid.

Sand and Gravel.—Sand and gravel, 6.4 million short tons, was produced in 55 counties; Johnston, Tulsa, Pontotoc, Oklahoma, Kay, Pushmataha, and Murray supplied over half of the total value. Most sand and gravel produced in the State was used as concrete aggregate. Next in importance, in terms of tonnage and value, was high-purity glass sand produced by two plants in Johnston and Pontotoc Counties.

Stone.—Tulsa, Comanche, Murray, and Ottawa Counties supplied over half of the 14.1 million tons of stone produced in 36 counties. Crushed limestone was used principally for cement, concrete aggregate, and road construction. Agricultural limestone and manufacture of glass consumed smaller amounts. Dimension granite was used mostly for monumental stone and to some extent for exterior trim. Chemical-grade limestone quarried at Marble City, Sequoyah County, was used for limemaking, for use as a flux in glass manufacturing, and for fertilizers and mineral food. Dolomite was produced in Johnston County for use as flux in glassmaking and for soil conditioner. Dimension limestone was quarried for building stone in the Arbuckle Mountains in Pontotoc and Johnston Counties, and in Caddo and Jackson Counties. Limestone for portland cement was quarried in Washington, Pontotoc, and Mayes Counties. Dimension sandstone was quarried in Pushmataha and Okmulgee Counties for use as building and veneer stone.

Tripoli.—Output of tripoli in eastern Ottawa County increased 12 percent from the previous year. The crude material was shipped to Seneca, Mo., processed by the American Tripoli Division of the Carborundum Co., and sold primarily for buffing compounds and in minor quantities for foundry use.

TABLE I.—MINERAL PRODUCTION IN OKLAHOMA[1]

MINERAL	1959		1960	
	THOUSAND SHORT TONS (UNLESS OTHERWISE STATED)	VALUE (THOUSANDS)	THOUSAND SHORT TONS (UNLESS OTHERWISE STATED)	VALUE (THOUSANDS)
Clays[2]	966	$ 970	734	$ 739
Coal	1,525	10,272	1,342	9,113
Helium (MCF)	89,749	1,619	289,096	4,691
Lead (recoverable content of ores, etc.) (short tons)	601	318	936	219
Natural gas (MCF)	811,508	81,151	898,008[3]	96,897[3]
Natural gas liquids:				
Natural gasoline and cycle products (1,000 gals)	448,353	29,443	531,995	33,074
LP gases (1,000 gals)	675,869	27,070	762,258	32,409
Petroleum (crude) (1,000 42-gal bbls)	198,090	578,423	192,288[3]	561,481[3]
Salt (common)	[4]	[4]	3	16
Sand and gravel	6,002	5,927	6,424	7,468
Stone	12,683	14,980	14,054[5]	16,098[5]
Zinc (recoverable content of ores, etc.) (short tons)	1,049	241	2,332	602
Value of items that cannot be disclosed: Asphalt (native), bentonite, cement, gem stones, gypsum, lime, pumice, stone (crushed granite), tripoli, and values indicated by footnote 4	------	18,156	------	16,756
Total Oklahoma[6]	------	$765,439[7]	------	$777,925

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2]Excludes bentonite; included with "Value of items that cannot be disclosed."
[3]Preliminary figure.
[4]Figure withheld to avoid disclosing individual company confidential data.
[5]Excludes crushed granite; included with "Value of items that cannot be disclosed."
[6]Total adjusted to eliminate duplicating value of clays and stone.
[7]Revised figure.

METALS

Lead.—Most mines in Ottawa County remained closed throughout 1960 due to a depressed market; however, the 936 short tons of recoverable lead mined in the county was 56 percent more than in 1959.

Zinc.—Output of recoverable zinc in Ottawa County increased over 100 percent to 2,332 short tons in 1960. Percentage of metal recovery from the ore was considerably higher as mining on a smaller scale was more selective.

Three horizontal-retort zinc plants were operated in Oklahoma throughout 1960: American Metal Climax, Inc., at Blackwell, Kay County; National Zinc Co. at Bartlesville, Washington County; and The Eagle-Picher Co. at Henryetta, Okmulgee County.

TRI-STATE DISTRICT

Depressed lead-zinc markets, which led to a general shutdown at mid-1958 of all major mining operations in the Tri-State District, continued throughout 1960. The quantities of lead and zinc concentrates recovered were up 93 percent and 119 percent, respectively, over the previous year. Oklahoma produced 54 percent of the district's lead concentrate and 53 percent of the zinc concentrate; and Kansas, 46 percent of the district's lead concentrate and 47 percent of the zinc concentrate. No output was reported from southwest Missouri in 1960.

Russian Treatise Volume on Bryozoa and Brachiopoda

The sixth volume of the 15-volume Osnovy Paleontologii has been received. Although it is dated 1960, it surely was not printed until 1961. The general editor was T. G. Sarytcheva, and sections were written by many specialists. The part on Bryozoa consists of pages 15 to 112, has 208 text-figures and 7 plates. Eridotrypellidae Morozova, new family, is proposed on page 65.

The part on Brachiopoda consists of pages 115 to 324, 482 text-figures, 75 plates. New taxa are:

Elsaella Alichova, new name, for *Bekkerella* Rosenstein, 1943 (p. 192). L. Silurian.

Anastrophiidae Nikiforova, new family (p. 202).

Plicostropheodonta Sokolskaja, new genus, genotype *Orthis murchisoni* Verneuil, 1842 (p. 214). L. and M. Devonian.

Licharewiella Sokolskaja, new genus, for *Derbyia magnifica* Licharew, 1939 (p. 219). L. Permian.

Daviesiellidae Sokolskaja, new family (p. 223)

Eodevonariidae Sokolskaja, new family (p. 223)

The Productacea section was written before the Muir-Wood and Cooper monograph appeared, and there are many conflicts.

Chonetellidae Licharew, new family (p. 226), for the genus *Chonetella* (placed in Costispiniferinae by Muir-Wood and Cooper).

Avoniidae Sarytchwa, new family (p. 226).

Compressoproductus Sarytcheva, new genus (p. 231), for *Productus compressus* Waagen, 1884. U. Carboniferous to Permian.

Semiplanidae Sarytcheva, new family (p. 231).

Bagrasia Nalivkin, new genus, genotype *Productus chonetiformis* Krestovnikov and Karpyshev, 1948 (p. 231). L. Carboniferous.

The genus *Spiridiophora* Cooper and Stehli, 1955, is referred to synonymy with *Alexenia* (p. 234).

Horridoniidae Sarytcheva, new family (p. 234), conflicts with Horridoniinae Muir-Wood and Cooper.

Teguliferidae Licharew, new family (p. 236). The name is improperly formed and conflicts with Teguliferinidae Muir-Wood and Cooper.

Wellerellidae Licharew, new family (p. 247).

Rhynchotetraidae Licharew, new family (p. 249) (should be Rhynchotetridae).

Tetracameridae Licharew, new family (p. 249).

Isjuminelina Makridin, new name, for *Isjuminella* Makridin, 1955 (p. 254). U. Jurassic.

Tannuspirifer Ivanova, new genus, genotype *Spirifer pedaschenkoi* Tchernyschev, 1937 (p. 267). Silurian.

Ziganella Nalivkin, new genus, genotype *Z. ziganensis* Nalivkin in coll. (p. 280). A nude name. Species illustrated on pl. 64, fig. 15. L. Carboniferous.

Labaidae Licharew, new family (p. 293). The Oklahoma genus *Pseudodielasma* is placed in the family.

Postepithyris Makridin, new genus, genotype *Terebratula cincta* Cotteau, 1857 (p. 294). U. Jurassic.

Rouillieria Makridin, new genus, genotype *Terebratula michalkowii* Fahrenkohl, 1855 (p. 295). U. Jurassic.

Uralella Makridin, new genus. Genotype *Terebratula strogonofii* Orbigny, 1845 (p. 295). U. Jurassic.

Clorindina alaica Nikiforova (in coll.), pl. 25, fig. 4 (nude name). L. Devonian.

Gypidulina rara Nikiforova (in coll.), pl. 25, fig. 9 (nude name). L. Devonian.

Thecidella gerassimovi Makridin, new species, pl. 26, fig. 19 (nude name). U. Jurassic.

Chonetoidea simorini M. Borissiak (in coll.), pl. 27, figs. 24-25 (nude name). M. Ordovician.

Plectatrypa marginalis sibirica Ržonsnickaja, new subspecies, pl. 53, fig. 24 (nude name). L. Devonian.

Phricodothyris mosquensis E. Ivanova, new species, pl. 63, figs. 12-13 (nude name). M. Carboniferous.

Thecocyrtella orientalis E. Ivanova, new species, pl. 64, fig. 9 (nude name). Triassic.

Reticulariina netschaewi E. Ivanova, new species, pl. 64, fig. 17 (nude name). U. Permian.

The part on Class Phoronoidea is on pages 325 to 326 and has three text-figures, all from Shrock and Twenhofel.

—C. C. B.

Albert L. Burwell
1885-1961

Albert Lewis Burwell, for twenty years Industrial Chemist of the Oklahoma Geological Survey, passed away at his home in Norman on September 20 at the age of 76 years. Since his seventieth birthday he had held a half-time appointment from the Geological Survey, continuing his investigations of Oklahoma clays and shales in spite of poor health and numerous trips to hospitals for treatment of an ailing heart. His passing is mourned by many friends, who will miss his friendly counsel and his deep interest in the mineral resources of Oklahoma.

Born at Winsted, Connecticut, January 21, 1885, the son of strong New England stock, Mr. Burwell attended Massachusetts Institute of Technology and in 1907 was graduated in chemistry with a bachelor's degree. The title of his thesis was "Formic Acid as a Food Preservative: Its Detection and Estimation." After graduation he was employed as a chemist in the manufacture of shoe polish and in tanning leather. During and shortly after World War I, he was employed in making smokeless powder and dyes for the DuPont Company in New Jersey.

Mr. Burwell came to Oklahoma in 1921, living first in Broken Arrow and moving to Tulsa in 1930. Here he became acquainted with mineral resources and took an active interest in the production of oil and gas in northeastern Oklahoma. As a salesman of heavy chemicals for industry in Tulsa, he learned the close relationship between chemical raw materials and mineral resources, enabling him to see the interplay of of chemistry, industry, and geology, to which he would devote his energy in later years at the Geological Survey.

His appointment as Chemical Engineer and Industrial Chemist for the Oklahoma Geological Survey was made in October, 1941. Mr. Burwell moved to Norman and assumed his duties, outlined by Robert H. Dott, Director, as consisting mainly of finding new uses for Oklahoma mineral raw materials. During the following years he made or supervised the making of hundreds of chemical analyses at the Geological Survey, took an active part in every economic investigation of that organization, lectured before scientific and industrial societies, and wrote some thirty reports and articles on mineral utilization. He described how little-used volcanic ash could be made into porous insulating material, and for this work he received a patent which was assigned to the University of Oklahoma Research Institute. Another patent, also assigned to the Research Institute, dealt with recovery of ammonium sulfate from the extensive deposits of gypsum and anhydrite of western Oklahoma. He showed how the feldspar of Oklahoma granites could be recovered for use in making glass, how it was possible to recover magnesia from waste oil-field brines, and how to make special types of cement from the marlstone of the Arbuckle Mountains. One of his special interests was in clays and their utilization—in the manufacture of ceramics, refractories, and lightweight aggregate. Another favorite investigation was the possibility of recovering alumina from the large anorthosite deposits of the Wichita Mountains, using the byproduct materials for the manufacture of portland cement. Rock wool, glass sand, limestone, dolomite, tripolitic rocks, coal, and salt also came under Burwell's scrutiny in an attempt to increase their use in Oklahoma.

For many years Mr. Burwell was a member of the American Chemical Society and the American Institute of Chemical Engineers. After coming to the Geological Survey, he became a member of the Oklahoma Academy of Science, the Southwestern Ceramic Society, and a director of the University of Oklahoma Research Institute and of the Oklahoma Development Council. He was a member of the Masonic Lodge in Broken Arrow and a member of St. John's Episcopal Church in Norman.

He is survived by his wife Getha of Norman, his sons Robert of Minneapolis, Minnesota, and John of Idabel, Oklahoma, and by five grandchildren. Friends wishing to make contributions in his memory may send checks to The University of Oklahoma Student Loan Fund, either to the Geological Survey or to R. Boyd Gunning, Executive Secretary of the University Foundation.

—W. E. H.

Blaine County Maps Issued

The *Geologic Map of Blaine County*, by Robert O. Fay, is now available. Published at a scale of one inch to the mile, the multicolored map will be included in Bulletin 89, *Geology and mineral resources of Blaine County, Oklahoma*, which is scheduled for release in early 1962. Copies of the map alone may now be purchased from the Survey offices for $1.75.

A New Desmoinesian Ammonoid Genus from Oklahoma

W. M. Furnish* and F. W. Beghtel*

The southern Midcontinent Region has provided a nearly unbroken sequence of Late Mississippian to Early Permian cephalopod faunas. Perhaps the best known ammonoids in this general area are those from Missourian-Virgilian strata (e.g., Plummer and Scott, 1937). A partially completed study of a collection of Desmoinesian species from the Wewoka Formation of Oklahoma reveals that this goniatite assemblage is, collectively, the most diverse of any yet recorded in a single formation older than the Upper Permian.

The Wewoka consists of several hundred feet of sandstones and shales. Many of the beds contain abundant marine faunas and certain zones contribute a great abundance of exceptionally well preserved fossils loose on shale slopes. One of the better known contributions of the late George H. Girty was a study of the invertebrate fossils of this stratigraphic unit (1915). Girty recorded some 100 species representing various groups, particularly brachiopods, pelecypods, and gastropods. Cephalopods are relatively less abundant, with nautiloids and ammonoids about equally represented. The following ammonoid species have now been identified from the Wewoka:

Maximites n. sp.
Proshumardites primus Plummer and Scott
Agathiceras ciscoense Smith
Vidrioceras n. sp.
Bisatoceras n. spp.
Wiedeyoceras n. sp.
Wewokites venatus (Girty)
W. n. sp.
Gonioglyphioceras gracile (Girty)
Gonioloboceras goniolobum (Meek)
Eoasianites angulatus (Girty)
E. hyattianus (Girty)
E. excelsus (Meek)
Eoschistoceras strawnense (Plummer and Scott)
Wellerites mohri Plummer and Scott
Dunbarites n. sp.
Shuichengoceras n. sp.
Neodimorphoceras oklahomae (Girty)
N. lenticulare (Girty)
Eothalassoceras n. spp.
Boesites girtyi (Plummer and Scott)
Stenopronorites arkansasensis (Smith)

All of the eleven ammonoid families known to be present at this stage are represented in the present collection of some 6,000 identifiable individuals. The twenty-five species belonging in eighteen genera are prob-

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ably as nearly representative of this molluscan element as is normally possible in one geographic setting. Still, some of the species, based on one or two individuals, are so rare that they may be considered to be outside their normal geographic or stratigraphic range. Such an occurrence also suggests that a number of additional species can yet be found in the Wewoka. Most of the specimens are small and inconspicuous; the present collection is composed to a large extent of shells less than 10 mm in diameter.

Genus Wewokites Furnish and Beghtel, new genus

Type species: *Gastrioceras venatum* Girty, 1911, New York Acad. Sciences, Annals, vol. 21, p. 149; 1915, U. S. Geol. Survey, Bull. 544, p. 254, pl. 32, figs. 1-3b.

It is proposed that *Gastrioceras venatum* Girty be recognized as type of the new genus *Wewokites*. This species is small, attaining diameters of the order 10 mm, but is considered adult on the basis of its small protoconch, consistent septal crowding in the ultimate volution, and the development of six or more volutions in the larger specimens (Miller and Furnish, 1957, p. 14). Girty erected this species in 1911 for material collected from the Wewoka Formation and referred it to *Gastrioceras* because these forms bear umbilical nodes and display the proper number of sutural elements; he recognized, though, that the suture, with its rounded lobes, is more similar to the young of *Gastrioceras* than to adults. In the light of an additional half-century of ammonoid studies, this Wewoka species should not be regarded as a close relative of *Gastrioceras,* sensu stricto.

Diagnosis.—Mature conch is subglobular to globular and attains a maximum diameter of only some 15 mm; umbilicus is relatively broad. Immature forms bear transverse constrictions which are nearly linear to diameters of 3 mm, after which slight ventral sinuses appeared; constrictions became obsolete and transverse umbilical nodes appeared at diameters of about 4 mm; nodes are very prominent and slightly sinuous in largest individuals. Growth lines parallel constrictions of young growth stages; these lamellae are biconvex and became more sinuous in larger specimens and developed deep, rounded ventral sinuses. Suture contains eight rounded primary lobes; a rounded secondary saddle divides the ventral lobe in forms larger than 1.5 mm and is half as high as the first lateral saddle in mature specimens. Another character present in about one-half the specimens belonging in the type species of this genus is the "intra-ventral carina"; these carinae are variable in width and depth and are discontinuous even in a single whorl. Inasmuch as carinate specimens are otherwise identical to the non-carinate, it does not seem that this character should be considered an essential part of the generic diagnosis. In the only other known species belonging in *Wewokites,* however, which is associated with *W. venatus* in the Wewoka, the intra-ventral carinae are universally present and are generally broader and deeper than in the generitype.

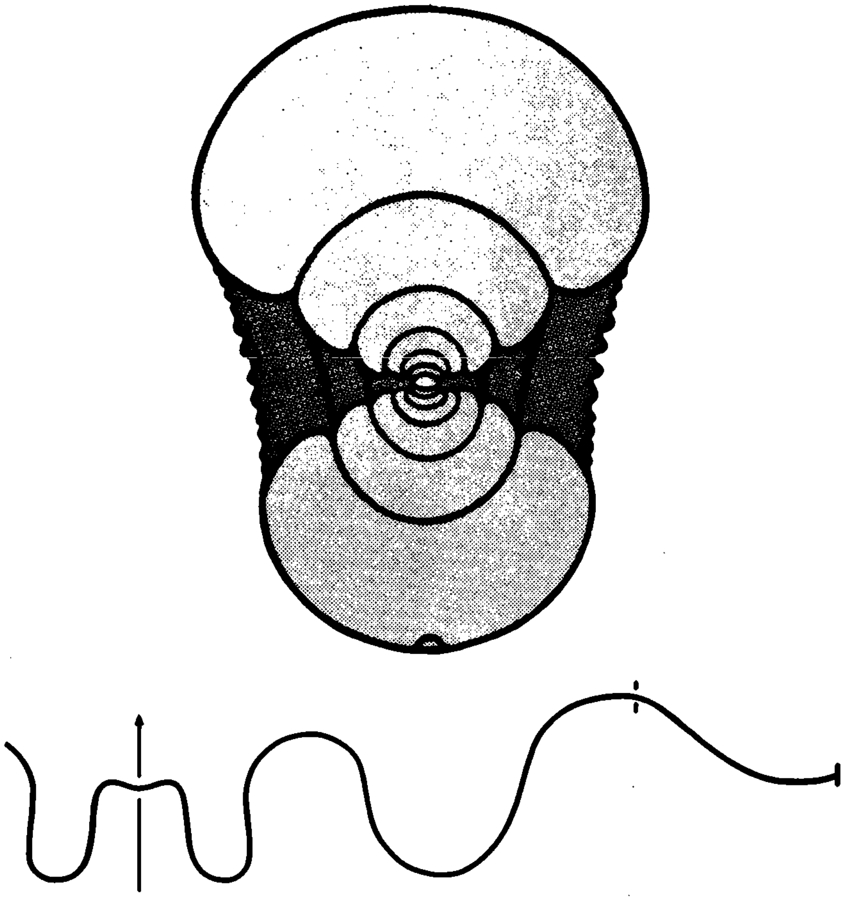

Figure 1. Wewokites venatus (Girty), **diagrammatic cross section and suture, enlarged.**

Discussion.—This genus resembles, or is related to, the following Pennsylvanian goniatites: *Bisatoceras* Miller and Owen, 1937, *Gonioglyphioceras* Plummer and Scott, 1937, *Pennoceras* Miller and Unklesbay, 1942, *Pygmaeoceras* Gordon, 1960, and *Wiedeyoceras* Miller, 1932.

These similarities are believed to be largely superficial except in the case of *Pygmaeoceras;* the resemblance to *Pennoceras* probably represents parallel development. It seems, however, that *Pygmaeoceras* of the Morrowan is ancestral to *Wewokites* and possibly to *Gonioglyphioceras* as well. Evidence supporting this phylogenetic sequence includes the proportions shown in cross-section. For example, during later growth, the diameter of the conch increased more rapidly than the width in all three forms so that the width/diameter ratio decreased. However, in *Pygmaeoceras* this tendency developed only in the last whorl, whereas in *Wewokites* such a change developed by the fourth whorl and in *Gonioglyphioceras* this trend persisted from the second whorl. Also, the umbilicus of the three forms increased relative to the conch diameter during early evolute growth; this early growth was followed by impression of the dorsum so that the umbilicus/diameter ratio underwent a steady decrease in value. In both *Wewokites* and *Gonioglyphioceras* the width of the umbilicus decreased not only relatively but absolutely. This development could be interpreted as simply an extension of a tendency inherited from *Pygmaeoceras*. The reopening of the umbilicus as *Wewokites* approached maturity is a distinctive character added to the adult stage of the ancestor by this genus.

The strong similarity of the sutures in *Pygmaeoceras, Wewokites,* and young *Gonioglyphioceras* is believed significant. The change in the adult suture of the latter genus could be interpreted as additional evolution.

Evidence provided by the sculpture is less certain. The ribs, but not the constrictions, of the adult *Pygmaeoceras* may have become obsolete in the adult stage of some intermediate ancestor of *Gonioglyphioceras;* the latter genus, by accelerated development, bears ribs and constrictions in early growth; the ribs became obsolete in an intermediate stage and the constrictions were obsolete in the adult. *Wewokites* may then be considered the result of early divergence from this strain so that the constrictions of the mature *Pygmaeoceras* are confined to immature stages, but the ribs are retained in the adult.

In spite of the similarities in sutures, in prominence and sinuosity of growth lines, and in an evolute character of early growth, *Wewokites* can be distinguished from the Morrowan form. The younger form is less compressed, has more prominent nodes, and lacks the constrictions of *Pygmaeoceras* in the adult stage. *Wewokites* also differs in earlier growth stages; although the first two whorls are evolute, the conch is nevertheless subglobular to globular throughout ontogeny. *Pygmaeoceras,* however, is discoidal and evolute through the first five or more whorls and is more compressed throughout ontogeny. There is a possibility that specimens of *Pygmaeoceras* larger than those yet available will display a different form than is now considered characteristic; for example, *Agastrioceras* Schmidt 1938 is closely similar in early growth stages.

In the suture and shape of conch, *Pennoceras* Miller and Unklesbay, 1942, from the Conemaugh of Ohio and Pennsylvania is so similar to *Wewokites* that a close relationship is indicated. The younger genus differs considerably in other respects; its sculpture is more prominent and its umbilicus is much smaller than those of *Wewokites,* and the trace of the sculpture is less sinuous than in the latter genus. Slight differences in the sutures can also be observed; the lateral lobe of *Wewokites* is both wider and more broadly rounded adapically than is this lobe in *Pennoceras,* and the ventral saddle in the latter genus is relatively shorter than in *Wewokites*. Actually, the young of *Wewokites* are more similar to adult *Pennoceras* than are the adults; young *Wewokites* pass through a stage in which the ventral saddle is of comparable height to that in *Pennoceras,* the umbilicus is very nearly closed, and the constrictions and growth lines are almost linear.

Wewokites is also related to *Bisatoceras* Miller and Owen, 1937, but less closely than to *Pennoceras.* Immature shells of *Bisatoceras* have a suture with rounded lobes, nearly linear growth lines, strong constrictions, a subglobular conch, and a small umbilicus as do the young of *Wewokites. Bisatoceras* can be distinguished from the latter genus in these youthful stages, however, by its smaller umbilicus and more compressed conch; the genus also differs from *Wewokites* in that mature characteristics appeared relatively early. These adult characteristics in *Bisatoceras* are angular lobes of the suture, more compressed conch, lack of nodes, and closed or small umbilicus.

Wiedeyoceras Miller, 1932 [=*Gordonites* Miller and Furnish, 1958, p. 685] is similar to *Wewokites* only in the biconvexity of the growth lines and in the general character of the suture. *Wiedeyoceras* lacks the umbilical nodes of *Wewokites* at maturity and has a compressed rather than subglobular conch, a smaller umbilicus, and pointed rather than rounded sutural lobes.

References Cited

Beghtel, Floyd W., 1959, Ammonoid fauna of the Pennsylvanian Wewoka Formation of Oklahoma: unpublished thesis, State University of Iowa.

Girty, G. H., 1915, The fauna of the Wewoka Formation of Oklahoma: U. S. Geol. Survey, Bull. 544, 353 p., 35 pl.

Gordon, Mackenzie, Jr., 1960, Some American midcontinent Carboniferous cephalopods: Jour. Paleontology, vol. 34, p. 133-151, pl. 27, 28.

Miller, A. K., and **Furnish, W. M.**, 1957, Paleozoic Ammonoidea, **in** Part L, Treatise on Invertebrate Paleontology, R. C. Moore (Ed.): Geol. Soc. America, p. 1-79.

———— 1958, The goniatite genus **Anthracoceras:** Jour. Paleontology, vol. 32, p. 684-686, pl. 94.

Plummer, F. B., and **Scott, Gayle**, 1937, Upper Paleozoic ammonites in Texas: Texas, Univ., Bull. 3701, 516 p., 41 pl.

Unklesbay, A. G., 1954, Distribution of American Pennsylvanian cephalopods: Jour. Paleontology, vol. 28, p. 84-95.

Borate Minerals of Oklahoma

Bulletin 92, *Borate minerals in Permian gypsum of west-central Oklahoma,* by W. E. Ham, C. J. Mankin, and J. A. Schleicher, was released by the Oklahoma Geological Survey on October 11, 1961. The book is a comprehensive discussion of the occurrence and origin of the borate minerals probertite, ulexite, and priceite in the bedded marine evaporites of the Blaine and Cloud Chief Formations in Blaine and Custer Counties.

The book comprises 77 pages, 20 figures, 8 tables, and 2 plates. Copies may be purchased from the Survey office, $3.00 cloth bound, $2.00 paper bound.

ADDITIONAL NOTES CONCERNING *Paragassizocrinus*

HARRELL L. STRIMPLE

A few months ago Allen Graffham of Ardmore, Oklahoma, took the author to an exposure of the Bostwick Formation on U. S. Highway 70 west of Ardmore, Oklahoma, that contained specimens of the stemless crinoid *Paragassizocrinus.* The zone is a dark shale between two conglomerates on the south side of the highway. The shale is also exposed in the road-cut on the north side of the highway but no evidence of *Paragassizocrinus* was found there. Distinctive primibrachials, belonging to an undescribed species of *Plaxocrinus,* have been found on both sides of the highway as well as at an exposure of the Bostwick Formation on the access road to the west of Lake Murray State Park, which is several miles to the southeast. This distribution suggests that these specimens of *Paragassizocrinus* lived in a rather limited area, perhaps because of highly restrictive environmental conditions. It is strange that the statozoic form, *Plaxocrinus,* occurs over a wide area in the same horizon. Two species of the genus are found at the exposure and are readily separable. One form has an infrabasal cone that is high, narrow, and has a truncated base (Strimple, 1960, p. 7, text-fig. 1, Group A-II). The other has an infrabasal cone that is low and wide, with a pointed base (Group C-I). The first is described herein as *P. elevatus* new species, and the second as *P. bulbosus* new species.

A form represented by a single infrabasal cone from the Chanute Formation of Osage County, has a high, narrow shape with a pointed base (Group A-I). It is described as *P. ellipticus,* new species. The exposure is an abandoned quarry in SW¼ SE¼ sec. 23, T. 22 N., R. 11 E., west of Skiatook. The zone is a dark blue-gray, fossiliferous shale, two or three feet below the Iola Limestone. A comparable zone of the Chanute Formation is known to the author in the new railroad-cut southeast of the Keystone Dam in NW¼ SE¼ sec. 9, T. 19 N., R. 10 E., Tulsa County. No specimens of *Paragassizocrinus* were found in the Keystone area but the other forms of fossil life collected there were comparable. The railroad exposure is at this time thoroughly covered by powdered straw and debris. It will very likely be grassed over in the future.

Another infrabasal cone was found in the Seminole Formation, NE¼ SE¼ sec. 3, T. 16 N., R. 12 E., Tulsa County. It is referred to the species *Paragassizocrinus mcguirei* (Strimple).

A few months ago, I collected a large infrabasal cone in the Wapanucka Formation and assign it here to *P. disculus* Strimple, 1960. The exposure is at the spillway of the small lake southwest of Wapanucka, near C S½ sec. 4, T. 1 S., R. 8 E., Johnston County.

SYSTEMATIC DESCRIPTIONS

Genus PARAGASSIZOCRINUS Moore and Plummer, 1940

Paragassizocrinus mcguirei (Strimple), 1939

The specimen considered here is from the Seminole Formation south of Tulsa. One infrabasal cone was ascribed to the species from this same exposure by Strimple (1960). The present cone is somewhat smaller. It is free of matrix, but the upper articular facets are weathered. Indications of sutures or of a columnar attachment are not present.

Measurements in millimeters:

	OU 3977
Height of cone	8.2
Width of cone (maximum)	8.3
Width of cone (minimum)	8.0
Ratio of height to maximum width	0.988

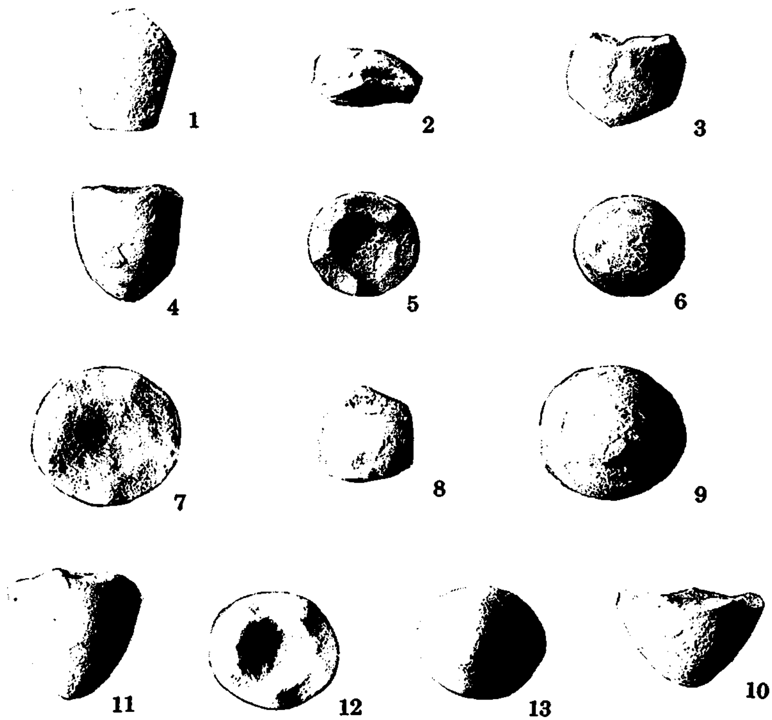

Plate I

Paragassizocrinus elevatus, new species

Figure 1. **Paratype (OU 3970a). Basal plate from the exterior.**

Figures 2, 3. **Paratype (OU 3970b). Radial plate from below and from exterior.**

Figures 4-6. **Holotype (OU 3970). Infrabasal cone from side, above, and below.**

Paragassizocrinus bulbosus, new species

Figures 7, 9, 10. **Holotype (OU 3971). Infrabasal cone viewed from above, below, and side.**

Figure 8. **Paratype (OU 3971a). Basal plate from exterior.**

Paragassizocrinus ellipticus, new species

Figures 11-13. **Holotype (OU 3973). Infrabasal cone viewed from side, above, and below.**

(All figures ca. x1)

Plesiotype.—Paleontological collections, The University of Oklahoma, OU 3977.

Occurrence.—Bank of stock pond on west side of U. S. Highway 75 (Okmulgee Beeline) south of Tulsa, NE¼ SE¼ sec. 3, T. 16 N., R. 12 E., Tulsa County, Oklahoma. Seminole Formation, Skiatook Group, Missourian, Pennsylvanian.

Paragassizocrinus disculus Strimple, 1960

The specimen considered here is considerably larger and slightly more robust than the holotype and paratypes, which specimens were from another exposure of the Wapanucka Formation in Pontotoc County.

Measurements in millimeters:

	OU 3978
Height of cone	12.0
Width of cone (maximum)	24.9
Width of cone (minimum)	24.2
Body cavity (maximum width)	19.8
Thickness of facets	4.2

Plesiotype.—Paleontological collections, The University of Oklahoma, OU 3978.

Occurrence.—Spillway of lake southwest of Wapanucka near C S½ sec. 4, T. 1 S., R. 8 E., Johnston County, Oklahoma. Wapanucka Formation, Morrowan, Pennsylvanian.

Paragassizocrinus bulbosus new species
Plate I, figures 7-10

Three infrabasal cones and one basal plate have been selected as type specimens. The cone is broad, low, and has a pointed base. The upper facets are thick. The basal plate is relatively short with a height of 8.2 mm, width 8.4 mm. The body cavity has gradually sloping sides.

Measurements in millimeters:

	HOLOTYPE OU 3971
Height of cone (maximum)	8.5
Width of cone (maximum)	13.2
Width of cone (minimum)	12.1
Body cavity (maximum width)	7.7
Thickness of facets	2.2

Remarks.—This species has a pointed base and the nature of the body cavity, within the broad cone, is different from that of *Paragassizocrinus atoka* Strimple and Blythe, 1960, which form is also normally somewhat larger than *P. bulbosus*. *P. disculus* Strimple, 1960, has a somewhat lower cone. Other known species have relatively high infrabasal cones.

Types.—Holotype and paratypes in the paleontological collections, The University of Oklahoma, OU 3971, 3971a, 3975a, 3975b.

Occurrence.—Road-cut on U. S. Highway 70, west of Ardmore, NW¼ NW¼ sec. 34, T. 4 S., R. 1 E., Carter County, Oklahoma. Bostwick Formation, Atokan, Pennsylvanian.

Paragassizocrinus elevatus new species
Plate I, figures 1-6

Three infrabasal cones, one basal plate, and one radial plate have been taken as types of the present species. The infrabasal cones are high, narrow, and have truncated bases. The infrabasal plates are completely anchylosed and there is no evidence of columnar attachment. The facets are relatively short. The basal plate is elongate and pentagonal, with the lower edge curved rather than straight. The articulating facets are short. The radial plate is pentagonal and its lower articular facets are short. It has a height of 8.0 mm, width 10.0 mm.

Measurements in millimeters:

	HOLOTYPE OU 3970
Height of cone	10.2
Width of cone (maximum)	9.7
Width of cone (minimum)	9.1
Body cavity (maximum width)	5.7
Thickness of facets	2.1

Remarks.—The facets of the infrabasal cone are like those of *P. tarri* (Strimple) or of *P. mcguirei* (Strimple) but the cone is longer than in those species and does not have a pointed base.

Types.—Holotype and paratypes in the paleontological collections, The University of Oklahoma, OU 3970, 3970a, 3970b, 3976 (two specimens).

Occurrence.—Road-cut on U. S. Highway 70, west of Ardmore, NW¼ NW¼ sec. 34, T. 4 S., R. 1 E., Carter County, Oklahoma. Bostwick Formation, Atokan, Pennsylvanian.

Paragassizocrinus ellipticus new species
Plate I, figures 11-13

The infrabasal cone is high, narrow, elliptical, with a pointed base. There is no evidence of division between infrabasals or of any columnar attachment. The upper facets are rather short with sharp edges.

This is the same kind of cone ascribed to *P. tarri, P. elevatus,* and to some representatives of *P. mcguirei.* It is distinguished from those species by the slightly greater length and by the decidedly elliptical shape of the cone when viewed from above or from below.

Measurements in millimeters:

	HOLOTYPE OU 3973
Height of cone	10.8
Width of cone (maximum)	11.7
Width of cone (minimum)	10.0
Body cavity (maximum width)	6.0
Length of facets	2.0

Holotype.—Paleontological collections, The University of Oklahoma, OU 3973.

Occurrence.—Abandoned quarry west of Skiatook, SW¼ SE¼ sec. 23, T. 22 N., R. 11 E. Upper part of Chanute Formation, Ochelata Group, Missourian Series, Pennsylvanian, about four feet below the Iola Formation.

References Cited

Moore, R. C., and **Plummer, F. B.**, 1940, Crinoids from the Upper Carboniferous and Permian strata in Texas: Texas Univ., Pub. 3945, p. 9-468.

Strimple, H. L., 1939, A group of Pennsylvanian crinoids from the vicinity of Bartlesville, Oklahoma: Bull. Amer. Paleontology, vol. 24, no. 87, p. 18.

——— 1960, The genus **Paragassizocrinus** in Oklahoma: Okla. Geol. Survey, Circ. 55, 37 p.

Strimple, H. L., and **Blythe, J. G.**, 1960, **Paragassizocrinus** in the Atoka of northeastern Oklahoma, in The genus **Paragassizocrinus** in Oklahoma: Okla. Geol. Survey, Circ. 55, p. 25-29.

THE TYPE SPECIES OF *Pterotoblastus*, A PERMIAN BLASTOID FROM TIMOR

ROBERT O. FAY

The genus *Pterotoblastus* Wanner, 1924, with type species *P. gracilis* Wanner, 1924, may be characterized as a fissiculate blastoid with 8 (some with 6) moderately restricted hydrospire fields, lacking hydrospire fields on the anal side, with anal opening between a large epideltoid and adjacent radial limbs, possibly with an atrophied hypodeltoid on the aboral side of the anal opening, wing-like radials, 2-14 hydrospire slits in each field extending across the radiodeltoid sutures, flat summit, truncated conical base, short ambulacra well away from mouth, and 3 basal plates. It is reported from the Permian beds of Australia and the island of Timor, Indonesia.

There are 5 reported species of this genus and these may be distinguished by use of the following key:

1. Radial wings long, high .... *P. gracilis* Wanner, 1924
   Radial wings short, low, on or near summit 2
2. Radial wings small, round, moderately projecting beyond summit laterally .... *P. ferrugineus* Wanner, 1940
   Radial wings short, blunt, almost confined to summit 3
3. Hydrospire slits 7 or more in each field ..... *P. oyensi* Wanner, 1940
   Hydrospire slits 3 or less in each field 4
4. Base rounded in side view .... *P. brevialatus* Wanner, 1931
   Base conical, truncated in side view .. *P. decemcostis* Wanner, 1931

The genus belongs to the family Codasteridae Etheridge and Carpenter, 1886, characterized by having 8 exposed hydrospire fields. The other genera of this family do not have radial wings.

I wish to thank Dr. T. Soeradi, head of the geological museum, Djawatan Geologi-Bandung, Indonesia, for loan of the specimens for this study.

Pterotoblastus gracilis Wanner, 1924
Plate 1, figures 1-3

The figured specimen is 7 mm high by 11 mm wide, with each wing about 4 mm high by 3 mm long, and greatest width near top of wings. Basalia truncate conical, 2.5 mm high by 4 mm wide, with 3 normally disposed basal plates. Stem round, crenellar, in small basal concavity approximately 1 mm in diameter. Radials 5, elongate pentagonal, each 5 mm long by 3.5 mm wide, with a high, long wing-like extension extending laterally beyond the sides of the theca. Radials overlap deltoids.

Deltoids 4, large, arrow-shaped, each approximately 2 mm wide by 2 mm long, with 3 hydrospire slits in moderately restricted hydrospire fields on each side of an ambulacrum, confined to summit. On the anal side a large epideltoid, similar to the other 4 deltoids, is present, with a small anal opening between the epideltoid and adjacent radial limbs. It is possible that a small hypodeltoid was present on the aboral side of the anal opening but is now missing. There are no hydrospire slits on the anal side. Thus there are 8 hydrospire fields.

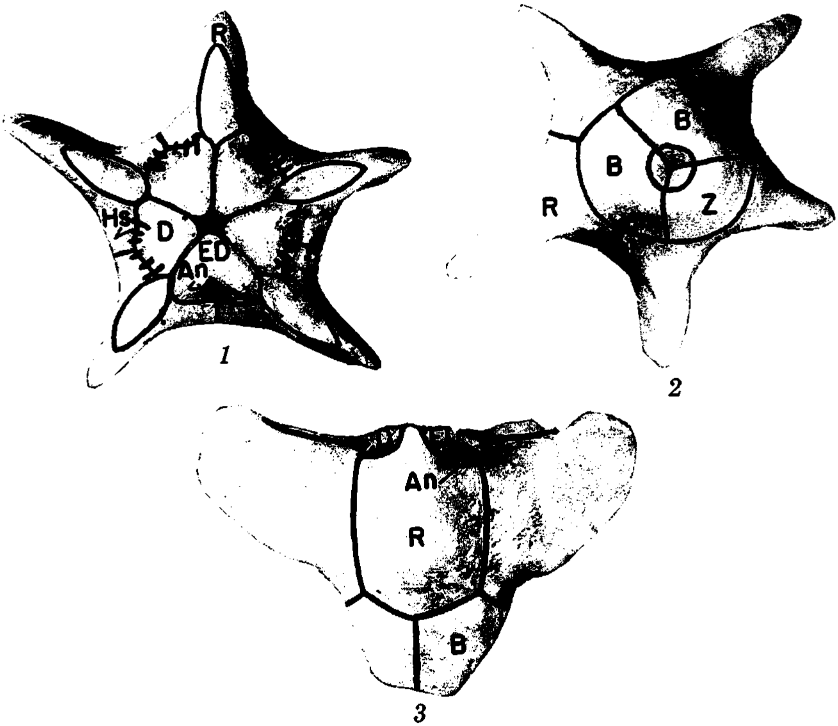

Plate I

Pterotoblastus gracilis Wanner, 1924. Permian, Basleo beds, Timor, Indonesia. Topotype 517, Musium Geologi-Bandung, Indonesia, x5.5.

Figures 1-3. Oral, aboral, and (D) ambulacral views of a perfect specimen, showing 3 basal plates and 3 hydrospire slits on each side of an ambulacrum except in anal area.

An—anal opening
B—basal plate
D—deltoid plate
Hs—hydrospire slits
R—radial plate
Z—azygous basal plate
ED—epideltoid plate

Ambulacra 5, with 4-5 elongate side plates covering the lancet plate in each ambulacrum, confined to summit, well away from oral opening, extending about one-half the length of the radial limbs. There are approximately 4 cover-plate sockets per side plate along each side food groove and 3 cover-plate sockets per side plate along the main food groove. The surfaces of the calyx plates are ornamented with fine granular growth lines subparallel to plate margins.

Types and occurrence.—The figured specimen is one of 5 specimens from the Basleo beds, Timor, Indonesia, on deposit in the Musium Geologi-Bandung, Indonesia, topotypes 517.

References Cited

Wanner, Johannes, 1924, Die permischen Echinodermen von Timor, Teil II: Paläontologie von Timor, Lieferung 14, Abhandlungen, vol. 23, p. 1-81, pls. 199-206, figs. 1-31, Stuttgart.

———— 1931, Neue Beiträge zur Kentniss der permischen Echinodermen von Timor, VI, Blastoidea: Bandoeng, Dienst van den Mijnbouw in Nederlandsch-Indie, Wetenschappelijke Mededeelingen, no. 16, p. 38-74, pls. 1-4, text-figs. 1-10.

———— 1940, Neue Blastoiden aus dem Perm von Timor: Amsterdam, Geological Expedition of the University of Amsterdam to the Lesser Sunda Islands in the south-eastern part of the Netherlands East Indies, vol. 1, p. 220-276, pls. 1-3, text-figs. 1-2.

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, 1961.

Distribution and thickness of pre-Desmoinesian rock units in south-central Oklahoma, by William Henry Bellis.

Areal geology of Bruno and Lane quadrangles, Atoka County, Oklahoma, by Richard Lee Boone.

Palynology of the Rowe coal (Pennsylvanian) of Oklahoma, by Phillip N. Davis.

A subsurface study of the Hunton group (Silurian-Devonian) in the Oklahoma portion of the Arkoma basin, by Richard L. England.

Ophitic pyroxene from the Raggedy Mountains area, Wichita Mountains, Oklahoma, by Anthony Wesley Warren Karns.

Ostracoda from the Haragan formation (Devonian) of Murray County, Oklahoma, by Anna Mae Killian.

Areal geology of Lane NE quadrangle, Pushmataha and Atoka Counties, Oklahoma, by Connie Mac Krivanek.

Subsurface geology of southwestern Lincoln County, Oklahoma, by Howard E. Kunz.

Isopach and lithofacies study of the Desmoinesian series of north-central Oklahoma, by Marcus Nelson McElroy.

Subsurface geology of the Cretaceous coastal plain, southern Oklahoma, by Billie Neil Prewit.

Geology of the basic rocks of the eastern portion of the Raggedy Mountains, southwestern Oklahoma, by Alexander B. Spencer.

Areal geology of southwestern Canadian County, Oklahoma, by Don E. Trapnell.

Stratigraphy and sedimentary petrology of the Dakota group, central Colorado foothills, by Robert James Morris.

—L. F.

Concretionary Stream Bar Deposits

William D. Pitt, Hulon M. Madeley, and John R. Robertson*

INTRODUCTION

Central bar deposits amazingly rich in organic material are present along West Elm Creek in T. 10 N., R. 2 W., of Cleveland County, Oklahoma. This organic matter is abundant only along West Elm Creek, and is less common in bars of East Elm Creek, a neighboring stream only a few hundred yards away. The two creeks are similar in several ways: both show about the same degree of incising; both flow on red-beds of Permian age, either the Garber Sandstone or the Hennessey Shale; both have equal channel widths; and they show the same variety of flow pattern, locally either meandering or braiding. Two problems were suggested to the writers; they were to determine: (1) the source of the concretionary bar deposits in West Elm Creek, and (2) the reason for the almost complete lack of organic deposits in East Elm Creek. A sedimentary analysis of the deposits of these two streams was made in order to find the answers to these questions.

COMPARISON OF BAR DEPOSITS

To study the sedimentation within these two creeks, samples were taken from the channel bottom and from three positions on each bar. The samples were sieved and their statistical parameters were calculated. The values of the parameters for each sample are shown in table I. Several similarities can be noted between East Elm and West Elm Creeks:

(1) Grain size decreases persistently downstream (as expected).

(2) Similar channel widths, equal degree of incising and the fact that both streams exhibit a grain-size mode at 2.0 phi suggest that the streams are equally competent.

(3) Both creeks flow in a southerly direction across redbeds of Permian age.

(4) In the analysis of bar deposits of both creeks, samples of the upstream ends were coarser grained than those of the downstream ends.

Sedimentary data disclosed the following contrasts in the bar deposits:

(1) The median grain size of East Elm Creek deposits is smaller than that of West Elm Creek. The samples show a difference of ±1.0 phi size for the median grain. West Elm Creek bars are coarser (very coarse- to medium-grained sand) compared to finer grained sand (fine-grained sand) in East Elm Creek.

(2) East Elm Creek deposits are better sorted than those of West Elm Creek. The sorting of East Elm Creek approaches the best known values of stream sorting. Using the scale of Folk (1959) for sorting,

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*Michael Wolfson assisted the writers in this study.

East Elm deposits are classified as moderately well sorted whereas those of West Elm are very poorly sorted.

(3) West Elm Creek deposits show a detectable difference in sorting and in skewness between the upstream and downstream ends of the bars. Along East Elm Creek, there is no detectable difference in these values.

(4) West Elm Creek deposits show asymmetrical skewness, those of East Elm Creek display symmetrical skewness.

(5) Probably the most striking difference in the bar deposits of these streams is the concretionary material found abundantly on West Elm Creek (40% plus of the sample), but which is either entirely lacking or present only in small quantities in East Elm Creek bars (less than 5% of the sample).

DESCRIPTION AND COMPARISON OF ORGANIC MATERIAL

According to L. R. Wilson, professor of geology at The University of Oklahoma, the concretionary material results from the formation of calcite around grass rootlets. This identification readily explains the branching form and central cavity of the cylindrically shaped organic material (pl. I, fig. 1). This identification was corroborated further by the finding of calcareous deposits around grass rootlets in soil profiles a few yards upstream from the concretionary bar deposits at the bridge in sec. 36, T. 10 N., R. 2 W., along West Elm Creek. Grass leaf cuticle cells, parenchyma and xylem (root) cells also were found and identified by Wilson, as well as were fungal spores of *Rhizophagites butleri* Rosendahl, 1943 (pl. I, fig. 2).

The question of the source area of the concretionary material in West Elm Creek is partially answered by the identification of the organic material as being calcium carbonate which has been precipitated around grass rootlets. The concretionary material itself is composed of fine-grained sand (approx. size 2 phi) cemented with calcium carbonate. Digestion of the organic material with dilute HCl reveals this fact. It must follow therefore that three causal factors are present in the source environment.

TABLE I.—GRAIN-SIZE ANALYSES OF BAR DEPOSITS

SAMPLE LOCATION	MEAN GRAIN SIZE (PHI)	INCLUSIVE GRAPHIC STANDARD DEVIATION (PHI)	INCLUSIVE GRAPHIC SKEWNESS
West Elm			
Downstream	1.38 med. sd	1.160 very poor	—.7229 (strong c'se sk'd)
Upstream	.33 c'se sd	1.262 very poor	.1658 (fine sk'd)
Top of bar	—.93 very c'se sd	1.884 very poor	.2464 (fine sk'd)
East Elm			
(First bar)			
Upstream	2.35 fine sd	0.455 (mod. sort.)	.0341 (sym.)
Downstream	2.03 fine sd	0.460 (mod. sort.)	.0716 (sym.)
(Second bar)			
Upstream	2.283 fine sd	0.432 (mod. sort.)	—.0049 (sym.)
Downstream	2.235 fine sd	0.437 (mod. sort.)	—.03960 (sym.)

(1) Fine-grained sand (as a constituent of a loam or sandy soil).

(2) Concretionary plant material with an extensive root system (mostly grass).

(3) A source of calcium ions in the soil.

The concretionary material is undoubtedly the result of precipitation of calcium carbonate around rootlets. The precipitation took place at the time water was absorbed by the root cells. With this absorption some calcium carbonate was encrusted around the root fibers and between the fine sand grains; this kind of encrustation commonly occurs in calcium-rich soils. The soil map of Cleveland County shows that West Elm Creek drains a soil high in calcium; East Elm Creek, according to this map, does not drain a soil high in calcium. Thus the concretionary material probably occurs only along the stream with the high percentage of calcium ions and is absent where the percent of calcium is low.

Gravel deposits (grain size = –1 to –4 phi) are present in the bars

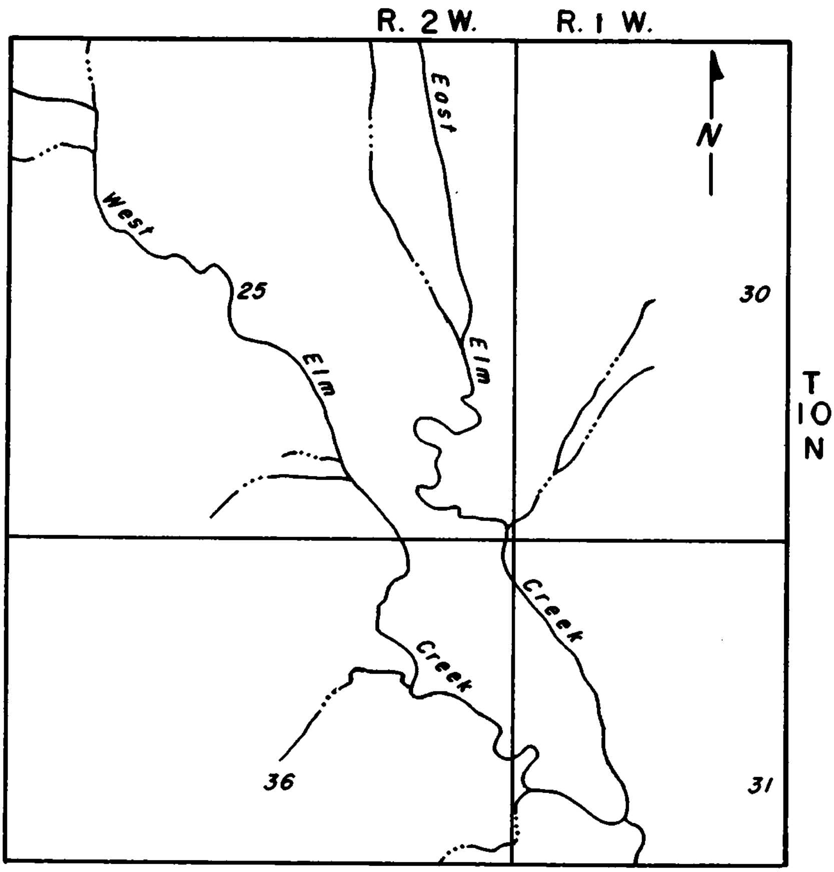
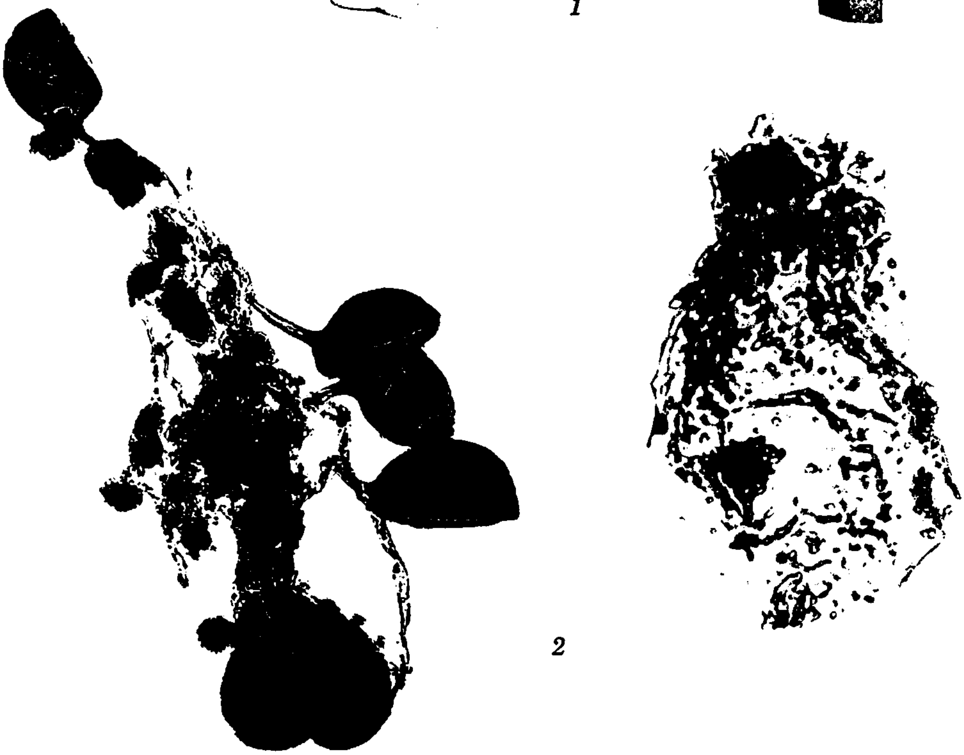


Figure 1. Map showing geographic relationship of West Elm Creek and East Elm Creek, Cleveland County, Oklahoma.

Plate I

1



2

of West Elm Creek but are almost completely absent along East Elm Creek. The semi-rounded fragments of gravel consist, in part, of a fine-grained sand cemented by calcium carbonate as proved by digestion with dilute HCl. A portion of the gravel fragments is the result of local precipitation of calcium carbonate that takes place only in the calcium-rich soils of the West Elm drainage area and is therefore a possible reason for the almost complete lack of gravels along East Elm Creek.

INTERPRETATION OF PRIMARY SEDIMENT DISTRIBUTION

The sediments of the downstream end of the bars sampled in West Elm Creek are strongly coarse-skewed; those from the top and the front (upstream) ends of the bar are slightly fine-skewed. This difference may be explained by the selective winnowing out of the fine sediments on the downstream end of the bar. This same process also could have acted upon the downstream ends of the bars sampled in East Elm Creek, but because the sorting values at all positions on East Elm Creek bars are close together, the effect of the winnowing is not pronounced. The differences in the median grain size at the upstream end, downstream end, and the top of the bar in West Elm Creek may be explained by differences in stream competency at the three positions.

When water flows over the bar, its velocity (competency) is reduced rapidly, largely because of greater friction-of-flow per unit volume of water. Because shallowing, as the water passes over the bar, results in an increased cross-sectional area while the flow rate remains the same, the velocity must decrease in agreement with the equation $Q=VA$, where Q equals the volume flow rate, V equals velocity, and A equals the cross sectional area through which the water flows. This velocity decrease results in a rapid dropping out of the coarser material on the top of the bar. When the water no longer "tops" the bar, the water channel is bisected by the bar, forming a relatively quiet-water area directly in front of the upstream end of the bar. Because this quiet-water area is the site of slowly moving water, the competency of the stream is locally reduced and coarse sediment settles out there.

On the downstream end of the bar, where the bar-bisected stream reunites, a velocity decrease also occurs. The decrease here results in the deposition of sediment whose median grain size is slightly less than that of the upstream end of the bar. A smaller median grain size here is reasonable because less of the coarse material is available, having been largely deposited at the upstream end of the bar.

Explanation of Plate I

Figure 1. Tubular deposits formed around grass roots (x10). This is the dominant material of the bar deposits along West Elm Creek. Notice central cavity and branched form.

Figure 2. Left. Rhizophagites butleri **Rosendahl, 1943. Soil fungus spores (x800).**
Right. Fragment of grass root (x800) showing a xylem vessel with scalariform pitting.
(Identification by L. R. Wilson)

CONCLUSIONS

(1) The streams were similar in all aspects except for the abundance of organic material and the gravel present in the bars of West Elm Creek.

(2) The formation of the concretionary bars and a portion of the gravel material in West Elm Creek was made possible by the abundance of calcareous material in nearby soils.

(3) The branching form and central cavity of the cylindrical concretionary material can be explained by the fact that it is an encrustation around grass rootlets.

(4) The values of the statistical parameters obtained from sieving analysis can be explained in terms of stream mechanics.

(5) A combination of soil map study, field observation, sieving analysis, and consultation with a palynologist was used as the basis for these observations and conclusions. Similar combinations of study could be utilized profitably in stream studies in other regions.

References Cited

Folk, R. L., 1959, Petrology of sedimentary rocks: Austin, Hemphill Publishing Company.

Rosendahl, C. O., 1943, Some fossil fungi from Minnesota: Torrey Botanical Club, Bull., vol. 70, no. 2, p. 126-138.

MORROWAN *Hydriocrinus*

HARRELL L. STRIMPLE

The species *Hydriocrinus? rosei* Moore and Plummer, 1938, was described from a single specimen from just north of Keough quarry, sec. 36, T. 16 N., R. 19 E., about two miles north of Fort Gibson, Cherokee County, Oklahoma. Moore and Plummer noted that the specimen was collected at the foot of a slope containing both Brentwood Limestone (Morrow Group, Pennsylvanian) and the underlying Pitkin Limestone (Chester Group, Mississippian). Most crinoids collected in the area are from the Brentwood Limestone, as noted by Moore and Plummer.

It is now possible to fix definitely the age of the species. An excellently preserved dorsal cup has been found by Jack Hood of Tulsa, Oklahoma, and is here designated as a plesiotype. The specimen was obtained from a slab of greenish limestone that occurs rather high in the spillway of Greenleaf Lake, southeast of Braggs, Oklahoma (sec. 10, T. 13 N., R. 20 E.). This exposure is all Brentwood Limestone Member, Hale Formation, Morrow Group.

Moore and Plummer assigned the species to *Hydriocrinus* with reservation. The holotype possessed the lower remnants of a strong anal tube. The plesiotype does not show any of the sac above the normal three plates of the posterior interradius within the calyx proper. Moore and Plummer reported that examination of several specimens of *H. pusillus* Trautschold, the genotype species, in the collection of the University of Chicago, failed to disclose any distinct sign of a sac, although the genus is reported to have a strong sac. Several years ago I had the opportunity to examine a specimen of Trautschold's species from the vicinity of Moscow in the collection of the late James Wright, the eminent Scottish crinoid specialist, and am able to verify the existence of a strong anal sac.

The arms of *H. rosei* are still unknown so that comparison is not possible. The remaining difference between the two species is in the arrangement of the anal plates within the posterior interradius of the calyx. Both species have three anal plates, but in *H. pusillus* there is a well-marked horizontal line approximately even with the top of the radial plates separating anal X and RX from the higher plates of the sac. In *H. rosei* RX is higher than anal X and projects well above the top of the radial plates. I am not prepared at this time to comment extensively on the possible significance of the condition where anal X and RX form a horizontal plane; however, it has been reported for *Haeretocrinus turbinatus* Strimple, (1952b), and various species of *Texacrinus* (Strimple, 1952a). It is also typical of *Melbacrinus americanus* Strimple, 1939.

The column of the plesiotype is not preserved but the columnar scar and the outer edges of the crenellae define a pentagon. This agrees with the holotype, and is characteristic of the genus *Hydriocrinus*. Surface ornamentation of fine pits and ridges is found in the plesiotype as in the holotype, which feature is not characteristic of the smooth genotype species. *H. pusillus* has a high, slender, conical calyx quite different in appearance from the relatively squat, broad calyx of *H. rosei.*

The dorsal cup of the plesiotype is 11.6 mm wide and 7.9 mm high. This is considerably smaller than the holotype, which is reportedly 21 mm wide and 15 mm high.

Mr. Hood has generously donated the plesiotype to the collections of The University of Oklahoma where it is catalogued OU 3619.

References Cited

Moore, R. C., and **Plummer, F. B.**, 1928, Upper Carboniferous crinoids from the Morrow Subseries of Arkansas, Oklahoma and Texas: Denison Univ., Sci. Lab. Jour., vol. 32, p. 209-314.

Strimple, H. L., 1939, A group of Pennsylvanian crinoids from the vicinity of Bartlesville, Oklahoma: Bull. Amer. Paleontology, vol. 24, no. 87, 26 p.

———— 1952a, Notes on **Texacrinus**: Wash. Acad. Science, Jour., vol. 42, p. 216-220, 16 figs.

———— 1952b, The arms of **Haerteocrinus** [sic]: Wash. Acad. Science, Jour., vol. 42, p. 245-248, 7 figs.

Trautschold, H., 1879, Die Kalkbrüche von Mjatschkowa. Eine Monographie des oberen Bergkalks: Moscow, Soc. Imp. Nat., Bull., vol. 40, pt. 2, p. 101-180, 7 pls.

Chalmer L. Cooper Retires

Dr. Chalmer Lewis Cooper, geologist and staff assistant in the Office of the Director, U. S. Geological Survey, retired on October 13, after 20 years of federal service and nearly 10 years with the Illinois Geological Survey.

Dr. Cooper received his B.S. and M.S. degrees in geology from The University of Oklahoma in 1923 and 1926 and his Ph.D. from the University of Chicago in 1945.

Prior to his entrance on duty with the U. S. Geological Survey in 1946, Dr. Cooper was an instructor in geology at The University of Oklahoma, 1924-25; assistant director and chief geologist of the Oklahoma Geological Survey, 1925-31; geologist, Kentucky Geological Survey, 1931; geologist, National Park Service, 1935-37; and geologist, Illinois Geological Survey, 1937-46. During World War I he served in the United States and in France from 1917 to 1919 with a West Virginia National Guard unit which was mustered into federal service in the 38th Division.

His early professional career centered around work in economic geology, stratigraphy, and micropaleontology, with published papers on coal in Oklahoma; the Sycamore Limestone; oil and gas geology of several counties in Oklahoma; fossil faunal studies of several areas; a number of monographs in paleontology; ammonium chloride sublimate apparatus for coating objects for photographing; and many articles for encyclopedias and yearbooks. In 1953 he was co-author, with Carl C. Branson, of a geology handbook for the Merit Badge series of the Boy Scouts of America, and in 1957 he produced a report on the ecology of Paleozoic Foraminifera for Memoir 67 of the Geological Society of America.

In *Covered Wagon Geologist,* Charles N. Gould, founder of the Oklahoma Geological Survey, cited Dr. Cooper's contributions to the furthering of the work of the survey:

> Much of the success for the publications of the survey is due to the activities of C. L. Cooper, who for six years served as editor. . . . Mr. Cooper seemed to be especially fitted for this kind of work. Careful, industrious, efficient, with a good knowledge of English and a keen eye for detail, he labored faithfully to turn out good reports. And the thirty reports of printed matter published during the six years he was with the survey bear testimony to his careful and painstaking work.

Dr. and Mrs. Cooper expect to build a new home near Sarasota, Florida.