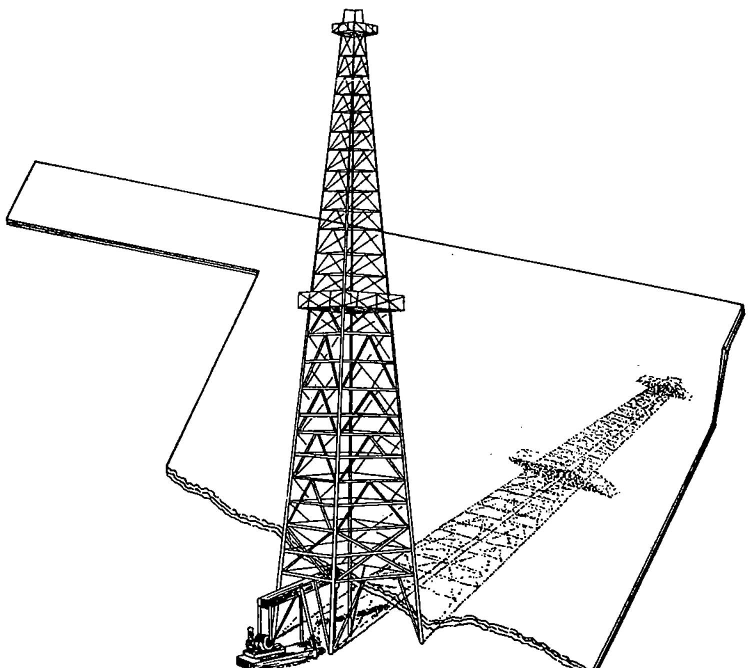
Oklahoma Geology Notes



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STATUS OF OKLAHOMA GEOLOGICAL SURVEY PUBLICATIONS

Circular 32. Pennsylvania plant microfossils of the Croweburg coal in Oklahoma, by L. R. Wilson and W. S. Hoffmeister. Released April 14, 1956. 57 pages, 5 collotype plates, 4 figures. Bound in blue cloth $1.75, paper $1.25.

Map 72-3. Tectonic map of Oklahoma, by J. Kaspar Arbenz. In press. Available in August 1956.

Guide Book IV. Geology of the Turner Turnpike, with chapters on vegetation, history, subsurface geology. Released April 13, 1956. 76 pages. Price $2.00.

Circular 38. Catalog of fossils of the Hunton group, Oklahoma, by Thomas W. Amsden. Issued in June 1956. 63 pages. Bound in blue cloth, $1.25, paper $0.75.

Circular 39. Microfossils of the Manning zone, Ringwood Pool, Oklahoma, by R. W. Harris. Issued in June 1956. 41 pages, 4 collotype plates. Bound in blue cloth, $1.50, paper $1.00.

Circular 40. Geology of northeastern Osage County, Oklahoma, by W. F. Tanner. In press. Available in November 1956.

Circular 41. Description and correlation of two complete stratigraphic sections of the Jackfork sandstone in Kiamichi Mountains, central Ouachita Mountains, Oklahoma. By L. M. Cline and Frank J. Moretti. In press, available in September.

SHALES and CLAYS

by A. L. Burwell

Questions

What is meant when a natural material is termed a shale or a clay? Why are shales and clays usually classed together? What are the chemical and mineralogical composition and the variations? What are the physical and chemical characteristics and how do they influence the commercial applications? These and many more questions come to mind in thinking on Oklahoma shales and clays. This paper will attempt to answer some of the questions and to do so briefly. To those desiring a better understanding of the subject a few selected references are given.

Answers to some of the Questions

Shales are very fine-grained sedimentary rocks which have been formed by the consolidation of beds of mud, clay, or silt. In color they range from light yellow through brown and greens to black. In composition they contain a wide variety of mineral materials of which the clay minerals, micas, and quartz of silt size are the most prominent.

Clays have very much the same composition although the clay minerals predominate and accessory materials are minor constituents. The color range is from white to brown and the deposits may be unconsolidated.

The commercial utilization of both shales and clays depends upon the peculiar physical and chemical properties of the contained clay minerals as well as the proportions of associated minerals. Sometimes it is difficult to classify or label the several minerals contained in a shale or clay as clay minerals or non-clay minerals. Certain minerals possess the properties of the clay minerals but are not so classed mineralogically: all of which indicates the complexity of the subject.

Since shales and clays are the basic raw materials upon which the ceramic industry has been built, it becomes important to understand something about these substances, their properties, their limitations, and the products which may be made from them. In the first place, the clay minerals and most of the non-clay minerals found in shales and clays are not amorphous, as was formerly believed, but are definitely crystalline even though individual crystals are submicroscopic. Probably the most important aspects considered in studying shales and clays are particle size, particle shape, base exchange capacity, accessory minerals, organic matter, color, and chemical composition.

No characteristic of a shale or clay is more important than the size of the particles of which it is composed. Plasticity, dry strength, and base exchange capacity are influenced by particle size. It is not always easy to measure the particle size because of the difficulty of dispersing the individual particles and in separating one mineral from another. Petrographic and electron microscopes offer help within certain limits but their use is tedious. The x-ray serves for study of particles of less than 0.1 micron size, but requires pain-staking care. The most feasible method for the average determination makes use of Stokes' law, and is known as the sedimentation method. A dilute suspension of the material is used and must be completely deflocculated. With few exceptions the maximum particle size in commercial clays is 100 microns. Most clays have a minimum particle size of 0.1 but there are a number in which several per cent may be smaller than 0.1 micron.

The electron microscope supplies the information on particle shape. Through the use of this instrument it is known that kaolinite is plate-like in form and usually the thickness is about 8 to 10 per cent of the width. Likewise, it is known that endellite, another clay mineral, occurs as single crystals that are very thin and are rolled up as tubes. Some of the other clay minerals appear ragged or spongy. The shape and thickness of the particles influence the surface area exposed and surface area influences the working properties.

The base exchange capacity of the several clay minerals covers a wide range. For example; commercial clay called kaolin may show a base exchange capacity of only 1 milliequivalent per 100 grams. Fire clays usually show between 5 and 7. Ball clays show about 12, whereas bentonite may show as much as 100. This wide range is accounted for by differences in the proportion of the different clay minerals. According to Grim (1953) the cation-exchange capacity is as follows:

Table 1

Cation-Exchange capacity of clay minerals, in milliequivalents per 100 grams.

Kaolinite	3-15
Halloysite $2H_2O$	5-10
Halloysite $4H_20$	40-50
Montmorillonite	80-150
Illite	10-40
Vermiculite	100-150
Chlorite	10-40
Sepiolite-attapulgite Palygorskite	20-30

A list of accessory minerals sometimes found in shales and clays would include albite, anorthosite, biotite, beryl, calcite, corundum, garnet, gibbsite, gypsum, hematite, ilmenite, limonite, magnetite, magnesite, microcline, muscovite, orthoclase, pyrite, quartz, rutile, tourmaline and zircon.

The organic matter in shales and clays ranges from graphitic through lignitic to humic acid materials. These materials influence the color but colors caused by such materials have little influence on uses of shales and clays in ceramics because these materials burn out. Colors due to the presence of metallic oxides, such as iron, manganese, and vanadium oxides, must be considered in most ceramics. The paper manufacturer in most cases demands clear white clays.

The chemical composition is important in many of the potential uses. For portland cement manufacture the proportions of silica, alumina, iron, and lime must be known to calculate a proper blend. The allowable magnesia is very small. For oil well drilling mud the physical properties may be more important than the chemical, but chemical composition may determine or influence the physical properties. In brick, pottery, refractories and other ceramic uses the chemical composition decides the suitability of the material.

The physical properties which enter into the possible utilization of a shale or clay include plasticity, drying characteristics, dried strength, slaking, and firing properties. If one follows the course of manufacture of brick, tile, or pottery from the raw shale or clay, the importance of these properties will be evident. The crushed material should slake reasonably well in water. The dewatered material should be plastic enough to shape yet firm enough to retain its shape. It should have ample strength when wet and when dried. The shrinkage should not be excessive either during drying or firing.

Publications containing information on Oklahoma shales and clays are:

Sheerar, L. F., The clays and shales of Oklahoma. Oklahoma A&M College, Div. of Eng., Publ., Vol. 3, No. 5 (1932).

Snider, L. C., Clays and clay industries of Oklahoma. Oklahoma Geological Survey, Bull. 7 (1911).

Burwell, A. L., Lightweight aggregate from certain Oklahoma shales. Oklahoma Geological Survey, Mineral Report 24 (1954).

Burwell, A. L., and Branson, C. C., Occurrence of buff-burning ceramic clay in Kay County. The Hopper, Vol. 15, Nos. 10-11 (1955).

Publications containing scientific information on clays and shales and their uses:

Grim, R. E., Clay Mineralogy, McGraw-Hill Book Co. (1953).

Norton, F. H., Elements of Ceramics, Addison-Wesley Press, Inc. (1952)

Norton, F. H., Refractories, McGraw-Hill Co. (1931).

NOTES ON PARMORTHIS BROWNSPORTENSIS AND ISORTHIS ARCUARIA FROM THE HENRYHOUSE AND BROWNSPORT FORMATIONS

Thomas W. Amsden

The writer is making a study of the Haragan brachiopods and in the course of this work has compared certain species from this formation to similar forms from the Henryhouse formation. In particular the Devonian Dalmanellacea **Levenea subcarinata** (Hall 1857) has been compared to the Henryhouse species, **Parmorthis brownsportensis** and **Isorthis arcuaria.** Externally most specimens of **L. subcarinata** can be readily separated from either of these Silurian species by the somewhat carinate pedicle valve. However, there are specimens of **Levenea** with this character poorly developed and these may resemble **P. brownsportensis** or **I. arcuaria,** this being especially true of immature shells (the internal structure of all three is markedly different). It seems possible that workers in the past may have confused **L. subcarinata** with one or the other of these two Henryhouse species, thus contributing to the stratigraphic and faunal problems concerned with this part of the section. Since **Levenea** is fairly common in the Haragan, and **Isorthis** and **Parmorthis** are common in the Henryhouse, this distinction is of value in separating the marlstones of the Haragan from those of the Henryhouse. It therefore seems desirable to add some additional descriptive data to that which is already available on the two Henryhouse species. To make this supplementary description as broadly useful as possible the writer has included specimens from the Brownsport formation of western Tennessee, this being the type locality for **P. brownsportensis** and **I. arcuaria.** Through the courtesy of Professor C. O. Dunbar a number of Brownsport specimens of both species were borrowed from Yale University and the data obtained from these have been incorporated into the description given below. No detailed description of **L. subcarinata** is herein given because this will be included in a study of the Haragan brachiopods to be published in the future. However, for the purpose of comparison two of the graphs include information taken from specimens of **Levenea.**

PARMORTHIS BROWNSPORTENSIS Amsden 1949

Orthis elegantula Roemer 1860 (p. 62, pl. 5, fig. 7; not Dalman 1828).

Parmorthis brownsportensis Amsden 1949 (p. 42, pl. 1, figs. 1-6).

Parmorthis brownsportensis Amsden 1951 (p. 74, pl. 16, figs. 17-23).

The writer's original description and illustration (1949) of this species was based upon specimens from the Brownsport formation of western Tennessee. A short time later (1951) this species was identified from the Henryhouse formation of Oklahoma and additional information was presented. The illustrations in these two papers clearly show the internal and external characters of typical, mature specimens. The supplementary data here furnished is primarily to give a better idea of the degree of variation found among different individuals, and especially changes found at different growth stages.

A series of individuals were measured, ranging in length from 4.1 millimeters to 17.9 millimeters; elsewhere the writer (1949, p. 42) has recorded a specimen with a length of 20 millimeters. As shown in Table I, the length/width ratio of immature specimens (less than 9 millimeters) ranges from about

TABLE I
Fig. 1
PARMORTHIS BROWNSPORTENSIS

LENGTH mm	WIDTH mm	THICKNESS mm	RATIO Length/Width	RATIO Length/Thickness	COSTELLAE No. in 5 mm at anterior
Henryhouse specimens—Oklahoma					
4.1	4.6	2.2	0.89	1.86	—
5.0	5.9	2.6	0.85	1.92	13
6.5	6.9	2.9	0.94	2.25	10
6.7	7.1	2.5	0.94	2.68	11
6.9	7.2	3.1	0.96	2.23	—
6.9	7.3	3.7	0.95	1.88	—
7.8	8.1	3.7	0.96	2.10	13
8.2	8.5	3.9	0.97	2.10	—
9.3	8.9	4.1	1.04	2.26	11
9.5	9.5	4.6	1.00	2.06	12
9.5	9.5	4.6	1.00	2.06	12
10.1	9.9	5.1	1.01	1.98	—
10.1	9.6	4.4	1.05	2.30	12
10.2	10.5	4.6	0.97	2.22	—
10.5	10.2	5.2	1.03	2.02	18
10.5	11.2	4.6	0.94	2.30	15
10.9	11.0	4.5	0.99	2.42	16
11.2	11.5	5.4	0.97	2.07	14
11.4	11.9	5.1	0.96	2.24	14
11.5	12.3	5.2	0.93	2.21	13
11.7	10.5	6.0	1.11	1.95	9
11.8	10.8	6.0	1.10	1.97	14
11.9	12.1	5.2	0.99	2.29	18
12.8	12.8	—	1.00	—	10
14.0	14.2	5.4	0.99	2.60	17
14.6	14.6	—	1.00	—	13
17.9	17.8	—	1.01	—	16
Brownsport specimens—western Tennessee					
7.3	7.7	2.6	0.95	2.80	14
8.0	8.6	—	0.93	—	9
8.8	8.2	—	1.07	—	13
8.9	9.6	—	0.93	—	13
9.4	9.4	3.5	1.00	2.70	14
9.6	9.1	—	1.06	—	13
10.1	9.9	—	1.02	—	11
10.4	10.8	—	0.96	—	14
12.2	11.2	—	1.09	—	13
14.5	13.0	7.9	1.12	1.84	18

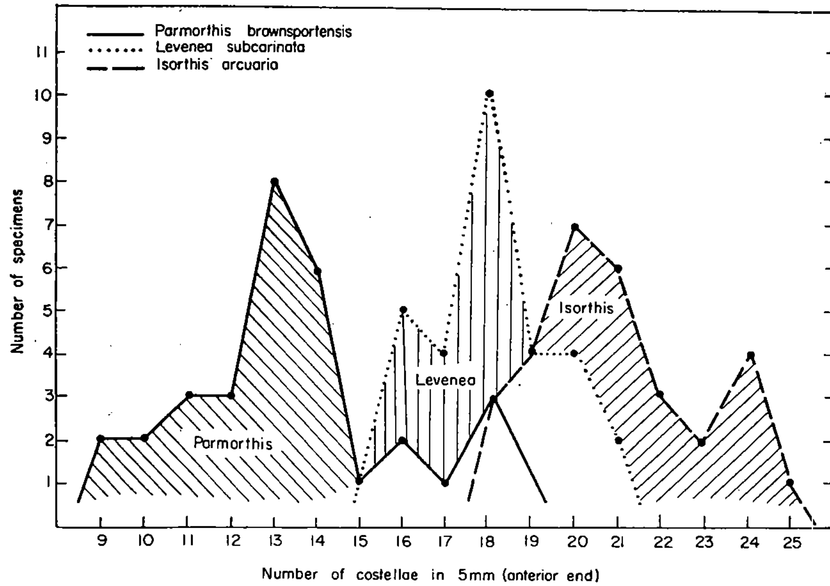

Figure 1. Graph showing the length-width relationship of **Levenea subcarinata** (Hall) [squares] from the Haragan formation, and **Parmorthis brownsportensis** Amsden [circles] from the Henryhouse formation of Oklahoma [solid circles] and the Brownsport formation of western Tennessee [open circles].

0.85 to 0.95, but in larger shells the length and width are approximately equal, ranging from 0.93 to 1.11. Figure I shows graphically the length width relationship in a suite of specimens of different sizes. It will be noted that for any given size the variation is commonly small. Included on this same graph are a series of measurements taken from specimens of **Levenea subcarinata** from the Haragan formation. The smaller specimens of this species have a length/width ratio similar to **Parmorthis**, but with increase in size this similarity largely disappears and in mature shells of **P. brownsportensis** the length is about equal to the width, whereas in **Levenea** the width is slightly, but consistently, greater than the length.

The length/thickness ratio shows a somewhat greater range than does that of length/width, however, as shown in Table I even this variation is slight. The number of costellae in a distance of 5 millimeters (counted at the anterior end) ranges from 9 to 18 (31 specimens), the average being approximately 13. The graph, figure 2, compares the costellae spacing on **P. brownsportensis** to those of **L. subcarinata** and **I. arcuaria.** It will be noted that while the "peaks" on this graph are separate, there is a distinct "overlap" progressing away from these maxima.

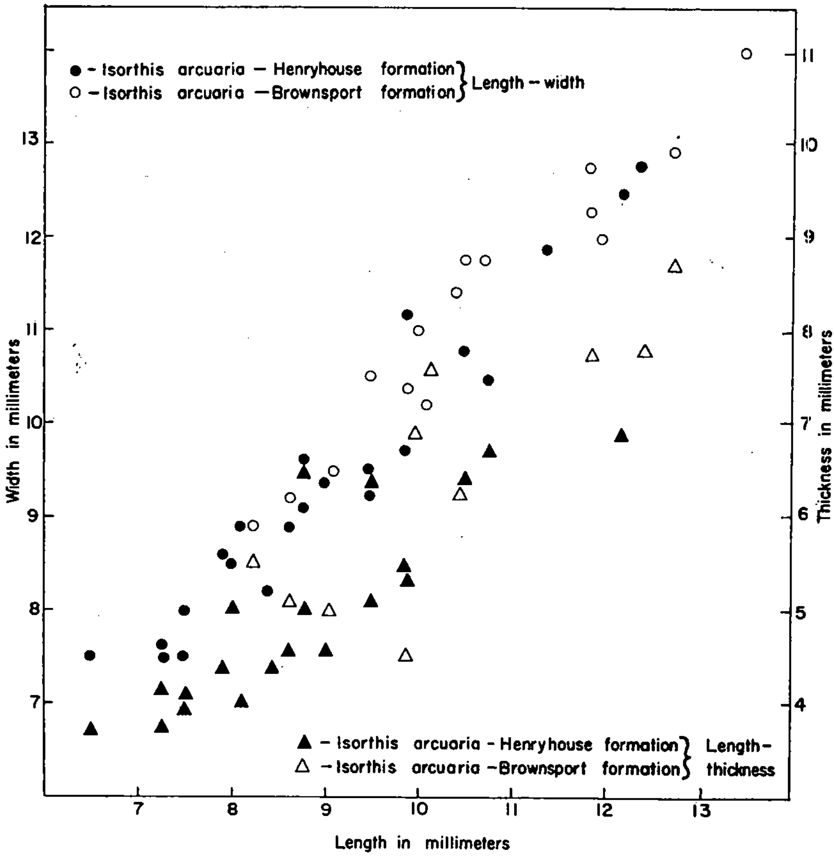

Figure 2. Graph comparing the spacing of costellae on: **Parmorthis brownsportensis** Amsden, Henryhouse formation of Okla. and Brownsport formation of Tenn.; **Isorthis arcuaria** (Hall and Clarke), same formations and localities; **Levenea subcarinata** (Hall), Haragan formation of Okla. In compiling this graph 31 specimens of **P. brownsportensis** were used, and 30 specimens for each of the other two species.

Of some help in the recognition of **P. brownsportensis** is the tendency to develop fasciculate costellae; this is marked on some shells, but in others it is obscure. A more characteristic feature of the ornamentation is the development of a narrow area along the mid-line of both valves on which the costellae are poorly developed. Schuchert and Cooper (1932, p. 129) called attention to this "nearly smooth or nearly plane" area and noted that it was almost a universal feature of the genus **Parmorthis.**

ISORTHIS ARCUARIA (Hall and Clarke)

Orthis (Dalmanella) arcuaria Hall and Clarke 1892 (pp. 224, 341, pl. 5c, figs. 20, 21).

Isorthis arcuaria (Hall and Clarke). Schuchert and Cooper 1932 (p. 150, pl. 21, figs. 21, 23, 24).

Isorthis arcuaria (Hall and Clarke). Amsden 1949 (p. 44, pl. 1, figs. 12-16).

Isorthis arcuaria (Hall and Clarke). Amsden 1951 (p. 76, pl. 15, figs. 39-44).

Hall and Clarke based their description of this species upon specimens from the Brownsport formation of western Tennessee. In 1949 the writer furnished additional information and illustrations on this species from the Brownsport, and in 1951 described the specimens from the Henryhouse formation of Oklahoma. These publications give a satisfactory description of the internal and external characters of typical, mature specimens, and the supplementary data given here is primarily to present a better idea on the degree of variation within this species, especially at different stages of growth.

A series of individuals were measured, ranging in length from 6.5 millimeters to 13.5 millimeters; the writer has previously recorded a specimen 18 millimeters long (1949). As shown in Table II the length is approximately equal to the width, varying from slightly longer than wide (length/width ratio 1.03) to slightly wider than long (length/width ratio 0.87). The length/thickness ratio shows a somewhat greater range, from 1.35 to 2.20. Figure 3 presents in graphic form the length-width and length-thickness relationship.

The number of costellae in a distance of 5 millimeters (counted at the anterior end) ranges from 18 to 25, the average falling between 20 and 21. Figure 2 shows that the "peak" of the costellae development on **I. arcuaria** falls at 20, this being distinct from that of **L. subcarinata** and completely removed from that of **P. brownsportensis.** However, this illustration also shows that progressing away from this maxima there is much "overlap" on **L. subcarinata,** and those specimens of **Isorthis** with the coarsest costellae extend well into the range of the finer costellate specimens of **Parmorthis.**

One of the more characteristic features of **I. arcuaria** is the subequally biconvex profile. Figure 3 shows that the length-width relationship varies rather widely, with most shells on the rotund side. In contrast, the typical specimen of **L. subcarinata** has a shallower brachial valve, although it is not uncommon to find specimens with a somewhat biconvex lateral profile. Most specimens of **Isorthis arcuaria** can also be separated from similar size individuals of **Levenea** by the uniform curvature of the pedicle valve, this valve showing little tendency towards the somewhat carinate curvature present in **L. subcarinata.**

Reeds (1911) makes no mention of this species. Maxwell (1936, p. 75) recorded it as **Dalmanella perelegans.**

TABLE II
Fig. 2
ISORTHIS ARCUARIA

LENGTH	WIDTH	THICKNESS	RATIO Length/Width	RATIO Length/Thickness	COSTELLAE No. in 5 mm at anterior
Henryhouse specimens—Oklahoma					
6.5	7.5	3.7	0.87	1.76	22
7.3	7.5	4.1	0.97	1.78	23
7.3	7.6	3.7	0.96	1.98	—
7.5	8.0	4.1	0.94	1.83	24
7.5	7.5	3.9	1.00	1.92	21
7.9	8.6	4.4	0.92	1.80	22
8.0	8.5	5.0	0.94	1.60	24
8.1	8.9	4.0	0.91	2.02	21
8.4	8.2	4.4	1.02	1.91	24
8.6	8.9	4.6	0.97	1.87	21
8.8	9.6	6.5	0.92	1.35	21
8.8	9.1	5.0	0.97	1.76	19
9.0	9.3	4.6	0.97	1.96	—
9.5	9.2	6.4	1.03	1.48	20
9.5	9.5	5.1	1.00	1.86	23
9.9	11.2	5.5	0.88	1.80	20
9.9	9.7	5.3	1.02	1.86	18
10.5	10.8	6.4	0.97	1.64	20
10.8	10.5	6.7	1.02	1.61	19
11.4	11.9	—	0.95	—	—
12.2	12.5	6.9	0.98	1.76	25
12.4	12.8	7.8	0.97	1.59	21
Brownsport specimens—western Tennessee					
8.2	8.9	5.5	0.92	1.50	20
8.6	9.2	5.1	0.93	1.69	19
9.1	9.5	5.0	0.96	1.82	20
9.5	10.5	—	0.90	—	24
9.9	10.4	4.5	0.95	2.20	18
10.0	11.0	6.9	0.91	1.44	—
10.1	10.2	7.6	0.99	1.33	21
10.4	11.4	—	0.91	—	22
10.5	11.8	6.3	0.89	1.66	20
10.7	11.8	—	0.91	—	—
11.9	12.7	—	0.94	—	19
11.9	12.3	7.7	0.97	1.54	20
12.0	12.0	—	1.00	—	—
12.7	13.0	8.7	0.98	1.46	18
13.5	14.0	—	0.97	—	—

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Amsden, T. W., 1949. Stratigraphy and paleontology of the Brownsport formation (Silurian) of western Tennessee: Peabody Mus. Nat. Hist., Yale Univ., Bull. 5, pp. 1-138, pls. 1-34, text figs.

————————, 1951. Brachiopods of the Henryhouse formation (Silurian) of Oklahoma: Jour. Paleontology, vol. 25, pp. 69-96, pls. 15-20.

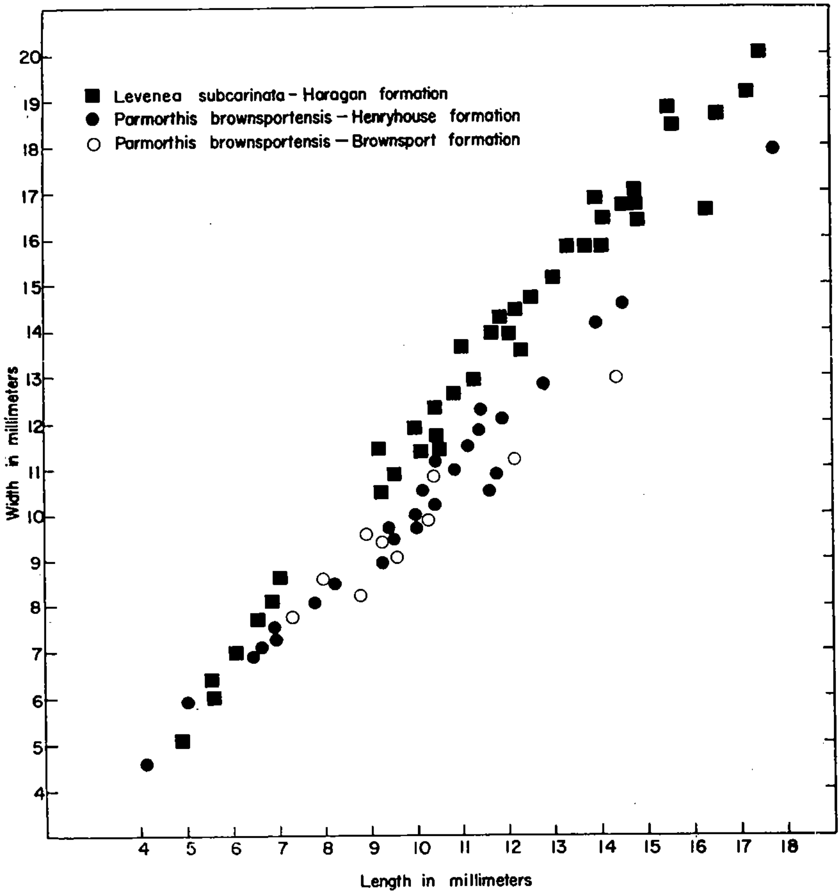

Figure 3. Graph showing the length-width relationship (circles), and the length-thickness relationship (triangles) of **Isorthis arcuaria** (Hall and Clarke). The circles are plotted from the base (length) and the left-hand side (width); the triangles from the base (length) and the right-hand side (thickness). Specimens from the Henryhouse formation of Oklahoma are indicated with solid circles and triangles, and those from the Brownsport formation of western Tennessee are in open circles and triangles.

Hall, J., 1857. Description of Palaeozoic fossils: New York State Cabinet Nat. Hist., 10th Ann. Rept., pp. 41-186, text figs.

Hall, J., and Clarke, J. M., 1892 (1893). An introduction to the study of the genera of Palaeozoic Brachiopods: Paleontology New York, vol. 8, pt. 1, pp. 1-367, pls. 1-20, text figs.

Maxwell, R. A., 1936. The stratigraphy and areal distribution of the "Hunton formation", Oklahoma. Northwestern University, Ph. D. dissertation, pp. 1-115, illustrations.

Reeds, C. A., 1911. The Hunton formation of Oklahoma: American Jour. Sci., vol. 182, pp. 256-268.

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Schuchert, C., and Cooper, G. A., 1932. Brachiopod genera of the suborders Orthoidea and Pentameroidea: Peabody Mus. Nat. Hist., Yale Univ., Memoir vol. 4, pt. 1, pp. 1-270, pls. 1-29, text figs.

COAL BEDS OF OKLAHOMA VIRGILIAN AND WOLFCAMPIAN ROCKS

by Carl C. Branson

Most of us think of the Dawson coal of the Seminole formation as the highest coal bed in the Paleozoic of Oklahoma. Malcolm C. Oakes has shown the presence of the Cedar Bluff coal and the Thayer coal in Missourian rocks of Oklahoma (Okla. Geol. Survey, Bull. 62). In 1921, the U. S. Geological Survey geologists noted a coal seam above the Iatan (?) limestone in Township 29 North, Osage Co. (Bull. 686, p. 330), but found no other coal beds.

All of Osage County has been remapped geologically by field geologists of the Oklahoma Geological Survey, W. F. Tanner, Clark Taylor, David Vosburg, James Carter, Patrick Shannon, Orville Russell, Henry Fisher, Joseph Carl, William Gardner, and David Bryant. They have found several coal seams, none commercial, but all stratigraphically useful. These and other coal seams have been found by Paul Greig in Pawnee County, by Eugene Nakayama and Antonio Fenoglio in Payne County, and by Alvin West and Kenneth Masters in Lincoln County. The Oklahoma coals of the Virgilian and Wolfcampian rocks are shown in the table.

TABLE SHOWING COAL SEAMS OF OKLAHOMA VIRGILIAN AND WOLFCAMPIAN ROCKS

Wolfcampian		Long Creek ls. mem.
	Foraker limestone	Hughes Creek mem., contains coal bed in Lincoln and Payne Cos.
		Americus ls. mem., contains coal bed in Osage Co.
	Hamlin shale	contains coaly shale in Osage Co.
	Five Point limestone	
	West Branch shale	(local coal in Kansas)
	Falls City limestone	
	Hawxby shale	(local coal in Kansas)

	Brownville limestone	
	Pony Creek shale	contains Ralston coal in Osage and Pawnee Cos.
	Caneyville limestone	
	French Creek shale	contains Lorton coal in Payne Co.
	Jim Creek limestone	
	Friedrich shale	contains coal in Osage Co.
	Grandhaven limestone	
	Dry shale	(local coal in Kansas)
	Dover limestone	
	Willard-Langdon shale	contains coal in Osage Co.
		Elmont ls. mem.
Virgilian series	Emporia limestone	Harveyville sh. mem., contains coal in Osage Co.
		Reading ls. mem.
	Auburn shale	contains coal in Osage Co.
	Wakarusa limestone	
	Soldier Creek shale	contains coal in Osage and Payne Cos.
	Rulo limestone	
	Cedarvale shale	contains Elmo coal in Osage Co.
	Bird Creek limestone	
	shale	contains Nodaway coal in Osage Co.
	Turkey Run limestone	
	Calhoun shale	contains coal in Pawnee Co.
	Deer Creek limestone	
	Lecompton limestone	
	Kanwaka shale	(local coal in Kansas)
	Oread limestone	
	Douglas group	(several coal beds in Kansas)

The coal beds enable the geologist to trace associated limestone beds and to identify non-marine cyclic units in the shale-limestone section. They are useful in helping to identify marker beds in geologic mapping and in interpreting the geologic history of the region.