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

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JOHN T. LONSDALE, Director

Report of Investigations—No. 13

Boundary of the Pennsylvanian and Permian (?) in the Subsurface Scurry Reef, Scurry County, Texas

By

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Prepared in co-operation with the United States
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Appendix

1. 1990

2. 1991

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BOUNDARY OF THE PENNSYLVANIAN AND PERMIAN(?) IN THE SUBSURFACE SCURRY REEF, SCURRY COUNTY, TEXAS*

W. A. Heck,¹ K. A. Yenne,¹ and L. G. Henbest²

ABSTRACT

The subsurface sedimentary complex that comprises the Scurry reef and the overlying terrigenous clastic unit in Scurry County, Texas, were formerly regarded as of Canyon and Cisco Pennsylvanian age. Core samples from depths of 6,804 to 6,828 feet in the Wilshire Oil Company's No. 8 Lunsford well reveal the presence of *Triticites pinguis*? Dunbar and Skinner, *Schwagerina longissimoidea* (Beede), and "*Schwagerina*" *compacta* (White), which indicate early Wolfcamp Permian(?) age. *Triticites pinguis*? continues downward in limestone to a depth of approximately 6,875 feet, and since this form, so far as known, is also restricted to rocks of early Wolfcamp age, the stratigraphic unit is classed as Wolfcamp. The overlying black shales are therefore at least as young as Wolfcamp.

The fusulinids in the limestone immediately below the 6,875-foot level indicate Canyon (Missouri) age. If beds of Cisco age are present in this well, they could not be recognized by their fauna.

INTRODUCTION

The limestone complex that comprises the subsurface Scurry reef of Scurry County in west-central Texas was formerly regarded as of Canyon Pennsylvanian age. Recently, paleontologists of the U. S. Geological Survey, working cooperatively with the Bureau of Economic Geology, The University of Texas, discovered fusulinid faunas of Wolfcamp age in core samples from the reef complex. The faunas indicated that a revision downward of 1,000 to 1,500 feet was required for the Pennsylvanian and Permian(?) boundary. Early work on the fusulinid faunas of the Scurry reef indicated that in at least part of the reef complex, rocks of Cisco age are missing, or are very thin, and that the rocks of Wolfcamp age lie directly on or close above

rocks of Canyon age. These conclusions were announced in the Bulletin of the American Association of Petroleum Geologists (Heck *et al.*, 1952). The purpose of this preliminary paper is to describe the evidence that led to these conclusions and to describe the later evidence that has made some revisions necessary.

The Scurry reef (fig. 1) is located in the western part of Scurry County and is the southeastern segment of an arcuate chain of subsurface reefs that Adams and others (1951) have called the "Horseshoe atoll." This group of reefs extends from Kent County on the north clockwise through Scurry and Borden counties on the south, northwest to Terry County, and then north to Hockley County. The ends of the "horseshoe" lie south of the southern flanks of the Matador arch, an east-west subsurface ridge lying just south of the Texas Panhandle. The eastern part of the atoll, including the Scurry reef, fringes the western edge of the Eastern Platform, as the limits of that feature are considered by some geologists. Adams and others (1951), however, show that the boundary between the Eastern Platform and the Midland basin lay to the east during Pennsylvanian time in Fisher and Nolan counties and that the atoll therefore lay entirely within the Midland basin.

The term reef, as defined by some authors, may not be correctly applied to the Scurry limestone mass, as it apparently does not contain abundant recognizable remains of frame-building and sediment-holding organisms. It is possible, however, that the sediment-holding organisms may have been blue-green algae, which would leave few distinctive remains in the limestone. Much of the limestone of the Scurry reef that was cored contains zones and abundant irregular blobs of dense rock that may be of algal origin. Much of it also contains small, ellipsoidal bodies and banded, tubular-shaped, irregular structures most likely of algal origin. As there is a strong possibility that much of the limestone of the Scurry reef and adjoining masses was

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precipitated by algae, and, as algae are definitely known to be a common origin of reef rocks (Wilson, 1950), the reservoir rock of the Scurry oil field is spoken of here as a reef.

In general, reefs of the "Horseshoe atoll" came into existence in early Pennsylvanian (Strawn) time and reached their maximum development during Canyon time; some reefs continued growing as late as early Wolfcamp time.

and 4,350 feet below sea level (fig. 2). This subsurface terrace or plateau has an irregular surface that contains closed depressions and many 400- to 500-foot-high pinnacles. Figure 3, a profile of the Scurry reef, shows the gentle slope of the flanks of the reef and the depressions and pinnacles of the plateau.

The rocks of the Scurry reef are clastic limestones chiefly of organic origin. They range from limestone breccias and lime

FIG. 1. Map of major structural features of west-central Texas.

The Scurry reef is approximately 30 miles long and 10 miles wide and is the largest reef of the atoll. Its flanks rise approximately 400 feet from the bottom of the Midland basin upward to a broad, irregular terrace that lies between 4,200

sands to dense limestones (calcirudites, calcarenites, and calcilutites, respectively; as classified by Pettijohn (1949, pp. 300-307)). Much of the rock consists of an accumulation of organic debris, chiefly of crinoids and fusulinids.

Overlying the reef are thick, dark gray to black, more or less silty shales, containing a few minor lenses of clastic limestone. The shales are overlain by beds of sandstone, limestone, shale, dolomite, and anhydrite of Permian and Triassic age. Surface rocks include beds of Cretaceous to late Tertiary age.

THE AGE OF THE SCURRY REEF AND THE OVERLYING BLACK SHALES

Heretofore fusulinids of Canyon age only have been recovered from the limestone cores taken from the Scurry reef. The black shales overlying the reef mass are sparsely fossiliferous, but Wolfcamp fossils were reported from the variable rock sequence above the black shales. From this evidence, geologists have considered the Scurry reef to be contemporaneous with the Canyon group and the overlying shales to be contemporaneous with the Cisco (Van Sieten, 1950). However, in the Wilshire Oil Company's No. 8 Lunsford well, section 253, block 97, H. & T. C. survey, cores of reef limestone from depths of 6,804 to 6,828 feet contain fusulinids of Wolfcamp Permian(?) age. At least six fusulinid species are present. They are *Triticites koschmanni* Skinner (1931, p. 20), *T. pinguis?* Dunbar and Skinner (1937, p. 620), *T. ventricosus* (Meek and Hayden) var., *Triticites* sp., *Schwagerina longissimoides* (Beede), Dunbar and Condra (1927, p. 114), *S. longissimoides*(?), and "*Schwagerina*" *compacta* (White), Dunbar and Skinner (1937, pp. 645-646). In the following discussion of the stratigraphic significance of these fusulinids, additional information on the genera may be obtained in Dunbar and Skinner (1931 and 1936) and in Thompson (1948).

Triticites koschmanni Skinner was originally described from the Neva limestone in central northern Oklahoma. The specimen here illustrated (Pl. I) agrees closely with the axial section illustrated by Skinner. Large species of *Triticites* that have thin keriotheca, prominently developed epitheca, and numerous volutions are found in great numbers in the Council Grove group as defined by the Kansas Geological Survey in northern Oklahoma and southern Kansas. These occur in many variations related to *T. koschmanni* Skinner, *T. tumidus* Skinner (1931, p. 21), and *T.*

obesus (Beede and Kniker), Dunbar and Condra (1927, p. 102). The species identified as *T. pinguis?*, or a closely similar form, is also found in the subsurface of western Kansas in sediments that are correlated with the Council Grove group. This species resembles and might be confused with *T. plummeri* Dunbar and Condra (1927, p. 98) from the Graham formation of the Cisco group of central Texas, but the specimens in the reef fauna appear to represent the stratigraphically younger form.

The specimens of *Schwagerina longissimoides* (Beede and Kniker) in this fauna seem to fall within the range of variants of this species that characterize the Neva limestone and perhaps also the Foraker limestone, Council Grove group as defined by the Kansas Geological Survey. These specimens apparently represent a slightly earlier stage of evolution than the average of the representatives so far observed from Kansas.

"*Schwagerina*" *compacta* (White), found at 6,804 feet, represents a stage of evolution in the generic stock of *Dunbarinella* that corresponds morphologically and chronologically to the evolutionary stage of *Schwagerina* ss. from the stock of *Triticites*. Recent discoveries indicate, however, that a similar if not identical species appears in the uppermost part of the Cisco group in central Texas. Accordingly the age significance of "*Schwagerina*" *compacta* (White), above, must be tentatively modified.

No fusulinid specimens were found in the samples from depths 6,804 to 6,827 feet in the No. 8 Lunsford well that would signify an age earlier than early Wolfcamp. A number of immature or fragmentary specimens and haphazard sections were encountered that are unidentifiable, but none contradicted the evidence from the species that are listed above. This assemblage of fusulinids seems definitely to represent the zone in which the latest species of *Triticites* and the earlier, but perhaps not the earliest, species of *Schwagerina* overlap in stratigraphic range.

Below 6,827 feet to a depth of 6,875 feet, only 43 percent of the cores were recovered in the No. 8 Lunsford well. The fusulinids obtained from this interval, *Triticites pinguis?* (Dunbar and Skinner) and *Triticites* aff. *T. ventricosus* Dunbar

FIG. 2. Generalized subsurface contour map of the top of the Scurry reef.

Fig. 3. Profile of reef along A-A' of figure 2. Vertical exaggeration is x6.

and Condra, are also Wolfcamp in age. Immediately below 6,875 feet, fusulinids of definite Canyon age were found. The contact between the Wolfcamp and older rocks falls within that interval from which no cores were recovered. Both the resistivity curve and the self-potential curve of the electric log (fig. 4) show a prominent break at approximately 6,870 feet, and this point is arbitrarily chosen as a boundary.

Later work by geologists of the U. S. Geological Survey on other cores of the Scurry reef indicates that reef rock of Cisco age is widespread and relatively thick. These Cisco rocks are commonly calcirudites containing much Canyon debris with abundant fusulinids. Also scattered throughout are the rarer, more ventricose fusulinids of Cisco age. Because of their abundance, fusulinids of Canyon age are more commonly recovered from these rocks than those of Cisco age, and consequently these rocks were at first believed to be of Canyon age. This situation may apply to the section below 6,875 feet in the No. 8 Lunsford well. The fusulinids immediately below 6,875 feet are of Canyon age but at 6,916 feet are ventricose forms that may be of Cisco age. Accordingly, although it was originally thought that rocks of Cisco age were absent or very thin in the No. 8 Lunsford well, on the basis of more detailed work on these cores, it is more probable that these rocks are of considerable thickness and contain abundant debris of Canyon age. In any case, at least part of the reef is of Wolfcamp age, and all the overlying black shales must be Wolfcamp. Because interfingering organic limestones and shales are relatively rare along the fringes of the reef, it is probable that the shales of Wolfcamp age extend a considerable distance down the flanks of the reef.

LITHOLOGY AND PALEONTOLOGY OF THE REEF ROCK AND OVERLYING BLACK SHALES

The No. 8 Lunsford well penetrates black shale from 5,265 to 6,792 feet, with the exception of approximately 100 feet of argillaceous limestone below a depth of about 5,900 feet. From 6,792 to 6,825 feet, the well penetrates shales and thin beds of alternating limestone and shale. The lime-

stone is solid below 6,825 feet and extends to the total depth of the well, 6,950 feet.

The shales overlying the reef are carbonaceous, slightly limy, hard and fissile. They are dark gray to black, depending on the content of material of silt size, the silt being generally lighter in color than the shale and in thin varve-like layers. Slickensides are common in the shales, and bitumen and fusain are found in small masses and layers. There are traces of sphalerite. Pyrite is abundant as nodules and rare as replaced fossil shells. The fossils are types commonly found in black-shale faunas: conodonts, inarticulate brachiopods such as *Lingula*, and fish scales. There are also abundant plant spores and some cordaitan leaves.

The limestones are clastic, consisting chiefly of lime breccia and lime sand, with thin zones of dense limestone. The limestones are quite pure, with generally less than 1 percent magnesium. They are composed of poorly sorted fragments of organic debris and fragments of limestone chiefly of organic origin. Chert is rare. Although the varied nature of the clastic particles of the limestones suggests detrital accumulation, there is no evidence suggesting that the particles have been transferred far. Fragments of the breccia are usually less than half an inch in length, but some fragments as much as 3 inches in length are found in a matrix of smaller particles. The lithology of these limestones (fig. 5) is typical of reef rock. As much as 80 percent of the clastic grains and phenoclasts are composed of organic remains. Crinoids are the most abundant of the definitely identifiable organic remains; but the filamentous, rounded, and crenulated particles considered to be algal are almost as abundant as the crinoids. Foraminifera, including the fusulinids, are next in abundance to crinoids and algae, and the remaining organisms found in the reef rock constitute but a minor part of the fauna.

The core from the No. 8 Lunsford well reveals no consistent lithologic criteria by which limestone beds of Pennsylvanian and Wolfcamp age can be differentiated in the reef complex. Limestones above the Pennsylvanian-Wolfcamp boundary are apparently identical in lithology with those below, and the contact is one of apparent

FIG. 4. Electric log and microlog of the Wilshire Oil Company's No. 8 Lunsford well, Scurry County, Texas.

Explanation of Figure 5

LITHOLOGIC DESCRIPTION OF CORE

1. Shale. Silty; carbonaceous; slightly limy; dark gray to black; massive; well-indurated; occasional slickensides; bitumen and pyrite very common; pyritized shells rare; traces of sphalerite and fusain; typical black-shale fauna of conodonts, inarticulate brachiopods, and fish scales; occasional cordaitan leaves.
2. Limestone. Argillaceous; unfossiliferous.
3. Limestone. Calcirudite; argillaceous; dark brownish gray; sugary siliceous dolomite cement; occasional phenoclasts; fragments poorly sorted and angular; organic debris (mostly crinoidal) constitutes 50 percent of rock; occasional large productid brachiopods.
4. Limestone. Calcarenite; dark brownish gray, very coarse grained, well-cemented, poorly sorted; 80 percent of rock is crinoidal debris; algal (?) debris increases toward base.
5. Limestone. Calcarenite with occasional calcirudite layers; slightly argillaceous, pale yellowish brown to brownish gray, very fine to coarse grained, well-cemented; siliceous cement common; phenoclasts, as much as $1\frac{1}{2}$ inches in diameter, have sutured boundaries that indicate solution; occasional streaks and lenses of siltstone, crinoid fragments, angular and much abraded, constitute 65 percent of rock.
6. Limestone. Calcarenite and occasional calcirudite layers; dark brownish gray, fine to very coarse grained, well-cemented; clear calcite cement common, secondary silica abundant; phenoclasts, with sutured boundaries, as much as 1 inch long; poorly sorted comminuted organic debris constitutes more than 75 percent of rock; composition of organic debris is roughly 50 percent crinoids, 30 percent algae (?), and 20 percent sponge spicules and foraminifers.
7. Limestone. Calcirudite; brownish gray to olive-gray; traces of siliceous cement and dolomitic cement; phenoclasts of varied textures, as much as 3 inches long; 80 percent of rock is organic debris; occasional fusulinids and bryozoans; brachiopods rare.
8. Limestone. Calcarenite; light olive-gray to dark brownish gray, very fine to coarse grained, well-cemented; 70 percent of rock is algal (?) debris in filamentous, ellipsoidal, and irregular fragments; fusulinids common.
9. Limestone. Calcirudite and calcarenite; yellow-brown; 50 percent of rock very coarse to granule-sized crinoidal fragments in matrix of very fine to fine-grained calcarenites; numerous vugs as much as 1 mm. in diameter; fusulinids common, slightly leached. Units 8 and 9, totalling 17 feet in length, occupy uncertain position in core between depths of 6,828 and 6,875 feet but are placed above unit 10 because lithology resembles that of units in core above.
10. Incomplete core. Scattered specimens; fine-grained calcarenite to calcirudite; argillaceous; dark brownish gray; well-cemented, occasionally with clear calcite cement; algal (?) and crinoidal debris abundant.
11. Limestone. Calcarenite; brownish gray, fine to medium grained; calcilutite cement near top, in which abundant white "algal tubules" are suspended; many arcuate and irregular calcite-filled fissures; extremely vuggy in some zones; occasional stylolites; debris appears mostly algal, but fusulinids are also common.

FIG. 5. Lithology of the reef limestones and overlying shales in the Wilshire Oil Company's No. 8 Lunsford well.

conformity. Changes in size of clastic particles, cementation, and type of organic debris are many and abrupt, both in areal and stratigraphic extent, and preclude correlations on a lithologic basis.

DEPOSITIONAL HISTORY

Reef-building organisms are extremely sensitive to their environment, and growth is not equal at all places over a reef surface. Accordingly, the depositional history of a reef complex, as understood from the evidence furnished by any one well or by scattered wells, is obviously inferential and somewhat tenuous. Nevertheless, on the basis of the available evidence from the No. 8 Lunsford and neighboring wells, a few conclusions can be drawn as to the history of the Scurry reef. These conclusions are:

1. In Canyon time, growth of the Scurry reef was continuous, and a maximum thickness of reef rock accumulated, indicating optimum conditions for reef growth.

2. No unconformities are apparent above or below the rocks of Canyon age, indicating that the environment at this time was relatively stable.

3. Growth of the Scurry reef continued uninterrupted into early Cisco time.

4. The absence of fusulinids of late Cisco age in the No. 8 Lunsford and neighboring wells shows that if any reef rock accumulated on the Scurry reef in late Cisco time, it accumulated only in scattered localities. A change of the water level relative to the reef could have permitted erosion of some parts of the reef and possible growth of other parts at the same time.

5. In early Wolfcamp time, growth was again limited to small isolated areas on the reef. Most of the reef was submerged below the growth zone, although some erosion took place at higher elevations. During this time the accumulation of black shale began.

CONCLUSIONS

Fusulinid determinations made from cores of the Wilshire Oil Company's No. 8 Lunsford well show that the Pennsylvanian-Permian(?) boundary lies within the body of the Scurry reef complex. This boundary requires that the black shales overlying the reef complex in Scurry County be assigned to the Wolfcamp series. The exclusion of approximately 1,000 feet of black shale from the Pennsylvanian supports the "starved Pennsylvanian Midland basin" theory of Adams and others (1951).

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PLATE I

Fusulinidae from the Wilshire Oil Company's No. 8 Lunsford well, Scurry County, Texas

Schwagerina longissimoidea (Beede and Kniker).

1. Axial section tangential to the proloculus. Immature specimen? Chomata disappear by third volution. From a depth of 6,814 feet. U.S.N.M. no. 123240.
 - 5, 6. Equatorial section showing the highly and irregularly arched vaults of the spiral wall of each chamber, the irregularity of septal plication and septal spacing, and the small departures from spiral growth that are characteristic of early species of *Schwagerina*. From a depth of 6,815 feet. U.S.N.M. no. 123241. Figure 6, x30.
 8. Axial section, slightly eccentric, showing septal loops that resemble chomata. A close study shows that chomata are definitely recognizable in the first volution of the proloculus but are not definitely distinguishable thereafter. From a depth of 6,817 feet. U.S.N.M. no. 123242.
- In another specimen from a depth of 6,814 feet, not illustrated, obscure and irregularly deposited chomata were recognizable to the fourth volution. Such variation from specimen to specimen is not unusual in early forms of *Schwagerina*.
- 10, 11. Axial section. From a depth of 6,814 feet. U.S.N.M. no. 123243. Figure 11, x30.

Schwagerina compacta (White).

2. Oblique axial section. From a depth of 6,804 feet. U.S.N.M. no. 123244. The exact age significance of this form is in doubt because this, or closely similar, species ranges from rocks of uppermost Cisco age into rocks of Wolfcamp age and is more commonly found in the latter.

Triticites pinguis? Dunbar and Skinner.

- 3, 4. Axial section of an immature or eroded specimen. From a depth of 6,826 feet. U.S.N.M. no. 123245. Figure 3 part of specimen in figure 4, x30.
7. Axial section. From a depth of 6,826 feet. U.S.N.M. no. 123246.

Triticites koschmanni Skinner.

9. Only a part of the axial section is illustrated. This specimen is well within the morphologic range of the species at its type locality in the Neva limestone of northern Oklahoma. From a depth of 6,806 feet. U.S.N.M. no. 123247.

(Magnification x10 unless otherwise indicated).

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