

**MISSISSIPPIAN STRATIGRAPHY IN SOUTHERN KANSAS AND NORTHERN
OKLAHOMA, BASED ON CONODONT FAUNA**

by

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Fort Worth Division
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February 29, 1963

Re: Fort Worth Division
Geological Report No. 96

Mississippian Stratigraphy in
Southern Kansas and Northern
Oklahoma, Based on Conodont
Fauna

Dr. Garvin L. Taylor
Building - 8th Floor

Dear Sir:

SUMMARY

This study is an example of the importance of a time-stratigraphic framework in a carbonate series to permit comprehensive age correlation between different rock facies. It shows how scattered paleontological control can be used along with lithologic and electric log data to develop a useful time-stratigraphic framework.

With additional subsurface paleontological control, a similar framework can be developed in the Hardeman Basin of North Texas and the Texas-Oklahoma Panhandle where a comparable "Mississippi Solid" rock sequence occurs. A small amount of paleontological control in these areas indicates that much of the pre-Chester Mississippian rocks is Meramec (St. Louis in age).

The occurrence of high energy carbonates in both the Meramec and Osage indicates the need for facies-isopach-oil occurrence maps of the Mississippian "Solid" section. A better understanding of the relationship of the "Chat" developments at the Middle Mississippian unconformity is needed.

CONCLUSIONS

1. The early interpretation of age correlations of Osage and Meramec lithologic units in Kansas with formations in the classic (Mississippian River) section is grossly correct.
2. The southward transition of shelf-type carbonates of Osage age to basin facies rocks from Western Kansas into Northwestern Oklahoma is valid.
3. The dark siliceous basin facies rocks in Oklahoma, which are productive in large areas west of the Nemaha Ridge, are not time-correlatives of the Osage Basin facies in Southwestern Kansas as previously thought. They are basin facies equivalents of shelf-type carbonates of Meramec age (mostly St. Louis) in Northwestern Oklahoma and Southern Kansas.
4. The "Mayes-Sycamore" facies which occurs in the subsurface of most of Central Oklahoma and outcrops in the Arbuckle Mountain area, although faunally barren, appears to be Meramec in age (St. Louis). The overlying Mississippian Caney shales are Chester in age (Markham Ferry of Northeast Oklahoma outcrops) based on paleontology and lithology. The underlying beds where sampled contain a Kinderhook fauna according to Gil Klapper.
5. One unconformity is conspicuous within the "Mississippi Solid"

section. It occurs in pre-St. Louis time and is apparent both in the Northeastern Oklahoma outcrops and in the subsurface west of the Nemaha Ridge. It is shown by the pinch out of Warsaw-Salem and Osage rocks from west to east approaching the Nemaha Ridge and also by variations in thickness of Bayou-Manard (St. Louis) rocks in Northeast Oklahoma outcrops.

6. Tripolitic chert beds ("Chat") can occur anywhere in the section from Osage thru Meramec and are not necessarily limited in occurrence at the pre-Pennsylvanian unconformity. Also, they may not always be a product of weathering because in some places they appear to be a form of deposition.
7. Porosity and permeability traps are more important than structural closure in the accumulation of oil and gas in Mississippian rocks.

INTRODUCTION

The purpose of this report is to combine subsurface sample and electric log control with the time framework from paleontological zonation presented in Research Report M57-G-34. A biostratigraphic correlation of pre-Chester Mississippian rocks, frequently called "Mississippi Solid", in Oklahoma should provide a sounder basis for interpreting the geological history of these rocks and consequently aid in future exploration for oil and gas accumulations in these formations.

Age determinations of faunas collected in surface sampling from outcrops in Northeastern Oklahoma, Northwestern Arkansas, and Arbuckle Mountain areas, from continuous cores of pre-Chester Mississippian from four wells in Northwestern Oklahoma, and scattered conodont control from a number of well cores in Southern Kansas have been presented in Research Department Reports No. M65-G-34 by Klapper and Ciriacks, No. M65-G-36 by Klapper, No. M65-G-47 by Ciriacks and Klapper, and No. M65-G-26 by Alan B. Shaw.

Illustrations prepared to accompany this report consist of four cross sections and one map. The cross sections extend (1) from Garfield County to Wagner County, Oklahoma, in two segments; (2) from Comanche County, Kansas, to Garfield County, Oklahoma; (3) from Garfield County, Oklahoma, to Sedgwick County, Kansas; and (4) from Ochiltree County, Texas, to Garfield County, Oklahoma, in two segments. The map covers Southern Kansas, Northern Oklahoma and part of the Texas Panhandle. It shows the distribution of major Mississippian stratigraphic units and rock facies, location of the cross sections, and some of the more important producing areas from "Mississippi Solid" rocks.

DISCUSSION

Previous reports in our files dealing with correlations in pre-Chester Mississippian rocks date back to about 1942. These correlations were based on lithologic units traceable over wide areas in Kansas and Oklahoma. Paleontological control was not available for developing a time-stratigraphic relationship between the different facies of Mississippian rocks in these states.

The development of large productive areas in a basin facies of pre-Chester Mississippian rocks in Kingfisher and Garfield Counties, Oklahoma, in recent years initiated extensive stratigraphic studies in an effort to explain this unusual occurrence of oil and gas. During this investigation, Research Department paleontological studies found usable fossils for age determinations in cores from several Pan American wells west of the Nemaha Ridge in Oklahoma. These wells were the No. 1 Smith Unit "F" Section 23-18N-10W, the No. 1 York Section 13-18N-9W, the

No. 2-D Barnes Section 23-22N-16W, and the No. 1 Lowenhaupt Section 34-25N-5W. Zonation of conodonts obtained from these cores has provided a more comprehensive biostratigraphic interpretation of "Mississippi Solid" rocks. (See Research Department Reports M65-G-26, M65-G-34, and M65-G-47.)

In Research Report No. M67-G-34, Ciriacks and Salk discuss the biostratigraphic relationship between the wells west of the Nemaha Ridge with subsurface control in Northeastern Oklahoma and the outcrop sequence in the Western Ozark Uplift.

This report, then, is a continuation of the biostratigraphic relations found east of Nemaha Ridge into the subsurface of the Anadarko Basin to the west and the Central Kansas Uplift to the north.

The conodont fauna indicates that much of the Mississippian in North-Central and Northeastern Oklahoma is St. Louis (Meramec) in age rather than Osage which necessitates a marked revision of stratigraphic relationships in Northern Oklahoma and Southern Kansas.

A series of cross sections radiate from the Pan American No. 1 Lowenhaupt (Section 35-25N-5W). The Pan American #1 Lowenhaupt contained an excellent conodont fauna and is a key well in the establishment of correlations west of the Nemaha Ridge with the surface and subsurface to the east. The central terminal well in these cross sections is the Oliphant No. 2 Hoover which was used rather than the No. 1 Lowenhaupt because of excellent lithological control from well cuttings. These two wells are only about a mile apart and show good electric log correlation.

Cross Section I

Correlations established by faunal control in the outcrop area and the subsurface of Northeastern Oklahoma are carried into the subsurface west of Nemaha Ridge by this section.

The section is in two parts with the eastern part showing sample and electric log correlations from 17N-18E to 18N-10E. In Research Report M67-G-34 it was shown that Mississippian previously called Osage is actually Meramec in age. This new correlation is carried eastward and tied with the east half of the section.

It should be noted that the only Osage rocks of Cross Section I are thin erosional remnants starting at the Leader Oil Co. #1 Vernon, T18N-R8E, and continuing eastward.

The old correlation of the Osage is shown by a solid red line, and a comparison shows that all of the previously called Osage rocks are actually Meramec in age from the Oliphant #1 Hoover eastward to the Leader #1 Vernon.

Cross Section II

This is a northwest-southeast section from Comanche County, Kansas, to Garfield County, Oklahoma. The key wells with faunal control are the Sinclair #1 Exchange Bank on the northwest end of the section and the Oliphant #1 Hoover on the southeast. On the basis of the stratigraphic position of a lithographic limestone known to be Meramec in age in the Oliphant well and lithologic characteristics of the Warsaw (L. Meramec), the Warsaw and Osage are interpreted as thinning southeastward by truncation and non-deposition. The basinal facies of the Meramec is overlapping the Osage and Warsaw and appears to be truncated in Woods County, Oklahoma, by the pre-Pennsylvanian unconformity.

The conodont fauna in the Sinclair well confirms the earlier correlation of the basin facies rocks in Southwestern Kansas called "Cowley" as a siltstone equivalent of the Keokuk-Burlington cherty

carbonates farther north. (Central Division Geological Report No. 4, 1961) This correlation can be traced southward into Oklahoma to the Sunray No. 1 Well in Ellis County, Oklahoma, without difficulty. The Sunray well is the westernmost subsurface control in Oklahoma on Cross Section No. 4 where these basin facies rocks correlate with the faunally barren rocks below Warsaw in the No. 2-D Barnes.

Cross Section III

This section from Garfield County, Oklahoma, to Sedgwick County, Kansas, is a south to north section with some conodont zonation. The section shows the change from basin facies rocks in Southern Kansas to shelf facies northward during both Osage and Meramec time. The pinch out of Warsaw beds and thinning of Osage southward is also apparent.

At the north end of the cross section, a red shaly crinoidal limestone facies occurs in lower Osage. It is frequently encountered in the area extending from this well to Pratt County and Barber County, Kansas, and again on the west flank of the Central Kansas Uplift in Kiowa County, Kansas. These red beds disappear in the subsurface as the section thins to the south, probably in part by transition to green-gray shales and by non-deposition.

Cross Section IV

Cross Section IV is a west to east section in two parts extending from Ochiltree County, Texas, thru Pan American No. 2-D Barnes and No. 1 Lowenhaupt to Oliphant No. 2 Hoover in Garfield County, Oklahoma. It shows our old interpretation of stratigraphy based on lithologic and electric log control as compared to our new correlations using conodont zonation in the No. 2-D Barnes and the No. 1 Lowenhaupt. Note that the old and new correlations correspond from extreme Western Oklahoma into the Texas Panhandle but diverge eastward toward the Nemaha Ridge. The correlation of the thick basin facies rocks in the western part of the area correlate very well to the north with the basin facies of Osage in Southwestern Kansas called "Cowley" facies. However, eastward basin facies rocks similar in lithology to these Osage rocks occur interbedded with shelf-type carbonates. These shelf-type carbonates show an almost complete transition to basin facies approaching the Nemaha Ridge. It was formerly assumed that the interbeds of high energy rocks were shoal deposits during Osage time. Conodont zonation in the No. 2-D Barnes and the No. 1 Lowenhaupt indicate that the interbedding of shoal and basin facies rocks between these two wells occurred during Meramec time. Not only do these Meramecian rocks show complete transition to basin facies eastward, but they show a pinching out of lower Meramec (Warsaw) to the east. This pinch out of Warsaw beds appears to be the result of non-deposition on a post-Osage unconformity which probably truncates eastward the non-fossiliferous pre-Warsaw basin facies rocks found in the No. 2-D Barnes. These non-fossiliferous pre-Warsaw beds correlate lithologically and by electric log to the west and north with basin facies Osage.

The western part of Cross Section IV which extends west-east across Ochiltree and Lipscomb Counties, Texas, is based entirely on electric log control. There is no conodont control available from this area, but commercial sample logs indicate that the gross lithology is comparable respectively to Western Oklahoma for the basin facies of Osage and to Southwestern Kansas and the Oklahoma Panhandle for the shelf facies. The Meramecian rocks are mostly a shelf facies that correlates very well lithologically and mechanically with adjacent areas in Oklahoma and Kansas.

Distribution Map

The network of cross sections presented in this report provides a starting point for future correlations of the Mississippian. It is beyond the scope of this work to construct isopach and facies maps of

the various Mississippian formats; however, a distribution map has been compiled from various sources to show known limits of different facies and age groups in Oklahoma and Kansas along with pertinent production information and porosity indications.

Reef-like buildups of high energy porous limestones are known east of the Nemaha Ridge. These appear to be within the St. Louis basinal facies, but they also may be associated with a St. Louis hinge line (see Cross Section I) and may be shelf-edge high energy rocks of good reservoir quality that are more extensive than is presently believed. This needs a more detailed study of facies relationships.

Another unusual development of porous reef-like limestone occurs in a well in Section 19-27N-12W, Alfalfa County, Oklahoma. The porous interval is approximately 160 feet thick and appears to be Osage in age.

"Chat", which is the name commonly applied to any porous chalky or tripolitic chert found in Mississippian rocks in Kansas and Northern Oklahoma, is generally considered to be a residual product of weathered cherty limestones at the pre-Pennsylvanian erosional unconformity. This is particularly true in subcrop areas of Kansas around the Central Kansas Uplift. However, in Northwestern Grant and Northern Alfalfa Counties and South-Central Kansas chalky white chert beds commonly occur below Warsaw limestones. These rocks are similar in texture and appearance to beds underlying the Keokuk in the outcrops in Northeastern Oklahoma which are Reads Spring (Osage) in age. These chalky chert beds may indicate either primary deposition or weathering by exposure in pre-Warsaw time. Most of the production from Mississippian rocks flanking the Central Kansas Uplift is related to permeability traps in this type of reservoir.

The large productive area in Kingfisher and Garfield Counties, Oklahoma, is from fractured basin facies rocks of St. Louis age rather than Osage. These rocks consist of calcareous, siliceous, cherty dark siltstones which locally develop some intergranular porosity in the more silty areas. The lithology of these rocks was discussed in detail in Oklahoma City District Geological Report No. 225 (1965) by Thompson. All of this production is related to porosity and permeability traps in a fracture system probably related to movement along the Nemaha Ridge. Other than age determination, this study adds nothing to the understanding of this type of production.

Important Lithological Features

Several lithological features are distinctive in Mississippian rocks. The most usable of these for stratigraphic control is a gray to tan and brown lithographic limestone zone near the base of the St. Louis which is widely traceable in North-Central Oklahoma. It occurs where St. Louis is predominately a basin facies and is best developed in Grant and Garfield Counties. This zone is shown in all the cross sections and constitutes a valuable zone marker in or near the base of the St. Louis.

A zone of glauconitic shale and siltstone frequently occurs near the base of the Mississippian, usually at the unconformable contact with Kinderhook or older rocks. It has no age significance because it can occur in Chester, St. Louis, or Osage rocks, whichever is in contact with the unconformity. The lithology of this zone is so distinct that it looks the same in well cuttings regardless of the age of the rocks in which it is found.

Yours very truly,

E. L. Selk *EL Selk*

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