[PS]Characterization of Kinderhookian and Osagean Strata of Northeast Oklahoma*

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Abstract

Mississippian strata of the midcontinent are prolific hydrocarbon reservoirs but the Lower Mississippian carbonates prove challenging to geologists working the play. The main focus of this work is to characterize the Lower Mississippian section of northeast Oklahoma, while also determining their spatial distribution in the subsurface. In order to accomplish this, the stratigraphic position of these rocks in the subsurface must be determined. A broad description of lithology and porosity is intended for the study area, while also determining the distribution and depositional environments of this Lower Mississippian section. The study area is located in northeast Oklahoma on the geologic province known as the Cherokee Platform and is situated on the southwest flank of the Ozark Dome. This area was located between 10-15 degrees south of the equator, on a shallow water carbonate platform known as the Burlington Shelf during early Mississippian time. This thesis will encompass 8 Oklahoma counties in northeastern Oklahoma from T29N to T17N and R1E to R17E. Thorough investigation will be carried out through methods such as subsurface geologic mapping, well log correlation, Formation Micro- Imager (FMI) log interpretation, core descriptions, outcrop studies, and geospatial analysis. The results of this work will better provide an insight to the depositional environment, spatial distribution, stratigraphic position, and reservoir properties of Lower Mississippian strata in the subsurface of northeast Oklahoma. The product of this work will further the understanding of Mississippian strata in the subsurface of the midcontinent and help constrain the deposition of the Mississippian section in northeast Oklahoma.

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Characterization of Kinderhookian and Osagean Strata of Northeast Oklahoma

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Abstract

Mississippian strata of the midcontinent are prolific hydrocarbon reservoirs but the Lower Mississippian carbonates prove challenging to geologists working the play. This work characterizes Lower Mississippian strata, which are Kinderhookian and Osagean in age, in the subsurface of northeast Oklahoma. This was accomplished by determining the stratigraphic position of these units in wireline log. A broad description of lithology and porosity was achieved for the study area, as well as the interpretation of depositional environments of the Lower Mississippian section. The study area is located in northeast Oklahoma on the geologic province known as the Cherokee Platform and is situated on the southwest flank of the Ozark dome. This area was located between 10-15 degrees south of the equator, on a shallow water carbonate platform known as the Burlington Shelf during early to middle Mississippian time. This work encompasses 9 Oklahoma counties in northeastern Oklahoma from T29N to T17N and R1E to R17E. Thorough investigation was carried out through methods such as subsurface geologic mapping, well log correlation, Formation Micro-Imager (FMI) log interpretation, core description , outcrop studies, and geospatial analysis. The results of this work will better provide an insight to the depositional environment, spatial distribution, stratigraphic position, and reservoir properties of Kinderhookian and Osagean strata in the subsurface of northeast Oklahoma. The product of this work will further the understanding of Mississippian strata in the subsurface of the midcontinent and help constrain the deposition of the Lower Mississippian section in northeast Oklahoma.

Study Area

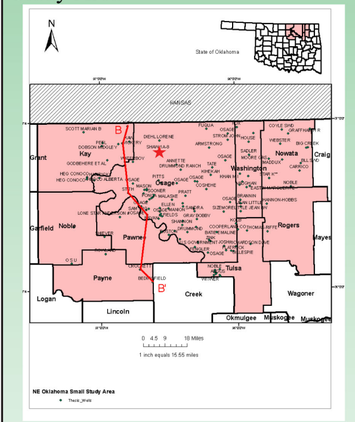


Figure 1. Map of study area (highlighted in red) showing 130 wells with both raster and digital logs. Mississippian rocks outcrop to the east of the study area in northeastern Oklahoma, northwestern Arkansas, and southeastern Kansas. North to south cross section (B-B') is depicted by the red line and is shown by Figure 26. Type log shown by the Shaw 1-8 well in Figure 4.

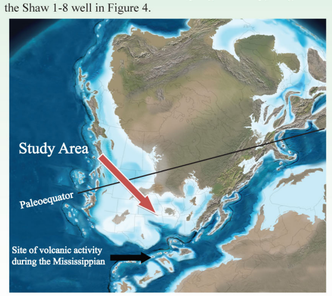
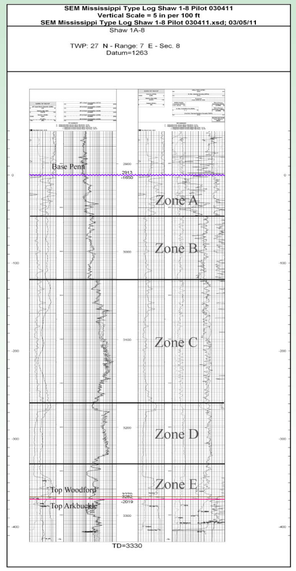


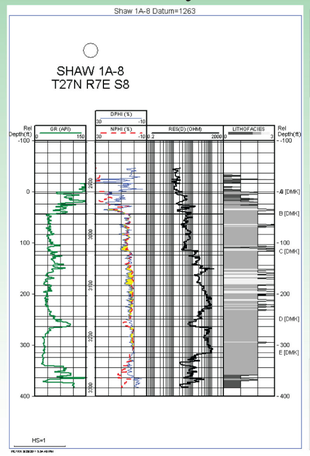
Figure 2. Paleogeographic location of the study area during the Missippian (after Blakey 2005). The location of the paleoequator is from Gutschick and Sandberg (1983).

Figure 3. (left) Informal subsurface nomenclature in the study area. (Modified from Rogers, 2001).

Figure 4. (below) Type log for Mississippian section in NE Oklahoma. This is the Shaw 1A-8 well (Sec. 8, T27N, R7E, Osage County, Oklahoma). Type log location show in Figure 1 by the red star. Subdivision of the Mississippian section indicated by Zones A-E.



Neutron-Density Cross Plots



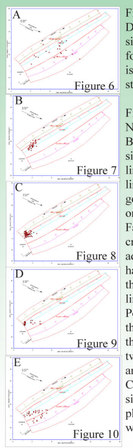


Figure 5. Digitized log of the Lower Mississippian section showing the tops for zones A, B, C, D, and E. This is the Shaw 1A-8 (type log) for the study area.

Figures 6-10. Neutron-density plots for zones A, B, C, D, and E of the Lower Mississippian section. Pure lithology lines are plotted for dolomite, limestone, and chert. Facies polygons are outlined by red polygons on the neutron-density cross plots. Facies polygons were used in the creation of the Facies log in the adjacent type log. Three facies have been determined from the lithology plot; dolomitic limestone, limestone, and cherty limestone. Porosity is also interpreted from the neutron-density cross plot. Lithology varies considerably between each zone. Porosity values are considerably low in Zones B, C, and D, due to an increase in the silica content of the rock. Cross plots were created in PETRA workstation.

N-S Cross Section

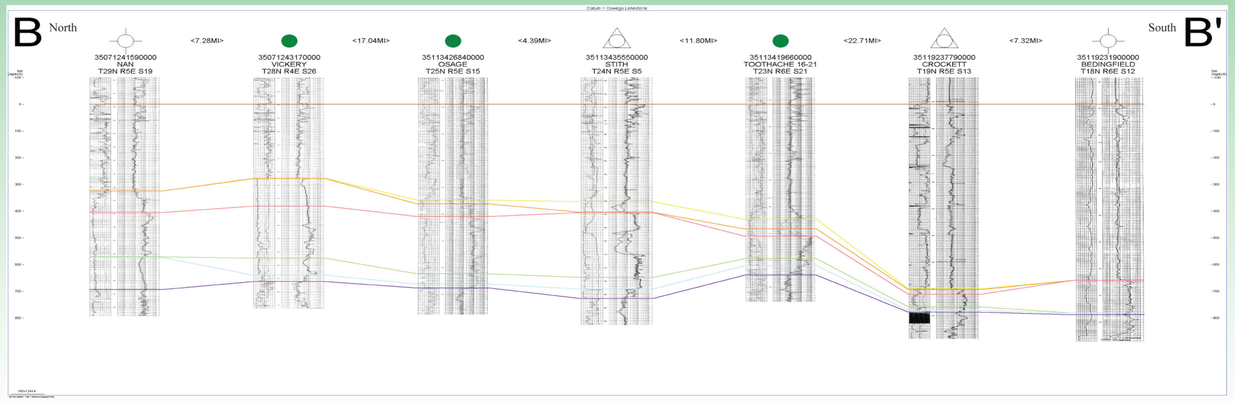


Figure 26. Stratigraphic cross section B-B' trending north-south through the study area (see Figure 1 for cross section line). The selected datum for flattening is the Pennsylvanian Oswego Limestone (brown line). The purple line represents the Chattanooga/Woodford Shale. The Mississippian section can be seen here subdivided into 5 zones. Overall, a general pattern of thinning of the Lower Mississippian carbonate section is seen to the south. General thinning in the southern direction is evidence of tectonic uplift during this time and is suggestive of a paleo-topographic high, according to Mazzullo and others (2011). Carbonate platform development is seen to be both aggradational in the lower zones (E and D) and progradational in the upper zones (C and B).

Reservoir Characteristics

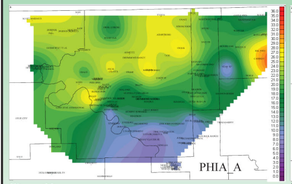


Figure 11

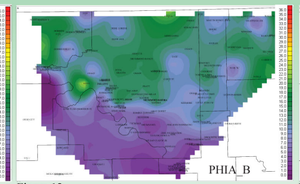


Figure 12

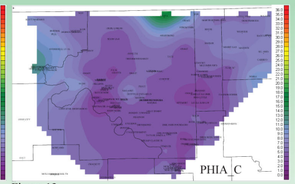


Figure 13

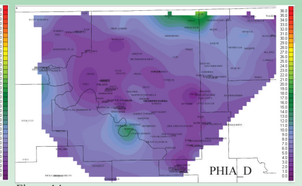


Figure 14

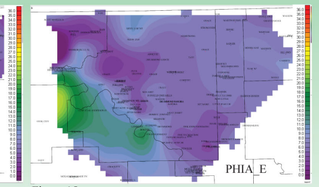


Figure 15

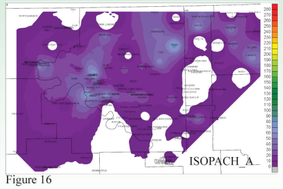


Figure 16

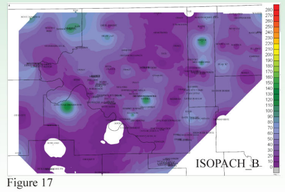


Figure 17

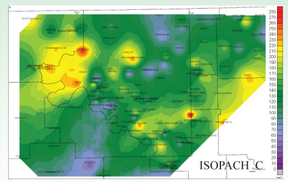


Figure 18

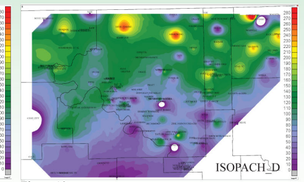


Figure 19

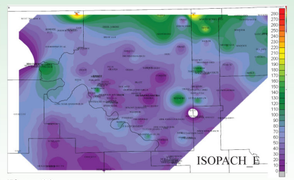


Figure 20

Figures 11-20. Reservoir characteristic maps showing average porosity (PHIA) and average thickness of zones A, B, C, D, and E for the Lower Mississippian section. The average porosity values are expressed in percent porosity and the average thicknesses are expressed in feet. Maps were created in the PETRA workstation. Zones A and B have considerable areas of high porosity. Note the decrease in porosity in Zone C (highly siliceous interval).

Silica Analysis

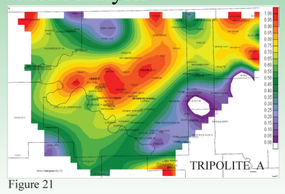


Figure 21

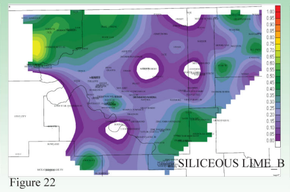


Figure 22

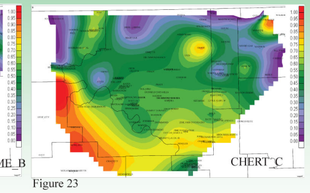


Figure 23

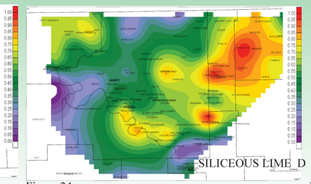


Figure 24

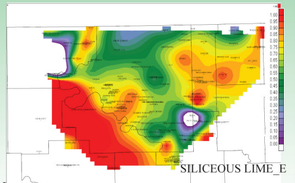
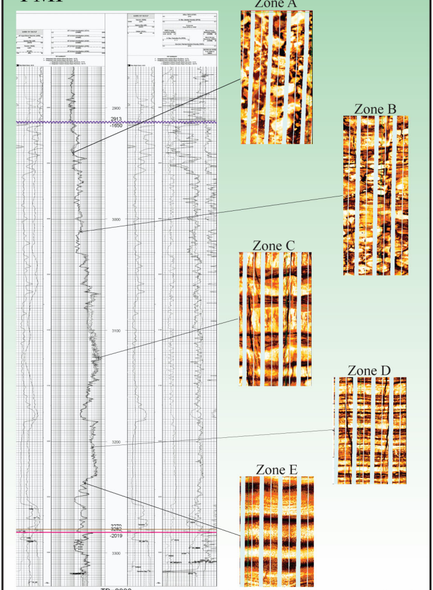


Figure 25

Figures 21-25. Silica analysis of Zones A-E for the lower Mississippian carbonate section. The most abundant silica type within each zone is indicated in the figures above. The three most common types of silica represented in the lower Mississippian section are: tripolite, siliceous lime, and chert. The scale represented in each figure represents the percent silica type for the stated silica in the bottom right hand corner of each figure. Notice that the siliceous lime and chert content increases to the south of the study area.

FMI



FMI logs courtesy of Spyglass Energy Group, Tulsa, OK

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