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Mississippian (Osagean) Shallow-water, Mid-latitude Siliceous Sponge Spicule and Heterozoan Carbonate Facies: An Example from Kansas with Implications for Regional Controls and Distribution of Potential Reservoir Facies

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Abstract

Mixtures of biosiliceous and heterozoan-dominated carbonate deposits are commonly interpreted as recording cold-water polar or deep basinal conditions. However, a growing body of literature is documenting examples from the rock record that show these deposits accumulated in shallow-water middle- to low-latitude environments. The continued recognition of ancient neritic heterozoan carbonate and biosiliceous accumulations is broadening our understanding of the various paleoenvironmental controls on their development.

Early-Middle Mississippian time was characterized by the development of biosiliceous and carbonate accumulations in North America. This study focuses on Osagean cherty dolomitic strata in cores from the Schaben field in Kansas, which is located in Ness County on the southwest flank of the Central Kansas uplift (CKU). During the Osagean, Kansas was located at approximately 20° S latitude, within the tropical to subtropical latitudinal belt. Study area strata are characterized by shallow-water inner-shelf carbonates that were deposited on a gently southward-sloping shelf (ramp). Two depositional sequences (DS1 and DS2) are identified in cores and are separated by a sequence boundary (SB1) that evidences subaerial exposure. The primary facies in the two depositional sequences include 1) Mudstone-Wackestone (MW); 2) Sponge Spicule-Rich Wackestone-Packstone (SWP); 3) Echinoderm-Rich Wackestone-Packstone-Grainstone (EWPG); and 4) Dolomitic Siltstones and Shale facies. Other features identified in cores include 1) Silica Cementation and Replacement; 2) Silica Replaced Evaporites; 3) Brecciation and Fracturing; and 4) Calcite Cementation and Replacement.

The abundance of echinoderm facies with other diverse fauna, evidence of extensive reworking by burrowing organisms, and only rare occurrence of evaporites suggest subtidal deposition in a normal to slightly restricted marine inner-shelf setting for DS1. After the SB1 subaerial exposure event, marine conditions returned but the depositional environment over the study area changed compared to that for much of DS1 deposition. The volumetric increase of sponge-spicule wackestone and packstone (SWP) with less diverse fauna, abundance of early evaporites (replaced by silica), and evidence for shallowest water to subaerially exposed conditions throughout DS2 suggest deposition in more restricted environments that likely ranged from restricted inner shelf/protected embayment to evaporative lagoon and possibly supratidal flat.

One of the more significant characteristics in DS2 is the dominance of siliceous sponge spicule facies and heterozoan carbonates that were deposited in shallow-water and restricted environments. This study and others from numerous periods in the geologic record are indicating that shallow-marine, mid-latitude biosiliceous and heterozoan carbonates may be more common than previously thought. Especially interesting are the examples from Mississippian (Osagean-Meramecian) strata in North America that show similar facies associations with DS2 strata of this study.

The predominance of Early-Middle Mississippian heterozoan carbonate and biosiliceous (spiculitic) deposits, and lack of

photozoan deposits, in the mid-latitude shallow-shelf setting in Kansas and surrounding areas was likely due to abundant nutrients and dissolved silica derived from basinal and/or terrestrial sources. Based on available evidence, upwelling of basinal waters rich in nutrients and dissolved silica appears to have been a primary control on shelf margin and shelf facies. Upwelling even may have had a primary imprint on shallow-water, inner-shelf areas, especially during transgression(s). Nutrients and dissolved silica from terrestrial sources may have contributed to the facies associations in shallowest water, inner-shelf areas. However, the available evidence suggests that terrestrial sourced nutrients and dissolved silica were not the dominant control.

The results of this study have implications from a petroleum reservoir standpoint. The DS2 sponge spicule, heterozoan carbonate, and silica-replaced evaporite facies in this study form reservoirs in Schaben field and another nearby field composed of similar facies. Because regional upwelling is likely to have had at least some control, facies similar to DS2 strata may form important reservoirs in Lower-Middle Mississippian strata that were deposited in shallow-water inner shelf/ramp settings elsewhere in Kansas and North America.

Continuing studies of the controls on biosiliceous and heterozoan carbonate deposition and diagenesis in mid-latitude neritic settings will improve our understanding and predictive capabilities.

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