Controls on Mississippian (Osagean) Inner Ramp Heterozoan Carbonate & Biosiliceous Deposits in a Midcontinent Setting

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SUBSURFACE APPLICATION: The specific rocks of this proposed study form reservoir systems in the midcontinent. These types of rocks also form Mississippian reservoirs in other North America locations such as the Williston Basin.

STATUS: Ongoing research; several projects complete and results reported to sponsors

FUNDING: Seeking sponsors

Purpose
Osagean-Meramecian time was characterized by extensive development of biosiliceous and carbonate accumulations in some areas of North America (Lowe, 1975; Gutnick and Sandberg, 1983). During this time a low-latitude, shallow tropical sea covered most of the southern North American continent. In low-latitude, tropical systems, shallow-water carbonate facies would be expected to contain abundant Photozoan Association components. Importantly, photozoan components are notably absent in low-latitude Osagean ramp settings in the Midcontinent, including inner ramp settings. Instead the facies are dominated by Heterozoan Association carbonates and siliceous sponge-spicule facies. The system of interest forms the Mississippian lime play. Most work has focused on ramp-margin areas, whereas inner-ramp areas remain less studied. Not only are inner ramp areas important in that they are reservoir targets, but these areas are important for understanding controls on the entire ramp system. An initial study of the Schaben field in Ness County, an inner ramp location that produces from sponge spicule-rich facies, suggested regional upwelling as a major control for the dominance of heterozoan and biosiliceous facies across the ramp system (Franseen, 2006). Additional study of inner ramp areas is important for further evaluation of upwelling as a control. Distinguishing between regional and local controls on facies types and distribution on the entire ramp system can provide predictive capabilities for exploration and exploitation of unconventional and conventional reservoirs.

Project Description
Paleogeographic studies place Kansas at about 20° S latitude (Fig. 1). Osagean deposition in the region was characterized by carbonate and biosiliceous facies that were deposited on a gently sloping ramp to the south, with the ramp edge bordering the Anadarko basin located near the Kansas-Oklahoma border. Previous detailed studies of Osagean strata in Kansas have focused on shelf-margin areas where thick accumulations of sponge-rich chert deposits occur (informally termed “chat”) and form significant reservoir facies known as the Mississippian Lime Play (e.g. Montgomery et al., 1998). Osagean strata in Kansas are cherty, partially dolomitized skeletal (especially crinoidal) packstone and grainstone and cherty, partially dolomitized and argillaceous wackestones and mudstone (Watney et al., 2001; Franseen, 2006). Inner ramp areas are characterized by siliceous sponge-dominated wackestones and packstones (with and without evaporites) and echinoderm/bryozoan packstones and grainstones.

Several hypotheses are proposed if regional upwelling and sea level are dominant controls: 1)
expect less biosiliceous deposits and redistributed silica away from upwelling areas, and grainstone-packstones as a dominant reservoir facies. 2) Relative sea-level history may play a major role for reservoir facies distribution. Transgressions can facilitate upwelling water reaching inner ramp areas (Lowe, 1975) thereby promoting biosiliceous facies in those locations. Regressions may result in less, or no upwelling and less or no silica across the ramp. Under these conditions, photozoan facies may be more abundant, including ramp-margin areas.

Subsurface well logs, cores, structural data, and literature examples will be analyzed for facies distribution in inner ramp locations near proposed upwelling areas along basin margins, as well as locations away from proposed upwelling areas. A sequence stratigraphic framework of inner ramp locations will be constructed by integrating core and subsurface well log data. This framework will be integrated with existing sequence stratigraphic frameworks for ramp margin and basin areas to identify significant relative sea-level fluctuations. Facies types and distribution tied to sea-level rises and falls will be examined to determine if hypothesized rises result in abundant biosiliceous facies in inner ramp areas, and sea-level falls result in less biosiliceous facies in inner ramp areas, and if any photozoan components are present.

**Deliverables**

The outcome of this study will provide a better understanding of depositional environment and distribution of inner ramp lithofacies, and determining how sea-level changes, and other regional controls, such as upwelling, affect nature and distribution of reservoir facies. Paleogeographic maps showing inner ramp facies types and distribution in the continental U.S. will be created. Detailed cross sections depicting the sequence stratigraphic framework will be constructed to illustrate geometries and determine sea-level effects on facies. The results of this study will contribute to a better prediction of facies distributions to delineate areas of additional conventional and unconventional gas reservoirs in inner ramp areas in detail, and across the entire ramp system in general.

**References**


Figure 1. Paleogeographic map of Kansas and schematic inner ramp to ramp margin cross section.