AAPG HEDBERG CONFERENCE
"*MICROBIAL CARBONATE RESERVOIR CHARACTERIZATION*"
June 4-8, 2012 – Houston, Texas

Microbially Influenced Waulsortian Mounds in the Lower Mississippian (Tournasian) Lodgepole Formation, Dickinson Field Complex, Williston Basin, North Dakota

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Lower Mississippian (Kinderhookian, Tournasian) Waulsortian mounds are well known from the Lodgepole Formation of the Williston basin and Montana trough (Cotter, 1996; Smith, 1972 a, b; Stone, 1972; Wilson, 1975; Winfrey, 1983; Elrick and Read, 1991; Young et al., 1998).

In the Dickinson field complex, mounds are classified as Type 1 Early Carboniferous buildups (*sensu* Bridges et al., 1995) and consist mainly of fenestrate bryozoan cementstones (with radiaxial calcite being common) and peloidal muds. Skeletal wackestones, packstones, and grainstones are common as interbeds. Less common skeletal components include crinoids, ostracods, forams, and sponge spicules. Centimeter-scale stromatactis vugs that may contribute significantly to total reservoir porosity are characteristic of the mounds. The stromatactis cavities contain radiaxial calcite linings (commonly on fenestrate bryozoan sheets), geopetal peloids, cavity-dwelling microfossils that are absent from coeval, level-bottom beds, and internally resedimented peloids of multiple origins.

The mounds do not exhibit classic microbial structures such as stromatolitic or thrombolitic forms. The microbial signature within the mounds is in the form of small peloids that commonly form a clotted texture and are endemic to the mounds, in contrast to larger peloids found locally within the mounds and in coeval, off-mound sediments

Mounds in the Williston Basin and in outcrop at Swimming Woman Canyon, Montana exhibit normal Mississippian carbon isotopic signatures and mound fossils exhibit high species richness and moderate dominance and are not chemoautotrophic. They are usually disarticulated, but are not aligned by currents. The mounds appear to have grown below wave base, and neither shallowing-upward trends nor evidence of subaerial exposure have been recognized in the mound succession.

In the Dickinson field complex, the mounds are located within the oldest two of three 3rd-order (2+ My each) sequences that compose the Lodgepole Formation in the Williston Basin.

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*Deceased

The Lodgepole in this area ranges upwards of 300m in thickness and forms part of the transgressive phase of the 16 My Madison Group 2nd-order sequence. The two 3rd-order sequences comprise 9 to10 ramp-dominated, 4th-order (400 Ky) sequences. Mound complexes can be identified on 3D seismic data using four seismic criteria, but 4th-order sequences are too thin to be seismically imaged. Consequently, detailed well-log correlations are necessary to identify the sequence hierarchy of the Lodgepole in the subsurface.

The Dickinson mounds appear to have nucleated on a subtle paleohigh that was situated some 80 km basinward of the toe-of-slope, unlike other mounds in the Williston basin which grew within a few kms of the toe-of-slope. An individual Dickinson area mound is typically 100 m thick. As inferred from seismic data, the smallest mounds, which are 800 m in diameter, coalesced to form circular and loaf-shaped complexes as large as 2300 m by 7500 m.

Porosity within the mounds is dominated by fractures and diagenetically enhanced depositional porosity that includes stromatactis vugs and interparticle porosity in grainstones. Fractures appear to have formed in response to slope failure during deposition, differential compaction in and around mounds, and tectonic stresses. Average porosity in the mounds is 5%, and reservoir permeability ranges from approximately 200 to 2000 md.

Waulsortian mounds and closely associated facies in the Dickinson field complex contained approximately 104 MMBOOIP when the field was discovered in 1993 and have produced 54 MMBO and 37 BCFG through February 2012.

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