High Frequency Cyclicity, Facies and Deposition of Condensed Zones in the Fayetteville Shale (Miss) – An Outcrop to Subsurface Perspective*

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Abstract

Exploration for unconventional gas in the Fayetteville Shale of north Arkansas takes place just a few 10's of miles structurally downdip and down the paleo-depositional slope from the outcrop belt of the Fayetteville Shale and overlying Pitkin Limestone (Mississippian-Chesterian age). The succession was deposited in an E-W trending ramp bordering the southern margin of Laurussia. Surface to subsurface transects utilizing outcrops, cores and well-logs are key to documenting the stratigraphic architecture and facies belts from the inner to outer ramp system, where organic-rich, condensed zones are the exploration targets in the subsurface. Stacking patterns indicate that the lower Fayetteville Shale deepens upward above the Moorefield-Batesville lowstand wedge to a condensed zone at 328.3 Ma in starved outer-ramp setting. The condensed zone consists of several high-frequency cycles of organic-rich shale and calcareous shale. These cycles are the distal downlapping toesets of progradational, highstand deposits, which are present ~10 miles updip as inner-middle ramp wackestones-grainstones and outer ramp calcareous shales. The condensed zone cycles range from 15-30 ft thick. Each begins with transgressive, fining-upward, thin storm beds and starved ripples followed by organic-rich high GR shale, which represent maximum sediment starvation and organic preservation. The regressive hemicycle coarsens upward with starved ripples followed by thin storm beds to an erosional surface. These cycles are variously composed of transported fossil debris, mud clasts, phosphatic grains, siliciclastic silt, biogenic silica, clay and organic matter. The thickness and composition of laminasets and bedsets in each hemicycle are controlled by sediment input (siliciclastic, carbonate, biogenic silica) and depositional site (proximal-distal and axial or marginal). All of these factors are critically important for identifying target zones and locations for drilling and reservoir stimulation.

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