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High-Resolution Stratigraphy and Structure of an Unusual Woodford Outcrop, Arbuckle Mountains, Oklahoma

Caleb Bontempi[1] and Roger M. Slatt[1]

[1]University of Oklahoma, Norman, OK, USA (Caleb.p.bontempi-1@ou.edu)

Abstract

Detailed facies analysis and high-resolution sequence stratigraphy of the Devonian Woodford Shale were investigated at a previously undescribed outcrop in the Arbuckle Mountains, Oklahoma, which contains a complete stratigraphic section of the Woodford with associated bounding unconformities at the top of the Hunton Limestone and base of the Sycamore Limestone. This outcrop is unusual in that the upper Woodford is highly deformed, containing numerous tight folds, abundant fractures, and significant intraformational faulting. Intense deformation is likely the combined result of early slumping and regional Arbuckle tectonism. The unconformity at the top of the Woodford is marked by a well-developed paleosol, previously undocumented in other outcrops.

The Woodford Shale has been interpreted to have been deposited over an approximately 29 my time interval, making it a second order depositional sequence (Serna-Bernal, 2013). Measurement of thin individual bed thicknesses, coupled with an outcrop gamma ray log, reveal a repetitive set of higher frequency thinning- and thickening-upward sequences that can be confidently correlated to the chemostratigraphic trends seen in the nearby Hunton Anticline Quarry Outcrop “B”. Based on spectral analysis, these sequences probably represent 3rd, 4th, and 5th order cycles superimposed onto the larger 2nd order eustatic cycle. Such higher order cyclicity is consistent with Milankovitch-scale cycles, containing 10-40 ky and 100 ky periodicities, while larger order cycles (~28 my) are interpreted to represent fluctuations in sea floor spreading rate and global tectonism.

Additionally, bed-thickness data were explored for their use in detailed stratigraphic interpretations. Bed thickness data can provide additional insight into the depositional trends of cyclically interbedded formations, like the Woodford Shale, and have the potential to be applied in other areas such as detailed basin modeling, geomechanical modeling, cyclostratigraphy, etc. Although gathered in the field for this study, bed-thickness data are not unique to outcrop- or core-based measurements. By generating a conceptual model, it is shown here that thickness data can be obtained from FMI logs, a tool that is routinely made available in place of core. By integrating FMI-derived measurements into the suite of standard tools used for characterization, the interpreter gains a more precise and robust interpretation of the reservoir of interest.