Critical Evaluation of Pennsylvanian Cyclicity in the Anadarko Basin: A Probabilistic Model of High Frequency Eustasy in a High Accommodation Setting

Mark W. Jensen[1] and Jack C. Pashin[1]

[1]Oklahoma State University

ABSTRACT

Pennsylvanian cyclothems have been studied in detail in the eastern interior of the United States, but few researchers have applied quantitative stratigraphic analysis to test the concept. The Anadarko Basin contains a thick Pennsylvanian section that provides an opportunity to assess stratal order in the Pennsylvanian sedimentary record. Detailed lithologic logs and stratigraphic cross sections of the Middle and Late Pennsylvanian section were constructed, and statistical analyses were performed, including Markov chain and recurrence-frequency analysis. Order was evaluated at four observational and interpretive levels: rock type, lithofacies, depositional environment, and sequence stratigraphy.

Shale forms rhythmic associations with all other rock types, and although lithologic successions are nonrandom, no evidence of cyclicity was found. Similar results were obtained for lithofacies and depositional environment. The highest degree of stratal order is at the sequence stratigraphic level. Probabilistic control of succession is related to the areal extent of individual rock types, lithofacies, and depositional environments. For example, widespread depositional environments, such as shelf, prodelta, and delta front, have higher successional predictability than heterogeneous channel, interchannel, and carbonate deposits. Evidence for cyclicity emerged only at the sequence stratigraphic level of interpretation, which is the level linked directly to sea level change. But even this cyclicity has a clear stochastic component.

Geochronologic analysis indicates that glacial eustasy in the short eccentricity band controlled lithologic ordering, sequence architecture, and cyclicity, while accelerating subsidence driven by the Wichita Orogeny was the dominant mechanism of sediment accommodation. Comparison with Pleistocene-Recent climate and sea level records helps explain the stratigraphic patterns observed in the Anadarko Basin, including depositional heterogeneity and the probabilistic nature of the sedimentary succession.