An Integrated Sedimentology, Geochemistry and Well Log Approach to Sequence Stratigraphy in Shale Formations

Nicholas B. Harris, Dept. of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada
nharris@ualberta.ca

GeoConvention 2012:Vision

Summary

A detailed core- and log-based analysis of the Upper Devonian Woodford Shale, Permian Basin, identifies two orders of sea level cycles: (1) a second order sea level fall with a duration of approximately 15 m.y.; and (2) superimposed third order cycles of shorter duration. The second order sea level fall, approximately 70 meters based on eustatic curves, resulted in increasing restriction of the basin with time; this is manifested by increased biogenic silica in the upper part of the formation. The third order cycles are manifested by bundles of carbonate turbidite beds, deposited during high stands, and by spikes in total organic carbon (TOC) that mark either transgressive or high stand systems tracts.

The sea level cycles are important to shale reservoir analysis and performance. They provide a rigorous basis for correlation of reservoir elements, both at field and regional scales. Moreover, the second order upward increase in biogenic silica exerts a strong influence on rock mechanical properties and behavior of the formation during hydraulic fracturing, with the Upper Woodford being significantly more brittle and easier to fracture. Organic carbon content varies at both second and third order scales, important both to gas generation and storage.

Key elements of the analysis were: core description for identification of third order cycles (characterizing depositional facies, including thin non-shale beds); major element geochemistry for second order cycles (large scale changes in mineralogy), minor and trace element geochemistry for second and third order cycles (evidence of basin restriction) and for regionally correlative redox events, radiometric age dating to obtain a fit to the global eustatic sea level curve, and log interpretation for characterizing mechanical properties, organic carbon content and a correlation framework.

Acknowledgements

This study has been supported by contributors to the Colorado School of Mines Woodford Shales Consortium, including: ConocoPhillips, Chesapeake, Devon, Encana Oil and Gas (U.S.A.), EOG Resources, Newfield Exploration, Petro-Hunt, Pioneer Natural Resources, and Whiting Petroleum. Pioneer, Chesapeake, EOG, Petro-Hunt and Whiting contributed cores to the study.

References

Larry, S. M., Curly, H., and Moe, W. W., 1955, Prestidigitation, strabismic filtering and ocular violations in the San Andreas strike slip fault zone: Geophysics, **24**, 338-342.