Woodford Shale and the Evaporite Connection – The Significance of Aridity and Hypersalinity in Organic Matter Productivity and Preservation and Unconventional Reservoir Property Enhancement

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ABSTRACT

Woodford Shale (Givetian to Kinderhookian) in the southern Midcontinent is a prolific hydrocarbon source rock and an unconventional reservoir for both natural gas and crude oil. Woodford sediments were deposited in epeiric seas that developed along a passive continental margin during a period of global marine transgression. Episodes of hypersalinity during deposition are documented by anhydrite, quartz pseudomorphic after anhydrite, and length-slow chalcedony, all of which are found in burrows and syneresis cracks. In addition, low rainfall and arid climate are indicated by the absence of coarse grained clastics, lack of deltas and fans, and paucity of terrestrially derived organic matter. Penecontemporaneous, fine-grained dolomite is common and consistent with local shallow-water, hypersaline settings within the epeiric seas. Aridity and the resulting high rate of evaporation created a negative water balance and promoted the net flow of upwelled, nutrient-rich ocean water into the basin, thus supporting high biologic productivity in surface water. Dense, hypersaline brine accumulating in the lower part of the water column enhanced density stratification, thus severely restricting vertical circulation and promoting widespread bottom stagnation and organic matter preservation. Recognizing that aridity and hypersalinity were major influences on water circulation, nutrient supply, and water density stratification leads to the conclusion that both were major controls on the high organic carbon content and the resulting enormous resource potential of Woodford Shale. Persistent marine upwelling along the west-facing Devonian continental margin gave rise to widespread deposition of biogenic silica and the resulting brittle, organic-rich, cherty lithofacies represents the optimum unconventional target in Woodford Shale.