geoconvention
Virtual Event
September 21-23
2020
CSPG • CSEG • CWLS • GAC • MAC • IAH

Widespread pedogenesis of early Mississippian carbonate sand bodies

Abstract

The Frobisher Beds of southeastern Saskatchewan are part of an extensive conventional oil and gas play hosted in grainy carbonate rocks, long interpreted as marine oolites. This sedimentological and diagenetic study of core from the Frobisher in the Bryant and Pinto areas of southeastern Saskatchewan concludes that the ubiquitous coated grains in these rocks are in fact predominantly pedogenically modified rather than purely marine in origin. Areally, Frobisher grainstones form elongate finger-like carbonate sand bodies, persistently supratidal, separated by interpreted marine channel deposits. These shoals consist of numerous stacked shallowing-upward, cyclical deposits composed of peloids, coated grains and compound grains. Unmodified true marine ooids are a minor component. Units within paleochannels consist of allochems of open marine origin and lack the cyclicity seen in shoal units. The Frobisher succession consists of six facies: 1) Fenestral Peloid Wackestone-Packstone, 2) Peloid Coated Grain Packstone-Floatstone, 3) Coated Grainstone-Rudstone, 4) Multiple Crust Complex, 5) Argillaceous Mudstone/Wackestone,and 6) Skeletal Packstone-Grainstone/Rudstone with variable oolite. Facies 1 to 5 are found within shoal units, whereas Facies 6 occurs only in the channel deposits. Grains within Facies 2 and 3 display shrinkage cracks, inverse grading and irregular coatings, features which are common indicators of pedogenesis in a vadose environment. Mudstones of Facies 5 and complex crust horizons in Facies 4 suggest that the shoal was subject to early diagenetic alteration in an arid subaerial environment. In contrast, Facies 6 contains broken and abraded open marine allochems (bryozoans, crinoids, coral fragments and foraminifera) interpreted to have been deposited and transported in marine channels. Coated grain lithoclasts within the channel deposits suggest active erosion of the finger-like shoals, whereas well ordered ooids-pisoids on the shoals may have originated in the marine channels. These observations demonstrate that there is an alternative interpretation to the published subtidal ooid sand shoal model. In this revised interpretation each shoal cycle shallows up from a thin marine or restricted peritidal facies at the base to grainstones and rudstones of coated grains and complex carbonate crusts, interpreted as a paleo calcrete. Such pedogenic alteration is characteristic of an arid climate and occurred during base level falls which exposed the shoals, and occasionally the intervening channels.