SMALL-SCALE SHALLOWING-UPWARD CYCLES OF THE PENNSYLVANIAN WAHOO LIMESTONE, A MEANS OF DETAILED CORRELATION??

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The Pennsylvanian upper Wahoo Formation formed as an ooid shoal complex comprised of numerous shallowing-upward cycles which are analogous to similar lithologic cycles in major hydrocarbon reservoirs at Prudhoe Bay. Biostratigraphic and lithologic correlation of these widespread, laterally persistent cycles provide an excellent means of subdividing the unit to understand its paleogeography and internal structure. A number of paraconformities occur within the sequence as indicated by heterogeneous grainstone lag deposits and diagenetic evidence. These paraconformities provide a means of subdividing the upper Wahoo Formation into smaller packages that can e further subdivided into a number of shallowing-upward cycles.

Based upon microfacies analysis, the shallowing-upward cycles provide a means of developing an understanding of facies relationships and allow us to interpret the succession of depositional environments using Walther's Law. The bases of cycles are locally marked by heterogeneous grainstones that seem to represent transgressive lag deposits. Also forming the lowest parts of a cycle, dark-colored shales or argillaceous limestones have been used to subdivide the Wahoo Formation in the Lisburne field (both in core and on electric logs). Unfortunately, these shales are poorly exposed in outcrop but seem to represent offshore muds deposited during the initial stages of rapid transgressions before carbonate sedimentation became well established (short-term drowning events). Upsection, skeletal wackestones and packstones contain a normal marine fauna including delicate fenestrate bryozoans and articulated pelmatazoans (crinoids and other echinoderms) that formed below wave-base. Skeletal material becomes increasingly abraded and micritized upsection and grainstone becomes the dominant lithology. In cycles capped by oolitic grainstone, superficial ooids first occur as coatings on abraded fossil fragments in skeletal grainstones and ooids become more well developed upsection. In the upper part of the upper Wahoo Formation, lithologic cycles are capped by peloidal packstone and spiculitic mudstone that formed in restricted lagoonal environments which prograded over the shoal deposits.

The lower part of the upper Wahoo Formation is Morrowan, Early Pennsylvanian in age. Near the base, a number of lithologic cycles are capped by dolomitic cryptalgal laminite. This suggests that the shallowing-upward cycles culminated with the progradation of intertidal to supratidal environments over open-marine skeletal limestones. Farther upsection, oolitic grainstones occur in the upper parts of the cycles becoming progressively better developed upsection.

A paraconformity occurs near the Morrowan-Atokan boundary and generally coincides with the first lithologic cycle containing Donazella algae.

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Abundant oolitic grainstones are typically superceded by peloidal and Donazella grainstones indicating progressive progradation of restricted lagoonal environments over shoal and open-marine environments.

Over another paraconformity in the upper part of the Atokan upper Wahoo Formation, Osagia oncolite associated with oolitic grainstones apparently formed on lower energy, more restricted shoals than did the oolite. At the top of the cycles, spiculitic lime mudstones and laminated peloidal packstones containing a restricted fauna also suggest relatively restricted lagoonal conditions.

Shallowing-upward cycles can be caused by a number of factors including variations in rates of sedimentation or subsidence/uplift, and eustatic sea level fluctuations. The skeletal-cryptalgal shallowing-upward sequences could possibly be caused by self-induced variations in carbonate sedimentation rate with periodic "deaths" of the carbonate platform caused by overproduction of carbonate sediment and platform emergence. This autocyclic mechanism can't explain the cycles culminating in oolitic or oncolitic shoal deposits or peloidal lagoonal deposits that never prograded above sea-level. Extremely regular variations in rate of tectonic subsidence/uplift that would be required to explain shallowing-upward cycles in the upper Wahoo Formation are hard to envision. It is more likely that the short-duration shallowing-upward cycles of the upper Wahoo Formation formed in response to glacioeustatic sea-level fluctuations associated with Gondwanaland glaciations postulated for Pennsylvanian time. Rapid transgressions would have accompanied melting of glacial ice and gradual regressions would have resulted from sea-level lowering associated with glacial maxima. In fact, all of these factors (sedimentation, isostasy/tectonism, and eustasy) contribute to the ultimate relative sea level changes, a difficult record to unravel.

The Pennsylvanian ooid shoals extended from Prudhoe Bay across the Sadlerochit Mountains and eastward to Leffingwell Ridge but pinched out southward into deeper water on a gently sloping carbonate ramp. At Wahoo Lake, rocks in this stratigraphic position are deeper-water, argillaceous lime mudstone with lesser skeletal wackestones and packstones.