Physical and biological seafloor processes in the marginal-marine Redmans Formation, Bell Island Group, Newfoundland: Implications for organic carbon cycling in an early Ordovician wave-dominated delta

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Understanding the processes that control the sequestration of organic matter are critical to reconstruct atmospheric CO_2 levels on geological time scales, and to predict the shelf-wide extent of potential source and seal- rock facies. Muddy, high-energy coastlines are subject to frequent wave reworking, tide-controlled grain-size sorting, and bioturbation. These processes control the remineralization efficiency of organic particles and impact the total organic carbon content (TOC, wt %) and quality ($\delta^{13}C_{(org)}$, ‰) of sedimentary organic matter.

This research presents combined sedimentological and geochemical data from a mud-rich, wave-dominated deltaic succession, namely, the Ordovician Redmans Formation, Bell Island, Newfoundland. Approximately 76 m of core was obtained from an aquifer exploration well and logged at a cm-scale. In the Redmans Formation, metre-thick packages of medium- to coarse-grained quartz arenite are interbedded with metre-thick intervals of silt- and clay-rich mudstone. Twelve sedimentological facies have been identified from these packages, comprising of proximal, central, and distal distributary mouth bars, with significant wave and tidal reworking. Sandstone facies are typically sparsely bioturbated (0–10%) and contain a low diversity of trace-fossil assemblages of *Diplocraterion* and *Planolites*. Sandstone facies are distinguished due to varying sedimentological features and depositional energies. The Redmans Formation has unbioturbated mudstones (interpreted as fluid muds) that were deposited under high- energy conditions unfavorable for organism colonization. However, facies of intensely bioturbated (30–90%) silt- and clay-rich mudstone facies with diverse ichnological assemblages including *Cruziana, Planolites, Trichophycus,* and *Diplocraterion* were favorable for these trace-producing organisms due to a suitable environment with both high quality and quantity of organic matter.

Samples of mudstone, siltstone, and silty sandstone exhibit TOC values less than 0.8 wt %. A significant compositional heterogeneity of sedimentary organic matter in mudstones, siltstones, and silty sandstones is explained by a combination of organic carbon sources and varying amounts of oxygenation due to both physical and biological seafloor reworking processes. Additionally, this is supported by a difference of 4.3‰ observed in $\delta^{13}C_{(org)}$ data. The combination of detailed facies descriptions with geochemical analysis of mudstones and siltstones can be integrated into a chronostratigraphic framework that allows for a shelf-wide correlation of potential source, seal, and (unconventional) reservoir rocks.

Atlantic Geology, 2014, Volume 50, Number 1
Geological Association of Canada Newfoundland Section Abstracts: 2014 Spring Technical Meeting
doi: 10.4138/atlgeol.2014005