Sedimentology and oceanography of Early Ordovician ironstone, Bell Island, Newfoundland and Labrador, Canada: ferruginous seawater and upwelling in the Rheic Ocean*

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Early Ordovician ironstones of the Bell Island and Wabana groups, Bell Island, Newfoundland and Labrador provide new information regarding the biogeochemical cycling of Fe and P just prior to the onset of the Great Ordovician Biodiversifiction Event (GOBE; ~485 to 460 Ma). The GOBE is the most important and sustained increase in marine biodiversity in Earth's history. While the Cambrian Explosion produced skeletonized organisms with a range of new body plans, the GOBE records the staggering increase in diversity of these taxa.

The Bell Island and Wabana groups are a ca. 150 m thick succession of both clastic and chemical sedimentary rocks composed of twelve distinct lithofacies that accumulated on the margin of the Rheic Ocean. Lithofacies stacking patterns indicate that deposition occurred during a marine transgression with superimposed small-scale sea-level fluctuations producing six parasequences. Ironstonedominated parasequences are 10 to 20 m thick and composed of hummocky cross-stratified sandstone interbedded with organic-rich mudstone and phosphatic Fe-silicate-bearing siltstone, which is overlain by hematitic granular ironstone capped by an erosive flooding surface.

This lithofacies association suggests deposition of upwelling-related ironstone on a storm-dominated shelf. The close association of Fe-silicates and phosphorite typical of upwelling systems suggests that Fe was delivered from deep, anoxic, nutrient-rich seawater that also stimulated high surface productivities. The result was the precipitation of authigenic sedimentary apatite and Fe-silicates in organic-rich sediments that accumulated near the center of upwelling. As Fe-rich waters advected away from the upwelling front and mixed with oxygenated shelf waters, Fe-oxyhydroxides precipitated that were later reworked by fairweather currents and storms to form hematitic granular ironstone on the lower shoreface. This model challenges longstanding ideas of ironstone formation that rely on a continental source of Fe. It also highlights the potential connection between the delivery of anoxic, ferruginous seawater to the margins of the Rheic Ocean and the Early Ordovician extinctions that punctuate the beginning of the GOBE.

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