Trace elements in carbonates as tracers of Earth's O_2 evolution?

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Different major and trace elements in sedimentary records (e.g. BIFs, black shales) have been developed as proxies to reconstruct paleoenvironmental information in deep time (e.g., Sahoo *et al*, 2012). However, many of the sedimentary records are underepresented during the "boring billion" (1.8 ~ 0.8 Ga). Carbonate rocks are pervasive through Earth's history and can provide additional information on paleoenvironments, such as seawater chemistry and/or atmospheric O_2, during the evolution of Earth.

We analyzed the major and trace element concentrations in micro-drilled carbonate rocks from six different localities around the world during the period of Paleo- to Meso-proterozoic and Ordovician. We explored the use of elemental ratios (e.g. Ce/Ce*, Cr/Sr) as redox proxies to trace redox-state of seawater evolution. In shale-normalized (PAAS) REE+Y diagrams, we observed similar patterns to modern seawater—relative depletion of the light REE over the heavy REE. A negative Ce anomaly (Ce/Ce* < 1) is present in most carbonates, suggesting these carbonates were deposited in oxic marine environements. In addition, we find that some redox-sensitive elements (normalized to Sr), such as Fe and Cr, are more depleted during times of more oxidized environments (e.g., Ordovician) compared to those in more anoxic environments (e.g., Proterozic) through Earth's history.

[1] Sahoo, S.K., Planavsky, N.J., Kendall, B., Wang, X., Shi, X., Scott, C., Anbar, A.D., Lyons, T.W., Jiang, G., 2012. Ocean oxygenation in the wake of the Marinoan glaciation. *Nature* **489**:546-549.