Great Oxidation Event: How quickly did it come and go?

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The loss of mass-independent fractionation of sulfur isotopes (MIF-S) defining the first appearance of oxygen in the atmosphere as a stable component, the so-called Great Oxidation Event (GOE), has been recently constrained between ~2.4 and 2.32 Ga. However, the texture of the pO_2 secular changes in the Late Archean to the Paleoproterozoic remains controversial and highly debated. Some authors favor a gradual rise in atmospheric oxygen starting at ca. 2.7 or 2.5 Ga and a peak at 2.1-2.0 Ga at the end of the Lomagundi positive carbon isotope excursion in seawater composition. Combining geological and geochemical constraints, we will discuss the history of atmospheric and oceanic redox conditions in the early Paleoproterozoic.

Detrital pyrite and uraninite in shallow-marine and terrestrial deposits persists until the loss of MIF-S at ca. 2.32 Ga, when sulfate evaporites first appear in the shallow-water marine record. This change indicates a rapid increase in the seawater sulfate content, at least 10 fold, to >>2 millimole level, associated with oxidation of the atmosphere-ocean system. Consistent with this rapid change, concentrations of redox-sensitive elements (e.g., Mo, Re, and U) in the ca. 2.32 Ga and younger GOE black shales are dramatically higher from those in the pre-GOE black shales. Although surface oxidation likely continued during the Lomagundi excursion, which was tied to high burial rates of organic carbon and high flux of oxygen to surface environments, evidence for this progressive rise is currently unrecognized, with the potential exception of the concentration of redox-sensitive elements in black shales.

The end of the Lomagundi excursion is associated with a sharp collapse in the surface oxidation state as reflected by an abrupt fall in seawater sulfate content, disappearance of sulfate evaporites from the rock record, and drop in concentrations of redox-sensitive elements in black shales. The surface oxidation state returned to the intermediate state between those before and during the GOE. In association with this collapse, methane flux from the ocean to the atmopshere and atmospheric methane concentrations increased, contributing to climatic stability during the Boring Billion. The end of the Lomagundi excursion at ca. 2.1-2.0 Ga and associated negative excursion in carbon isotope values of organic carbon in shales, the so-called Francevillian Event, thus reflects the collapse rather than a peak in the oxidation state of the atmosphere-ocean system.

Land use changes and mercury transfers to aquatic systems in the Brazilian Amazon

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In the Tapajos River region of the Brazilian Amazon, mercury (Hg) contamination has become a problem to human health trough fish consumption. Hg present in the water system rises into the trophic chain and affects riparian communities. Studies have shown that recent deforestation contributes to soil mercury release trough terrigenous organic matter fluxes to the aquatic environment. Changes in sedimentation patterns have also been observed, suggesting a large-scale modification of the natural organic matter dynamics in the drainage basins. Local small-scale farmers use slash-and-burn agricultural practices, which consist in slashing and burning a patch of forest to benefit from the soil fertility enrichment caused by fire. After one or two years, soil fertility drops and another patch is slashed and burned. This dynamics creates a mosaic of different land uses: agricultural lands, pastures, secondary forest fallows and forested areas. The aim of this study was to investigate the movements of organic matter and its associated Hg in the watershed and to relate it to land use characteristics. Three watersheds were characterized by geographical system analysis and sampled for vegetation (20 species), soils (33 cores), suspended particulate matter (6 stations) and sediment cores (3, one in each aquatic system). All samples were analyzed for total Hg, lignin biomarkers, C, N and Pb^{210} datation was performed on sediment cores. TOM signatures were elaborated for the different land uses and followed from the terrestrial environments to the aquatic systems. Our results show an increase of TOM and mercury concentrations in recent sediments, with maximum values ranging up to 310 ng/g, concomitant to land use changes and altered watershed characteristics. These findings on the newly colonized watersheds of the Amazon can help to establish the dynamic portrait of Hg movements, leading to the development of conservation measures adapted to this environment.