Microbes, sedex deposits and siderophile seawater at ~1.65 Ga in northern Australia

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Late Palaeoproterozoic to earliest Mesoproterozoic sequences in northern Australia host nearly a quarter of the world's zinc reserves [1]. Individual sedex ('sedimentary-exhalative') deposits may contain tens of millons of tonnes of base metals. Furthermore, the deposits and their primary dispersion halos contain several orders of magnitude greater amounts of iron (as pyrite and/or iron carbonate) than base metals [2]. This talk will discuss the origin of northern Australian sedex zinc deposits in the light of new ideas about the oxidation state and sulfur content of Proterozoic oceans [3,4].

These deposits are thought to form from oxidised fluids that already contained dissolved S (as sulfate) or obtain sulfate when the exhaling fluid mixed with seawater, or both [1]. Sulfide was produced through biogenic reduction at the site of ore deposition and local water column euxinia must have been important to fix (and preserve) base metal- and Fe-sulfides in the sediments. However, Fe enrichments expressed as carbonates, rather than sulfides, imply S-poor (and perhaps CO_2-rich) bottom waters. Such waters may have been anoxic, but were not euxinic.

We will present textural evidence from distinctive bottom precipitated carbonates, as well as S isotope data (sulfide and CAS) from the mineralised and unmineralised sequences, that support arguments for a low-S reduced ocean at this time. The extent of the influence of giant ore-forming exhalative systems on coeval ocean chemistry will be discussed.

References

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Microscale controls on contaminants at the Hanford Site

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Hanford was the site of intensive plutonium production from 1943 to 1989; the operation of reactors, chemical processing facilities, and waste storage and disposal facilities resulted in environmental contamination on a large scale. The vadose-zone mobility of these contaminants was controlled by microscale reactions with unconsolidated surface sediments. Waste-sediment interactions modified migrating solution compositions along the flow path, resulting in immobilization by precipitation or sorption. We used autoradiography, x-ray microprobe, electron microprobe, and scanning electron microscopy to determine the microscale controls on mobility for U, ^{90}Sr, ^{137}Cs, and Cr.

Uranium diffused into microscale fractures in granitic sediment clasts, and precipitated as sodium boltwoodite. The reaction was sustained by dissolution of silica from feldpars and by continued diffusion of uranyl from the pore-filling waste solution. Sequestration of uranyl in microfractures implied a limited possibility of subsequent dissolution and remobilization. ^{90}Sr was entrained in Na^+ rich solutions that displaced Ca^{2+} from ion exchange sites on sediment smectites, causing saturation and Sr coprecipitation with secondary calcite, suggesting that remobilization by subsequent dissolution would be moderated by exchange with Na^+. ^{137}Cs was found to be bound to interlayer sites on biotite and muscovite. The extent of weathering within the micas was critical to the penetration of ^{137}Cs; more weathered biotites included internal concentrations, while muscovite held ^{137}Cs predominantly along the muscovite clast boundaries. Chromate was observed associated with aluminosilicate coatings on sediment clasts, and as concentrated, reduced precipitates in interclast space. The mobility of these contaminants was limited by reaction within distinct reactive components not evident during macroscopic investigations.