

Mechanisms for the attainment of sulfide saturation in magmas derived from subcontinental lithospheric mantle

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Magmatic, sulfide-rich, Ni-Cu-(PGE) deposits occur in settings where potential interaction between mantle-derived magma and country is enhanced (and hence a particular significance to subcontinental lithospheric mantle). Although the presence of S-bearing country rocks should not be dismissed when exploring for Ni-Cu-(PGE) deposits, it is clear that immediate country rocks often may have very little to do with the process of ore genesis. For this reason local country rocks may be poor choices for end-members in various types of geochemical mixing calculations, and data collected from the igneous rocks and associated sulfide mineralization must be carefully evaluated to assess the extent of magma interaction with country rocks. In the case of komatiites the introduction of sulfur from relatively local country rocks has been well-documented. For deeper-seated systems the involvement of immediate country rocks as magma contaminants has been more difficult to prove.

Troctolitic intrusions of the Duluth Complex (Midcontinent Rift System) are hosted by sulfide-bearing pelitic rocks which provide a viable source of sulfur in a contamination process. Sulfur isotope values of the mineralized rocks show a strong crustal signature, but their variability also signifies the involvement of multiple sulfide-saturated pulses. In a system of multiple intrusions various pulses may interact with different country rocks in the conduit system, and as a result be characterized by distinct chemical and isotopic signatures. Situations such as these lead to a conclusion that assimilation of crustal S occurred in deeper chambers within the magmatic system.

When the incorporation of S from country rocks is not indicated, the size of the magma system becomes particularly important. Contamination of mafic magmas by silicic country rocks may lead to sulfide saturation and if orthopyroxene crystallization results rather than olivine, an added benefit is the availability of Ni ($D\text{-Ni (pyr)} < D\text{-Ni (ol)}$). However, in cases where S addition has not occurred extremely efficient collection of sulfide, from large masses of magma, is required for the formation of economically viable mineralization.

Long distance electron transmission couples sulphur, iron, calcium and oxygen cycling in marine sediment

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Geochemical observations in marine sediment have recently documented that electric currents may intimately couple spatially separated biogeochemical processes (1). When marine sediment rich in iron sulphide was exposed to oxygen we observed how the electric currents resulted in significant geochemical alterations in the upper centimetres of the anoxic sediment:

Sulphides were oxidized to sulphate in anoxic sediment layers. Electrons from this half-reaction were passed to the oxic layers cm above. In this way the domain of oxygen was extended far beyond its physical presence. Bioelectrical sulfide oxidation leads to electric field formation, sulfide depletion and acidification of the upper centimeters of the sediment. This promoted ion migration and dissolution of carbonates and iron sulfides. Sulfide released from iron sulfides was the major e-donor in the system. Ferrous iron released from iron sulfides was to a large extent deposited in the oxic zone as iron oxides and Ca^{2+} eventually precipitates at the surface as due to high pH caused by cathodic oxygen reduction.

The result show how long distance electron transmission allows oxygen to drive the allocation of important minerals and possibly many trace elements deep in marine sediment.

[1] Nielsen *et al.* (2010) *Nature* **463**, 1071-1074.