PGE-Au potential of sulphide-saturated melts from the subcontinental lithosphere

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The origin of platinum element metal (PGE) enrichment in large magmatic nickel sulphide deposits is controversial; both primary magmatic and hydrothermal processes have been invoked. Irrespective of their exact mode of deposition, the ultimate source of such extreme enrichments of these rare metals must be PGE-enriched parental silicate melts capable of reaching sulphide saturation and efficient PGE capture in immiscible sulphide liquids. Direct observation of coexisting primary silicate and sulphide melts at the onset of silicate-sulphide liquid is impossible because of intense magmatic processing up until ore deposition. Here we report the discovery of Fe-Ni sulphide melt globules highly enriched in noble metals (Pt, Pd, Os, Ir, Au, Ag; total 150 ppm) within an unusual high-Mg andesitic glass dredged from the southern Mid Atlantic Ridge [1]. The composition of this primitive glass (8.2 wt% MgO, Mg# 67.1 mol%) indicates derivation of its parental silicate melt from a garnet pyroxenite mantle source with pronounced 'continental' isotopic (Pb, Sr, Nd, Hf, Os, O) signatures [1]. We infer that the chemical properties of this melt, notably high SiO_2 (57.3 wt%) and Ni (310 ppm) contents, promoted sulphide saturation at low pressures in a purely oceanic setting and propose that this unique example, with its likely origin in the continental lithospheric mantle, may be a useful analogue for magmatic PGE enrichment and incipient Ni-PGE- sulphide melt generation within large Ni-PGE magmatic sulphide systems.

[1] Kamenetsky, V. S. *et al. Geology* **29**, 243-246 (2001).

A two-stage scenario for the formation of the Earth's mantle and core

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Various geophysical constraints on the deep Earth point to a chemically heterogeneous mantle. Based on such constraints, Bulk Earth compositions inferred from Enstatite chondrites (E-Earth composition) predict that, whereas the Primitive Upper mantle (PUM) had a pyrolitic composition, the Primitive Lower mantle (PLoM) was enriched in Fe and Si and depleted in Mg, Ca and Al relative to PUM. We will explain how, in E-Earth formalism, this chemical heterogeneity can be related to the formation and differentiation of the Early Earth, and mantle Si and Fe variations reflect variations in the efficiency of Si and FeO dissolution in the metal phase during core formation, through the reaction $SiO_2+2Fe_{metal}=Si_{metal}+2FeO$ which increases progressively the fO_2 of the silicate. In the simplest and most direct scenario of homogeneous accretion, we calculate by mass balance the composition and the mass fraction of the metallic extract in equilibrium with a pyrolite. The O, Si and Ni contents of this metal extract correspond to a silicate-metal equilibrium at high pressure (50±5 GPa) and high temperature (3500±500°C), in line with a giant impact scenario. The mass of pyrolite produced during that stage is significantly smaller than the mass of the Bulk Silicate Earth. Mass balance calculations then yield the composition of the proto-core and the proto-mantle prior to the giant impact. We obtain that the core of the proto-Earth was almost devoid of oxygen, hence formed under lower pressure and temperature conditions, in agreement with an early differentiation of planetesimals in the early solar system. In such a two-stage scenario of Earth's core formation, no massive silicate differentiation is required to create a pristine mantle heterogeneity. The concentration of lithophile elements in the Primitive Lower mantle, notably Ca, Al, U and Th, can then be constrained using RLE ratios in E-chondrites and in the upper mantle.

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