

Nanonuggets and their implication for core formation

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The Platinum group elements (Ru, Os, Ir, Pd, and Pt) together with Au and Re are defining the geochemical group of the highly siderophile elements (HSE) based on their 1 atm extremely high metal/silicate partition coefficients ($D^{\text{met/sil}} > 10^4$). In consequence, these elements are present in very low absolute elemental concentrations in the Earth's upper mantle ranging from 0.3 ppb for Re to 8 ppb for Pt.

However, two startling observations led to the "enigma of the overabundance of the HSE" in the Earth's upper mantle [1]. First, according to their extremely high metal/silicate partition coefficients at 1 atm, all HSEs should have been stripped entirely into the Earth's core by the Fe-rich liquid forming the Earth's core, resulting in unmeasurable low concentrations left in the mantle. Second, their elemental abundances show interelement ratios which are similar to what is observed in CI chondritic material.

The development of new analytical techniques made accurate HSE concentration determinations in basaltic, ultramafic and synthetic samples possible, and in consequence, stimulating fundamental experimental investigations of their partition behavior between metal, silicate and sulfide phases.

LA-ICP-MS techniques revealed another exciting feature of the HSE geochemical behavior: the so-called Nanonugget formation problem, mostly observed at very low oxygen fugacity conditions. At present it is under debate whether these Nanonuggets are intrinsic features of HSE solubility in silicate melts [2], contaminants [3] and, therefore, non-representative for its natural equilibrium solubility, and/or simply quench products. Including or excluding Nanonuggets during the elemental concentration determination procedure alone can account already for two to 3 orders of magnitude regarding their metal/silicate partitioning behavior. The clarification whether Nanonuggets represent the true solubility of an element, or are contaminants which, in consequence, have to be excluded from the concentration determination needs fundamental investigation.

In this paper, we present the latest results on our study on the formation and existence of Nanonuggets in Re, Os, Pt, Rh, and Ir containing experiments and discuss their influence on metal/silicate partitioning during core formation scenarios.

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Werner Schreyer's experiments on synthetic B-rich high-pressure tourmalines and micas

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Recently Werner Schreyer worked on the synthesis of B-rich mica (boromuscovite) and Al-rich tourmaline (olenite). He published many interesting papers with his colleagues, resulting from high-pressure experiments in Bochum. Olenites, where [4]B substitutes for up to ~2 apfu Si, were synthesized at PT-conditions in the range 10-40 kbar/450-700°C [1]. Like excess-B in olenite, B in boromuscovite is favoured by high pressures and low temperatures. Schreyer was also involved in investigations on natural olenite with [4]B up to ~1 apfu, from Koralpe, Austria [2-3] and from Kola Peninsula, Russia [4]. The unique pegmatite in the Koralpe, which contains B-rich olenite and muscovite may also have formed at relatively high pressures and low temperatures [5-7]. Pure endmember boromuscovite was found to be stable only at 500°C, >5 kbar and at 750°C, >10 kbar, up to 50 kbar [8]. Experimental incorporation of [4]Al extends the high-pressure stability field of boromuscovite to lower pressures [9]. We suggest a similar situation for B-rich olenite: the amount of [4]B may be pressure dependent but the stability field may be extended to lower pressures when significant amounts of [4]Al are present, as in the olenite from Koralpe. Future search for boron in muscovites and in tourmalines should be focused in high-pressure environments. Werner Schreyer's unique contributions in experimental metamorphic petrology and mineralogy together with his theoretical models should invite petrologists and mineralogists to conduct future work in this interesting field.

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