Ni/Co chondritic ratio in a deep magma-ocean: Partitioning experiments up to 60 GPa

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The segregation of an Fe-rich metallic core is one of the most important events experienced by the Earth in its earliest stage of formation. As a result of core formation, the Earth's mantle is depleted in siderophile elements (metal-loving elements) in comparison to primitive solar system abundances – see review by Walter *et al.* [1]. The way in which siderophile elements partition between metal and silicate depends strongly on pressure (P), temperature (T), oxygen fugacity (f_{O2}) and chemical compositions of both metal and silicate phases. Two elements that are especially important are Co and Ni, because the Co/Ni ratio in the Earth's upper mantle is nearly the same as in chondrites, indicating that they were not fractionated from one another during core formation. Consequently, the ratio of their partition coefficients, D_{Ni}/D_{Co}, is nearly unity, placing a powerful constraint on core-formation models.

We have conducted new high-pressure and high-temperature experiments on the partitioning of Ni and Co between metal liquid and molten silicate using the laser heated diamond anvil cell (LHDAC) (a continuation of our previous work on the same elements at lower pressures [2]). In the range of ~28 to 60 GPa and between 3200 - 3500 K and an oxygen fugacity of near 2 log units below the Iron-Wüstite buffer, we found that the effect of pressure is negligible on partition coefficients of Ni and Co. In addition, the ratio D_{Ni}/D_{Co} is about unity over the range of experimental conditions studied here suggesting that a magma ocean would have extended well into the top of the Earth's lower mantle.

[1] Walter *et al*. (2000) *Origin of the Earth and Moon,* Canup and Righter (eds) The University of Arizona Press. [2] Bouhifd M.A. & Jephcoat A.P. *EPSL* **209**, 245.

Evolution of arc-magmas during their transfer through the lower crust

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Understanding the formation of magmatic arcs requires not only an understanding of the formation of primitive arc melts, but also their evolution during migration from the mantle source to the arc. Indeed, the chemical characteristics of arc-melts are acquired during a complex process involving the slab input, the mantle wedge, and transfer (fractionation-assimilation) of the melt at the base of and in the crust.

The Sapat complex (Pakistan) exposes a lower crust section of the Kohistan Paleo-Island Arc. The section is composed of predominantly fine-grained meta-plutonics hosting kilometer-scale pyroxenite-wehrlite-dunite bodies which show intrusive contacts. Structures and lithological relationships indicate that the pyroxenitic bodies formed through thermal erosion of the host gabbros. We show that these bodies represent magma conduits and feeder pipes ("differentiation highways") of arc-magmas of the growing Kohistan arc. Various petrological compositions characterize the different ultramafic bodies. The largest is composed of hornblende-bearing wherlite, clinopyroxenite, and dunite. These lithologies provide evidence for melts intruding and reacting with their own, earlier cumulates that are magmatically eroded or cut. Another ultramafic body is composed of homogeneous hornblende-bearing websterite with, in places, sub-vertical layers. Within this body, plagioclase- and amphibole-rich, sub-vertical zones denote impregnation by a later reactive percolating melt.

The petrological differences in the various feeder pipes may reflect differences in melt composition, temperature and H_2O-concentration during crystallization, as e.g. suggested by the presence of garnet and fluid exsolutions. Mineral analyses coupled with structural interpretations lead to the conclusion that the arc magmas evolved and acquired at least part of their chemical signature in these conduits. Such magmatic bodies are analogues to deep-seated "magmatic chambers" and elucidate the mode of magma transfer from the top of the mantle to the final emplacement or extrusion level.