Underneath the magma ocean: Element distribution between calcium silicate perovskite and Sulphur-bearing iron melts

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Many attempts have been made to use the partitioning behaviour of elements in molten metal – *molten* silicate systems to constrain the conditions at which Earth's core and mantle last equilibrated during initial differentiation. It is now becoming increasingly obvious that observed mantle siderophile element abundances are not consistent with either single-stage or multiple stage metal-silicate melt equilibration at the bottom of a global magma ocean. Alternative hypotheses, such as heterogeneous accretion or mantle self-oxidation are being considered.

Missing from the current debate is an assessment of the role of partitioning between metal melts and *solid* silicate minerals in the lower mantle. At least some of the later stages of core formation must be characterized by liquid iron alloys in direct contact with a solid lower mantle matrix in the absence of silicate melt. In addition, the present-day core-mantle boundary is a region where molten core metal continues to be in contact with lower mantle minerals. Solid silicates have been in contact with core-forming metals for prolonged periods, leading to partial equilibration at a minimum.

We experimentally determined the distribution of a range of lithophile and siderophile elements between calcium silicate perovskite (CaPv) and molten sulphur-bearing Fe at pressures of 23-24 GPa and temperatures in the range 1623-1873 K. Chemical equilibrium was reached in our experiments despite low lattice diffusion rates in CaPv, probably through enhanced atomic mobility during phase transition of the wollastonite starting material. Our data show that in the presence of sulphur-rich liquids, Ni and Co behave significantly less siderophile in equilibrium with CaPv than if the same metal equilibrates with fully molten peridotite at the same depth and fO2 conditions. Our results add another layer of complexity to attempts to quantitatively constrain core formation models using Earth's mantle composition.

Chemical weathering of mafic rocks in boreal environment (NW Russia)

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Numerous works have emphasized the significant role of silicate weathering in atmospheric CO_2 consumption and climate regulation. However very few studies exist that estimate the impact of chemical weathering in environment underlain by mafic rocks such as gabbros and olivenite. In the Northwestern part of Russia, in the Karelia and Kola provinces belonging to the Eastern Fennoscandian Shield, coexist mafic (e.g., olivenite, gabbronorite) and felsic (e.g., gneiss, granite) types rocks. These zones are characterized by the full-scale presence of quaternary deposits (e.g., moraine) of Pleistocene age. Soils are mainly podzolic and hydromorphic in the depression zones. The main part of the studied zone belongs to the boreal taiga forest ecosystem with pine, spruce, birch, ericaceous species and moss. The arctic climate is marked by a snow-free period of 4-5 month (june to september), a mean annual temperature close to 0°C, and a mean precipitation amount between 550 and 700mm/yr. Investigations were conducted on rocks (i.e., mafic and felsic), soil and water samples taken within the Kivakka and Vetreny Belt magmatic formations during extensive sampling campaigns. This work is based on majors and traces elements analysis (i.e., ICPAES, ICPMS, microprobe), Sr isotopic measurments (i.e.,TIMS) and mineralogical investigations (i.e., XRD, MEB).

Mineralogical studies performed on soils samples show ubiquitous quartz or zircon whatever the nature of the parental rocks (i.e., mafic and felsic). Chemical analysis (e.g., major elements, Sr isotopes) put in evidence the strong influence of the morainic contribution to soils chemistry and mineralogy. In this context, calculations of weathering intensity based on bulk major an traces elements analysis are not suitable. Surprisingly, surface waters floading felsic environment shows higher Ca/Na and Mg/Na molar ratios than water draining mafic rocks, while Sr isotopic signatures of water and soil samples are similar. The data suggest that Ca-Mg vermiculite formation in soils and mineral phases belonging to the moraine partly control major elements signatures in surface waters. This should be taken into account in the estimate of mafic rocks weathering rates and calculations of atmospheric CO_2 consumption by weathering in such particular environment.