High Pressure and Temperature Partitioning of Palladium: No Late Veneer

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Introduction

The highly siderophile elements (Pd, Rh, Ru, Ir, Os, Pt, Au and Re) are present in Earth's rocky mantle in near chondritic relative ratios. For several decades it has been argued that the concentrations of these elements could only originate from the addition of chondritic material to Earth's mantle after the end of core formation, based on very high experimental partition coefficients (> 10^4) for these elements measured at low pressures (<1 GPa) and temperatures (<1400 °C). New partitioning experiments at the high temperatures and pressures (PT) of an early terrestrial magma ocean, demonstrate that D(Pd) metal/silicate is lowered to values (~250) required for that of a high PT equilibrium scenario, thus obviating the need for a late veneer.

Experimental

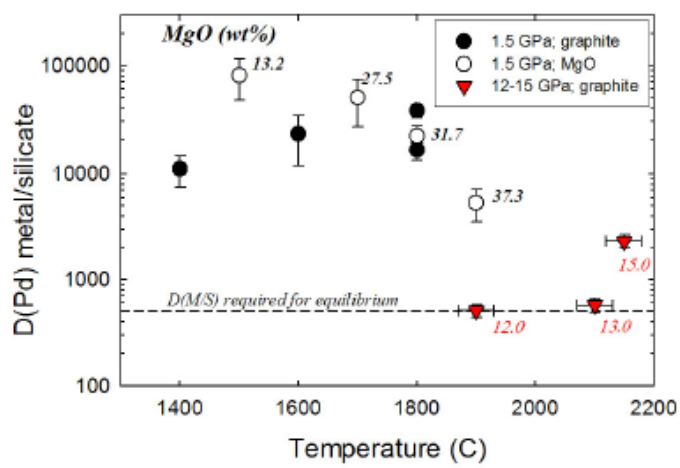
Basalt powders doped with palladium and other trace elements were equilibrated with Fe alloy in MgO or graphite capsules at pressures up to 15 GPa and 2300 °C at the John Space Center. The experimental charges were analyzed by laser ablation ICP-MS microanalysis using a New Wave UP 213 system at the Plasma Analytical Facility, NHMFL. The microanalytical capability of the UP 213 allows the analysis of areas of silicate glass free of metal.

Results and Discussion

Experimental results are summarized in Figure 1, where,

$$D(Pd) = \frac{[Pd]_{metal}}{[Pd]_{silicate}} \quad [1]$$

is a measure of the degree to which Pd is concentrated in the Earth's core (metal alloy) in preference to the Earth's mantle (silicate rock). At high temperature and pressure, D(Pd) drops from values of >10^5 to values observed for the Earth's mantle [1]. These results indicate that the Pd concentration in the Earth's mantle is consistent with chemical equilibrium between core and mantle. There is no longer a compelling need to invoke a late infall of meteoritic debris to explain the mantle's abundances of siderophile elements (e.g., Pd).



Conclusions

The Earth's metallic core and rocky mantle appear to have chemically equilibrated under conditions appropriate for a largely molten early Earth. This work overturns three decades of geochemical thinking by combining laboratory facilities capable of high pressure and temperature experimental chemistry with new microanalytical capabilities.

Acknowledgements

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References

[1] Righter, K. R., *et al*., Nature Geoscience, submitted (2008).