6.1.P06

Low abundances of highly siderophile elements in lunar mantle imply prolonged late accretion

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Earth's mantle has sufficiently high abundances of the highly siderophile elements (HSE: Re, Au, Ir Os, Ru, Pt, Pd and Rh) that it has been hypothesized that 0.1-0.5% of the mass of Earth was added by late accretion after core segregation. The timing and duration of late accretion is not well understood, but should be similar for both Earth and Moon. Moon's mantle, unlike Earth's mantle, largely was shielded from newly accreted material after 4.4 Ga because of the presence of a permanent lunar crust. The contrasting ages of crustal formation on Earth and Moon suggest that a comparison of HSE abundances in their respective mantle could contrain the timing of late accretion in the Earth-Moon system.

Because of the lack of direct samples of the lunar mantle, we estimate its concentrations of HSE from new isotope dilution analyses of Os, Ir, Ru, Pt and Pd abundances and Os isotopic compositions in a lunar dunite and in green and orange glasses. Picritic Apollo 15 green (15421 and 15426) and Apollo 17 orange (74001 and 74220) glasses are interpreted as products of fire-fountaining on the lunar surface. Osmium isotopic variability between etchates and residues of the glass beads indicate a significant portion of the Os and other HSE in the glass is meteoritic, probably added as micrometeorite contamination to the glass concentrates. Indigeneous components of lunar Os were calculated from mixing curves. Green glasses contain $\leq$0.020 ng/g indigenous lunar Os; and the orange glasses contain <0.009 ng/g indigenous lunar Os. These Os concentrations are more than 20 times lower than those in terrestrial rocks with similar MgO contents. Apollo 17 dunite 72415, interpreted as a cumlate from a pre-mare basalt, has HSE contents lower than terrestrial dunites by a similar factor.

These new results suggest that the mantle sources of the lunar glasses and dunite had HSE abundances that were lower by a factor of $\geq$20 relative to the terrestrial mantle, implying that the lunar mantle is missing a substantial share of late accreted materials. This implies that the "missing" HSE may reside in the lunar crust, and that a preponderance of late-accreted materials were added to the Earth-Moon system after 4.4 Ga.

6.1.P07

Metal/Silicate element partitioning - its not the pressure that matters but the heat of the moment!

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The current planetary core formation paradigm holds that pressure is the major constraint upon the metal-silicate partitioning behaviour of elements, (e.g [1]). On the other hand, free energy of oxide formation data [2] suggests that temperature should have an important effect on the partitioning of the elements between core and mantle. Since, however, the latter data refer to pure oxides at atmospheric pressure, they cannot be quantitatively extrapolated to the earth. Nevertheless, they do suggest that the role of temperature deserves further investigation/ Unfortunately, since the liquidus temperatures of silicates and metals rise with pressure, high pressure experiments tend to be performed at higher temperatures than low pressure experiments. This makes it impossible to deconvolve the effects of temperature from those of pressure.

In order to overcome this simultaneous rise of experimental temperature with pressure, we set out to perform a range of iso-baric experiements over as wide a temperature range as possible. Here we present a suite of isobaric partitioning experiments (Ni, Co, Si, Mn, Cr, Nb and V) performed at 2 and 25GPa with experiments at 2GPa covering a 1250K range. The results of these were then integrated with a wide range of previous published data, spanning a range of bulk compositions. After correcting for the various metal and silicate compositional effects, we find that the effect of pressure on partitioning is either negligeable or minor in comparison to that of temperature. Hence, we can show that for all the elements examined, their current mantle abundance may be best explained not by segregation of metal and silicate phases at high pressure, but by equilibration at temperatures in the region of 3500K.

References

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