EARTH'S CORE FORMATION: NEW CONSTRAINTS FROM SIDEROPHILE ELEMENTS PARTITIONING.
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Introduction: The abundances of siderophile elements in the Earth's mantle are the result of core formation in the early Earth. Many variables are involved in the prediction of metal/silicate siderophile partition coefficients during core segregation: pressure, temperature, oxygen fugacity, silicate and metal compositions. Despite publications of numerous results of metal-silicate experiments, the experimental database and predictive expressions for elements partitioning are hampered by a lack of systematic study to separate and evaluate the effects of each variable. Only a relatively complete experimental database that describes Ni and Co partitioning now exists, but it does not allow to unambiguously conclude in favor of the most popular model for core formation with a single stage core-mantle equilibration at the bottom of a deep magma ocean [1] or more recent alternative models [2,3]. In this experimental work, systematic study of metal silicate partitioning is presented for elements normally regarded as moderately siderophile (Mo, As, Ge, W, P, Ni, Co), slightly siderophile (Zn, Ga, Mn, V, Cr) and refractory lithophile (Nb, Ta). Moreover, we performed thermodynamics calculations to constrain the effects of light elements on metal-silicate partitioning and discuss their implications for core formation models.

Methods: A new piston-cylinder design assembly allows us to present a suite of isobaric partitioning experiments at 3 GPa within a temperature range from 1600 to 2600 ºC and over a range of relative oxygen fugacity from IW-1.5 to IW-3.5. Silicate melts range from basaltic to peridotite in composition. The individual effect of pressure is also investigated through a combination of piston cylinder and multi anvil isothermal experiments from 0.5 to 18 GPa at 1900 ºC. Absolute measurements of partitioning coefficients combining electron microprobe and laser ablation ICPMS analytical methods are provided. Effects of light elements (C, O, Si, S) on metal-silicate partitioning behavior were calculated for Ni, Co, V, Cr and Nb using interaction parameters derived from the metallurgy literature as done by Wade and Wood [2] and Corgne et al. [3].

Results and Discussion: New results are obtained for elements whose partitioning behavior is usually poorly constrained and not integrated into any accretion or core formation models. We model the metal silicate partitioning behavior of 14 elements using the new regressions parameters obtained from this experimental work. Pressure and temperature solution for a single stage core-mantle equilibrium scenario at the bottom of a deep magma ocean is calculated well above the peridotite liquidus and still cannot account for mantle abundances of several elements. Calculations show that the single stage core formation scenario is then only viable if 2-5 wt% oxygen is present in the Earth's core. Alternative core formation model of self-oxidation with a multiple stage magma ocean [2,3] are also considered. Our new partitioning results show that this model cannot account for the abundances of Mo, Ga, P and W.

References:
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