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The Effect of Core-Mantle Differentiation on V, Cr, and Mn: Preliminary Experimental Results

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The abundances of V, Cr, and Mn in the silicate portions of the Earth and the Moon are similarly depleted relative to chondritic values (Newsom, 1995; O'Neill and Palme, 1998). In contrast, best estimates of the silicate portions of the eucrite parent body, proposed to be the asteroid Vesta, and the shergottite parent body, proposed to be Mars, place the abundances of V, Cr, and Mn near chondritic levels (Newsom, 1995; Drake et al., 1989). Different conditions during core formation in each of these planetary bodies could explain the different abundances.

Recent models of core formation in the Earth, Moon, Mars, and Vesta, (Righter and Drake, 1999 and references therein) have suggested the observed mantle abundances of some elements can be explained by liquid metal-liquid silicate equilibrium. The success of recent models has been due to increased understanding of the dependency of each element's partitioning behavior as a function of thermodynamic variables, such as pressure, temperature, oxygen fugacity, and silicate and metallic compositions. However, the current experimental data for liquid metal-liquid silicate partitioning of V, Cr, and Mn are limited. Drake et al. (1989) conducted experiments at 1 bar and oxygen fugacities ranging from 1.5 to 6 log units below the iron-wüstite (IW) buffer. Geßmann and Rubie (1998) reported a slight increase in metal-silicate partition coefficients for V, Cr, and Mn with increasing temperature at 90kbars. Isolated experiments by Hillgren et al. and Walker et al. (references in Geßmann and Rubie, 1998) are difficult to reconcile with these two systematic studies.

Additional experimental data are necessary to better understand the partitioning of V, Cr, and Mn before attempting to explain the abundances of these elements in planetary mantles. With this motivation, currently we have conducted experiments at 30, 60, and 100kbars in a multi-anvil device (Agee et al., 1995). Experiments were run at 2000ºC for durations of at least 5 minutes. Starting materials were varied to explore the effects of composition on the partitioning behavior. The estimated oxygen fugacities of the experiments varied from 1.8 to 2.7 log units below IW. Analysis was conducted using an electron microprobe and was complicated by the quench textures of both the metallic and silicate phases.

As a first look at the effects of composition on the liquid metal-liquid silicate weight ratio partition coefficients (D) for V, Cr, and Mn, exploratory experiments were conducted at 30 kbars and 2000ºC. D(V) is considerably larger for a run with a polymerized, K-feldspar silicate composition as compared to an experiment with a depolymerized, peridotitic composition. The measured values of D(Cr) for the two experiments with different silicate compositions were the same within error. D(Mn) appears to be affected by the silicate composition, but D(Mn) is slightly larger in the run with the more depolymerized silicate composition, which is unexpected.

Within error, V and Cr show no preference for partitioning between a S-bearing and a S-free metallic liquid. However, D(Mn) is smaller for partitioning into a S-free metallic liquid as compared to a S-bearing one. An experiment conducted in a graphite capsule contained a silicate liquid and two immiscible metallic liquids, one S-rich and one C-rich. Vanadium and Cr partitioned equally between the two metallic liquids, while Mn showed a clear preference for the S-bearing metallic liquid over the C-rich one.

Our current results can not account for the observed depletions of V, Cr, and Mn in the Earth's mantle. Though the oxygen fugacities of our experiments are lower than believed relevant for core formation in the Earth, our measured partition coefficients are still less than 1 in most cases, suggesting slight enrichments in the mantle rather than depletions during core formation. However, additional experimental work is planned to improve our understanding of V, Cr, and Mn partitioning as a function of the thermodynamic variables. For example, though we have conducted experiments at different pressures, the effects of pressure on the metal-silicate partitioning of V, Cr, and Mn remain to be determined. After additional experimental work, the issue of the abundances of these elements in planetary mantles can then be better addressed.

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Agee CB, Li J, Shannon MC & Circone S, *JGR*, **100**, 17725-17740, (1995).

Drake MJ, Newsom HE & Capobianco CJ, *GCA*, **53**, 2101-2111, (1989).

Geßmann CK & Rubie DC, *GCA*, **62**, 867-882, (1998).

Newsom HE, *Global Earth Physics: A Handbook of Physical Constants, AGU Ref. Shelf, Vol. 1, AGU*, 159-189, (1995).

O'Neill HStC & Palme H, *The Earth's Mantle: Composition, Structure, and Evolution, Cambridge University Press*, 3-126, (1998).

Righter K & Drake MJ, *EPSL*, **171**, 383-399, (1999).