

SOLID METAL/LIQUID METAL PARTITIONING OF TRACE ELEMENTS AT 14 GPa. V. J. Hillgren¹, R. Ash², W. F. McDonough², Y. Fei¹, and N. L. Chabot³, ¹Geophysical Laboratory, Carnegie Institution, 5251 Board Branch Road NW, Washington, D. C. 20015 ²Department of Geology, University of Maryland, College Park, MD 20742-4211 ³Johns Hopkins Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723

Introduction: In recent years there have been numerous studies exploring the effect of pressure on the partitioning of trace elements between solid metal and S-bearing metallic liquids [1-9]. These studies have often come to conflicting conclusions in part because they concentrated on different subsets of trace elements and also in part because varying amounts of S were present in the metallic liquids. Chabot *et al.* [9] attempted to clarify the situation by performing a suite of experiments covering a wide range S of contents with a large set of trace elements at 9 GPa. They found that the D's of some elements increased with pressure, some decreased and some were essentially unchanged. Here we extend the work of Chabot *et al.* [9] to 14 GPa to explore how the changes in structure of the metallic liquid with pressure effect partitioning.

Experimental Techniques: All experiments were performed in the multianvil apparatus. The sample assembly consisted of an 8 mm edge length MgO-Spinel octahedra with a Re heater and either an Al₂O₃ or MgO sample capsule. Starting materials were Fe-metal and varying amounts of FeS mixed with a few hundreds ppm each of Co, Ni, Cu, Ga, Ge, As, Mo, Ru, Rh, Pd, Ag, Sn, Sb, W, Re, Os, Ir, Pt, Au, Pb, and Bi. All experiments were performed at 14 GPa with run temperatures ranging from 1140 K to 1750 K. Run times were 3 hours. Samples were recovered and polished, and major elements (Fe, S) plus Re, Ni and O were measured with JOEL 8900 electron microprobe at the Carnegie Institution with an accelerating voltage of 15 KeV and a beam current of 30 nA and counting times ranging from 30 to 120 seconds. All other trace elements were measured with laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) at the University of Maryland using the techniques described by Chabot *et al.* [11].

Results: Each sample consisted of two phases: a Fe-metal phase that was solid at run temperature and a dendritic Fe-S phase composed of Fe dendrites surrounded by Fe₂S which was liquid during the run (figure 1). In samples run in MgO capsules the Fe-meal phase is homogeneous. However, in samples run in Al₂O₃ capsules the Fe metal contains blobs of FeO (figure 2). The size and textures of these blobs lead us to believe that they existed as a separate phase at run conditions and are not a quench product. The sulfide phases of the samples from Al₂O₃ capsules also contain slightly more O than those run in MgO capsules (~0.8 wt. % versus ~0.5 wt. %).

To date LA-ICPMS analysis for trace elements have only been conducted for two samples run in Al₂O₃ capsules. During the analysis it was not always possible to avoid the FeO blobs, but because the blobs are enriched in Mn, whenever one was hit, there was a sudden spike in Mn counts, and therefore, we were able to remove that portion of the data during data reduction. In general, the data agree with the conclusions of Chabot *et al.* [9] where they found that D's for elements to left of the period table tended to decrease with pressure and those to the right increased. However, in contrast to Chabot *et al.* [9], there is some hint that there may be a pressure effect on Pt, Re, Ir, and Os. However, this conclusion is very preliminary and more data will definitely be needed to confirm this.

In Figure 2, our D's for Ni obtained from the microprobe are plotted along with the 1 bar data (see [10] for sources) and the recent high-pressure data. There is a clear difference between the D's from runs in MgO capsules versus the D's from runs in Al₂O₃ capsules. At this point we preliminarily conclude that this is due to the differing O contents of the sulfide. However, it is rather surprising that such a small difference in O contents could result in such large difference in D's.

We will present further LA-ICPMS data for our entire suite of elements for metallic liquids with S contents ranging from 3 to 18.5 wt. %. We will also extend our study to 21 GPa.

References: [1] Jones J. H. and Walker D. (1991) *EPSL*, 105, 127-133 [2] Walker D. (2000) *GCA*, 64, 2897-2911 [3] Lazar *et al.* (2004) *GCA*, 68, 643-651 [4] Walker D. and Li J. (2008) *Chem. Geol.*, 248, 166-173. [5] Van Orman *et al.* (2008) *EPSL* 274, 250-257 [6] Hazashi *et al.* (2009) *GCA* 73, 4836-4842 [7] Stewart *et al.* (2009) *EPSL* 284, 301-309 [9] Chabot et. al. (2011) *EPSL*, submitted [10] Chabot N. L. and Jones J. H. (2003) *MAPS*, 38, 1425-1436. [11] Chabot *et al.* (2008) *GCA*, 72, 4146-4158.

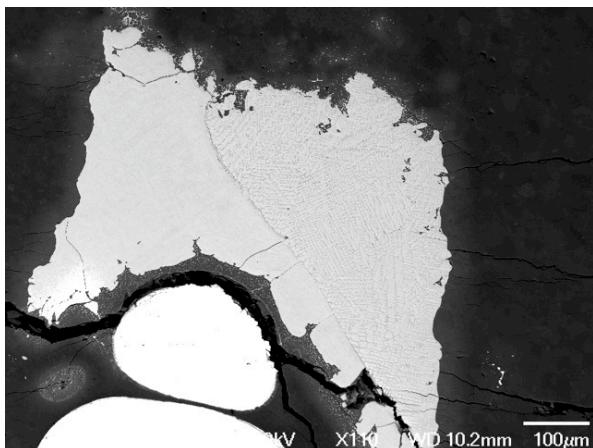


Figure 1. Backscatter electron image of run M1153. The sample was run in an MgO capsule. The solid metal phase is homogeneous and free of FeO blobs

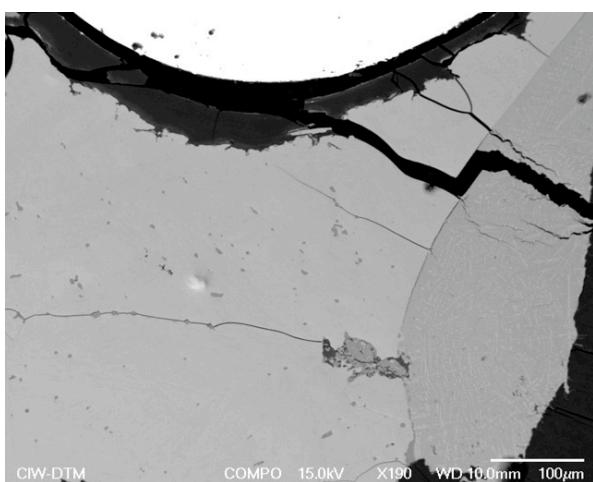


Figure 1. Backscatter electron image of run LO769. This sample was run in an Al₂O₃ capsule and the metal contains blobs of FeO

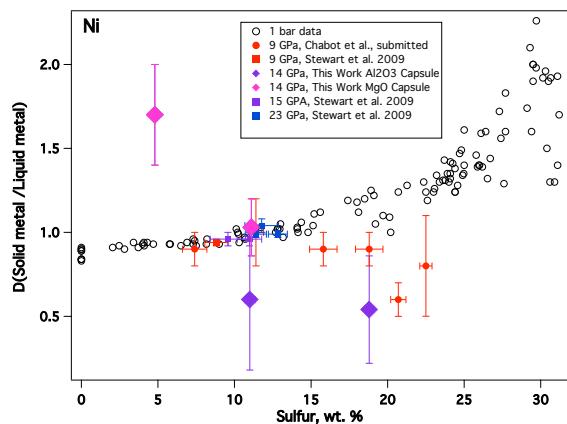


Figure 2. Plot of solid metal/liquid metal partition coefficients for Ni versus S content of the liquid metal. There is a distinct difference between the samples run in MgO and Al₂O₃ capsules.