

THE EFFECT OF PRESSURE ON POTASSIUM PARTITIONING BETWEEN METALLIC LIQUID AND SILICATE MELT. A. Corgne and Y. Fei, Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road, NW, Washington DC 20015; a.corgne@gl.ciw.edu; fei@gl.ciw.edu.

Introduction: The presence of potassium in the core as a significant heat source was suggested over three decades ago [1,2]. Experimental studies on the partitioning of potassium between metal and silicate have provided ambiguous results [3-10], because of experimental and analytical artifacts (as discussed in [8-10]). It has been recognized that polishing of a run product for chemical analysis using oil lubricants results in substantial potassium loss from the Fe-S phase [10]. Murthy et al. [10] developed a dry polishing technique using boron nitride powder as lubricant in the lapping operations to address the potassium-loss problem during polishing. They showed conclusively that potassium enters iron-sulfide melts with a strong dependence on temperature. In the pressure range of their study (1–3 GPa), they observed no significant pressure effect on metal-silicate partition coefficients. There are very limited high-pressure partitioning experiments conducted in the multi-anvil apparatus that can be used to evaluate the effect of pressure on potassium partitioning [6,7,9]. Furthermore, these studies were carried out without taking account of the experimental and analytical difficulties addressed by Murthy et al. [10].

Objective: At ambient and low pressures, it is known that potassium is not soluble in a pure Fe metallic liquid. All previous experiments were focused on potassium partitioning between Fe-S liquids and silicate melts on the basis that K_2S is soluble in Fe-S liquids. Theoretical calculations and experimental studies at high-pressures have proposed another mechanism for the incorporation of potassium in metallic liquids. Theoretical calculations [11] show that the electronic structure of potassium changes from 4s- to 3d-like orbital bonding between ~25–30 GPa. This change makes potassium behave like a transition metal, hence it should increase its solubility in metallic liquid. The effect of pressure on potassium solubility has remained uncertain, however. Shock experiments on $KFeS_2$ [12] and molecular orbital calculations [13] at high-pressures have provided arguments against the presence of potassium in planetary cores. Recently, it has been shown experimentally that potassium can alloy with nickel at 31 GPa and 2500 K [14] and with iron above ~26 GPa and 2500 K [15]. Following these observations, the aim of our study has been to determine whether or not the metal-silicate

partitioning of potassium is significantly greater at 27 GPa than at lower pressures where potassium has the 4s electronic structure, regardless of the metal composition.

Methods and Preliminary Results: Experiments at 27 GPa and 2200–2400 °C were performed in a multi-anvil apparatus using the 8/3 cell assembly described by Bertka and Fei [16]. The starting materials were synthetic mixtures of K-silicate glass and either pure Fe-metal or Fe-FeS mix. Initial experiments were performed using MgO capsules. Sample temperatures were measured with a W5%Re-W26%Re (type C) thermocouple. The quenched samples mounted into epoxy resin were polished under dry conditions to avoid potassium-loss [10]. Back-scattered electron images and quantitative chemical analyses were obtained with a JEOL JXA-8900 electron microprobe. Results show that, for experiments with the S-free starting material, conditions are too oxidizing to obtain reliable metal-silicate partitioning coefficients. In S-bearing experiments, both silicate melt and metallic liquid (quenched into S-rich and S-poor alloys) were observed. In comparison with data obtained at low pressures using the same starting material (experiments from [10]), preliminary quantitative analyses do not reveal any increase of the potassium solubility in metallic liquid at 27 GPa. However, the present experiments were performed using MgO capsules whereas Murthy et al. [10] used graphite-platinum double capsules. It is difficult to implement the double capsule technique in the high-pressure experiments because of volume limitation. In order to generate more reducing conditions and limit the loss of potassium and iron, we are currently performing experiments using boron nitride capsules. This capsule material was successfully used to investigate melting relations in Fe-S-Si system at high pressures and temperatures [17]. Additional experiments will be carried out using diamond capsules and possibly double capsules. These experiments should provide reliable metal-silicate partitioning data over a wide pressure range and under different redox conditions. These high-pressure partitioning data can be applied directly (i.e. without any extrapolation of pressure) to assess the radioactive heat contribution from ^{40}K in the core of both Earth and Mars.

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