



THE 12th ANNUAL UNLV GEOSYMPIOSIUM APRIL 28, 2017

EXPERIMENTAL STUDY INTO THE PARTITIONING BEHAVIOR OF FLUORINE, CHLORINE, HYDROXYL, AND SULFUR (S²⁻) BETWEEN APATITE AND A SYNTHETIC KREEP BASALT MELT.

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The mineral apatite (Ca₅(PO₄)₃(F, Cl, OH)) is known for its ability to constrain the petrogenesis of the rock in which it is hosted and for its ubiquity throughout the Solar System, as it is found in lunar, martian, and terrestrial rocks alike (McCubbin et. al, 2015). The abundance of volatile elements, and for this particular study, the elevated abundance of sulfur (S²⁻) in high-Al basalt samples bearing apatite, could provide more insight for inquiries posed about the behavior of volatiles in lunar and martian magmatic systems (Boyce et. al, 2010). Oxygen fugacity will be an important parameter for these experiments, as the Moon, Mars, and Earth have different redox states (Herd, 2008). The objective of this experimental endeavor is to determine apatite-melt partition coefficients for the volatile elements (F⁻, Cl⁻, OH⁻, S²⁻) that make up the X-site (i.e., the typically monovalent anion site) in the mineral apatite in a lunar melt composition under lunar oxygen fugacity conditions (~1–2 log units below the iron-wüstite buffer). All experiments will be conducted at NASA, Johnson Space Center in the High Pressure Experimental Petrology Laboratory.

In order to conduct apatite-melt partition experiments with oxygen fugacity as an additional parameter, we will create a synthetic mix of the lunar KREEP basalt 15386, a sample retrieved during Apollo 15 that is believed to represent an indigenous volcanic melt derived from the lunar interior (Rhodes, J.M et. al, 2006). Other geochemically significant elements including C, Co, Ni, Mo, and rare earth elements will be included in the mix at trace abundances in order to assess their partitioning behavior without effecting the overall behavior of the system. The synthetic mix will then be loaded into a piston cylinder, an apparatus used to simulate high-pressure/high-temperature conditions of planetary interiors, and exposed to 0.5 GPa of pressure, the pressure observed in the upper mantle of the Moon, and heated to the melting temperature of the materials. To make sure crystals grow large enough for the necessary analyses, the sample will be kept at the crystallization temperature for 8 hours. This extended run time should also allow the sample to achieve a steady state which is necessary to accurately assess the partitioning of these elements between apatite and melt. The results from this experimental study will allow us to determine the fate of F⁻, Cl⁻, OH⁻, and S²⁻ during the magmatic evolution of the Moon.