

ASSESSING THE VOLATILE INVENTORY OF BASALTIC FRAGMENTS IN LUNA SOILS.

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Introduction: Chlorine is an unusual isotopic system, being essentially unfractionated ($\delta^{37}\text{Cl} \sim 0 \text{ ‰}$) between bulk terrestrial samples and chondritic meteorites [e.g., 1–2], yet showing large variations in lunar, martian, and eucrite samples (from ~ -4 to $+81 \text{ ‰}$, [e.g., 3–5]). Among lunar samples, apatite ($\text{Ca}_5(\text{PO}_4)_3[\text{F},\text{Cl},\text{OH}]$) has been studied for volatiles in K-, rare-earth element (REE)-, and P-rich (KREEP), very high potassium, high-Al, low-Ti and high-Ti basalts, as well as samples representing the lunar highlands [e.g., 3,6–8]. These studies have revealed a positive correlation between in-situ $\delta^{37}\text{Cl}$ measurements and indicators of KREEP component (i.e., bulk-rock incompatible trace element abundances and ratios; [e.g., 3,7–8]). Such trends have been interpreted as mixing of mantle components, mixing between the light-Cl mantle and heavy-Cl urKREEP, during the purported overturn of magma ocean cumulates. In those models, the fractionated isotopic composition of Cl in urKREEP is established through the degassing of metal chlorides from urKREEP during or shortly after the differentiation of the Moon via a magma ocean. Some have speculated that the volatile loss might be related to impact events and propose that the Procellarum KREEP Terrane (PKT) might record such crust-breaching impacts/weakening events [e.g., 3,9–10].

To test the model that materials from the lunar nearside are contaminated by KREEPy Cl isotope compositions, we are studying samples returned from outside of the PKT. Here we investigate the mineralogy, chemistry, and volatile systematics of basalt fragments in Luna soils from Mare Fecunditatis (Luna 16) and Mare Crisium (Luna 24). The overall goal is to better understand the origin(s) of chlorine isotope fractionation on the Moon.

Samples and Methods: We have studied seven standard polished thin sections and grain mounts of Luna soils from the <1 mm size fractions. The samples were first surveyed using a Keyence Digital Microscope. We used plane-polarized, cross-polarized, and reflected light microscopy to categorize 235 soil particles as basalt, highlands, mineral, agglutinate, or breccia. Next, we imaged each of the 42 identified basaltic fragments in all three optical light settings. Thirteen basaltic fragments were selected for further investigation using electron probe microanalysis (EPMA) with a Cameca SX100 at the University of Arizona. To date we have performed X-ray (Si, Al, Ti, Ca, Fe, Mg, K, Na, P, Ni, Cr, S, Ba, and Zr) and backscattered electron mapping of the fragments (Figure 1). Mineral modal abundances of major phases (i.e., olivine, pyroxene) and minor to trace phases (i.e., apatite) were determined using the threshold method and quantified using ImageJ.

Initial Results and Future Work: As expected we find that basaltic fragments in the Luna 24 soils are of very-low-Ti type and fragments in the Luna 16 soils are low-Ti with high volume percentages of plagioclase and in some cases minor K-feldspar. We have begun mineral-specific EPMA spot analysis. We will present our progress and initial results at the meeting.

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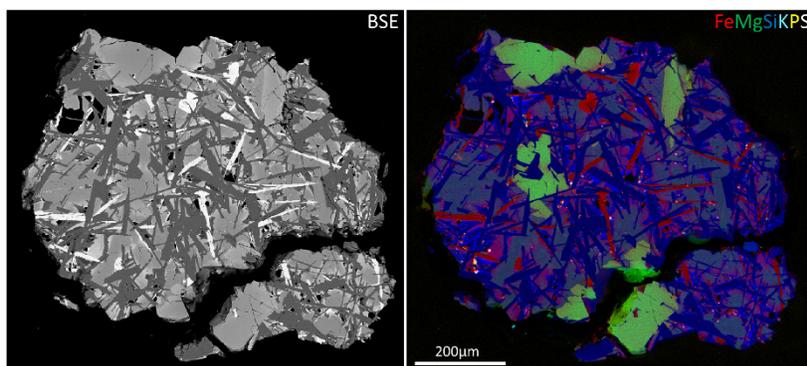


Figure 1. BSE (left) and elemental composite (right) of a basalt fragment from 21013. Observable phases are olivine (green), plagioclase (dark blue), ilmenite (red), pyroxene (intermediate colors of teal to purples), silica (bright blue), phosphate (yellow), and troilite (white).