MOONRISE: SAMPLING THE SOUTH POLE-AITKEN BASIN TO ADDRESS PROBLEMS OF SOLAR SYSTEM SIGNIFICANCE.

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Introduction: A mission to land in the giant South Pole-Aitken (SPA) Basin on the Moon's southern farside and return a sample to Earth for analysis is a high priority for Solar System Science [e.g., 1,2]. Such a sample would be used to determine the age of the SPA impact; the chronology of the basin, including the ages of basins and large impacts within SPA, with implications for early Solar System dynamics and the magmatic history of the Moon [3]; the age and composition of volcanic rocks within SPA; the origin of the thorium signature of SPA with implications for the origin of exposed materials and thermal evolution of the Moon [4,5]; and possibly the magnetization that forms a strong anomaly especially evident in the northern parts of the SPA basin [6].

It is well known from studies of the Apollo regolith that rock fragments found in the regolith form a representative collection of many different rock types delivered to the site by the impact process (Fig. 1) [7-9]. Such samples are well documented to contain a broad suite of materials that reflect both the local major rock formations, as well as some exotic materials from far distant sources. Within the SPA basin, modeling of the impact ejection process indicates that regolith would be dominated by SPA substrate, formed at the time of the SPA basin-forming impact and for the most part moved around by subsequent impacts [10,11]. Consistent with GRAIL data, the SPA impact likely formed a vast melt body tens of km thick [12,13] that took perhaps several million years to cool, but that nonetheless represents barely an instant in geologic time that should be readily apparent through integrated geochronologic studies involving multiple chronometers. It is anticipated that a statistically significant number of age determinations would yield not only the age of SPA but also the age of several prominent nearby basins and large craters within SPA. This chronology would provide a contrast to the Imbrium-dominated chronology of the nearside Apollo samples and an independent test of the timing of the lunar cataclysm.

The Desired Sample: Owing to the variety of landing sites and sample stations encountered during Apollo missions, we have a very good idea of what to expect to find in regolith from locations of different maturity on the Moon, with many examples among the Apollo samples. All regolith samples are dominated by fine material but contain some proportion of rock fragments, and the abundance of such rock fragments generally increases with depth, even within the upper few tens of cm. Rock materials are needed to determine impact ages as well as ages of volcanic rocks. Ages can be determined using bulk methods, mineral separates, and in-situ microbeam methods. In some cases, for example crystalline basalts or crystalline impact-melt breccias, SIMS analyses to determine U-Pb ages of Zr-bearing and phosphate minerals will be used [14-16]. For rocks with sufficient grain size, mineral separates can be used for Sm-Nd and Rb-Sr, methods [17]. Rock subsamples can be analyzed using ^{40}Ar-^{39}Ar and (U-Th)/He methods [18,19].

Coherent, crystalline rock material is best suited for these types of analyses, thus we plan to sieve the regolith, which in effect increases the scientific content of the sample many-fold. Sieving to collect rock fragments in the ~4-20 mm size range will produce thousands of rock fragments in a kilogram of material, although much more than a kg might need to be sieved to obtain this quantity of rock fragments.

Preliminary Examination (PE): A critical aspect of any sample return mission is the PE. The purpose of the PE is to document the collection and to provide sufficient initial characterization to enable appropriate distribution of sample materials for analyses that will address mission science objectives. Modern methods that provide petrographic, mineralogical, and compositional information using non-invasive methods can be done with modern technology (e.g., micro-CT scanning and micro-XRF [20]). A subset of representative samples should be sectioned for micro-beam characterization. Following PE, samples would be allocated to the mission science team, which includes international partners, as well as to the broader science community for analysis according to established Curatorial procedures.

Curation and Allocation: In addition to PE, long-term curation of the sample-return materials would be done in a manner similar to the way Apollo samples and other more recent returns have been curated. Controlled atmospheric conditions for handling and storage are critical for preservation of a portion of the collection for future research as new scientific questions and analytical methods are developed. As is done now, samples would be carefully monitored for allocations of requested materials of a type and amount that is appropriate for a given scientific investigation, with review of sample requests by NASA's Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM), working with the sample Curator, handling and distribution by the Curatorial Facility (JSC), and oversight by NASA.

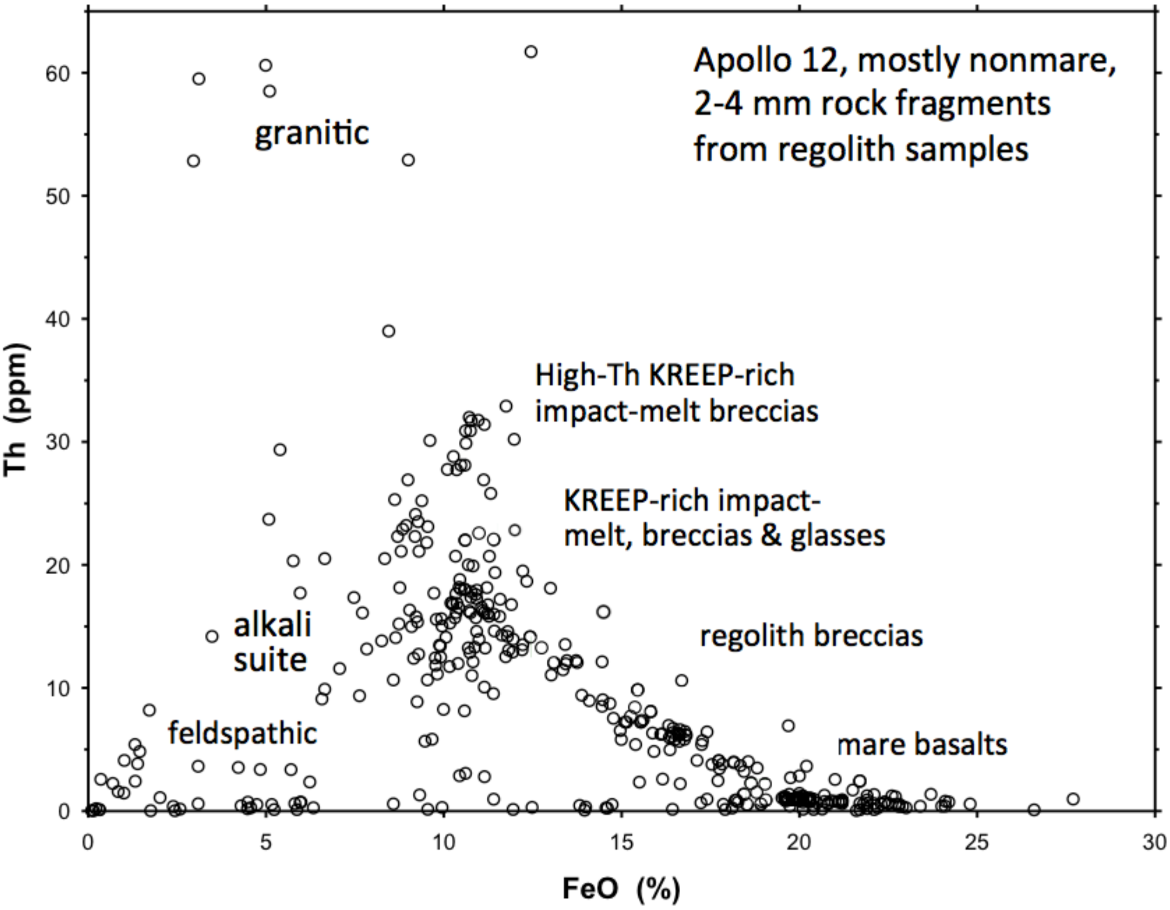

Figure 1. At the Apollo 12 landing site, rocks and regolith are dominated by the basalts that underlie the landing site. However, all of the soils contain rock components from the surrounding region, as well,

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