POTENTIAL SAMPLE SITES FOR SOUTH POLE–AITKEN BASIN IMPACT MELT WITHIN THE SCHRÖDINGER BASIN. Debra Hurwitz[1] and David A. Kring[1]; [1]Center for Lunar Science and Exploration, NASA Solar System Exploration Research Virtual Institute, Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX, 77058, (hurwitz@lpi.usra.edu)

Introduction: The intensity of impact activity during the earliest history of the Solar System is poorly constrained, because the record has largely erased from the Earth and, thus far, we have very few samples from ancient terrains preserved on other planetary surfaces. The South Pole–Aitken (SPA) basin is the oldest basin identified on the Moon based on stratigraphic superposition and, thus, represents a key target for characterizing this earliest impact record [1,2]. To determine the absolute age of SPA, rocks that formed as a result of the impact, such as impact melt, must be identified, collected, and analyzed. In this paper, we use high-resolution images obtained by the Lunar Reconnaissance Orbiter Narrow Angle Camera (LROC NAC) to explore locations that are enriched in FeO, a signature interpreted to be SPA impact melt. One particular region of interest is southeastern Schrödinger basin (Fig. 1), which lies within the FeO anomaly associated with SPA and may provide an optimal location to address several key science priorities.

Identifying SPA Impact Melt: Petrological modeling suggests the melt sheet generated in the central transient crater during the SPA impact event would have differentiated, forming a shallow layer of FeO-enriched (~29 wt% FeO) low-Ca pyroxene (pyx) + plagioclase (plag)-bearing material beneath a layer of quenched melt [3,4]. This quenched melt would have the same bulk composition as both the initial melt within the melt sheet and the melt ejected from the transient cavity. Modeling suggests this initial melt composition contained ~15 wt% FeO and, when crystallized, would have been dominated by low- and high-Ca pyx with plag [4].

SPA Melt Preserved in SPA Interior: The iron content within SPA is currently observed to be 10-15 wt% in the basin center and 7-10 wt% in the modification zone where Schrödinger is located [5]. In the surrounding highlands, FeO content is 3-5 wt% [6,7]. The discrepancy between the modeled FeO contents in the differentiated (29 wt% FeO) or quenched (15 wt% FeO) impact melt and observed FeO contents can be resolved if SPA material was diluted by FeO-depleted impact ejecta from outside SPA. Previous estimates of the proportion of SPA-generated materials residing within the basin vary greatly from ~40% [8] to 50–80% [9] based on the volume of material balistically emplaced in SPA from younger impact events.

Using previous petrological model results with observed FeO contents, we independently estimate the amount of SPA impact melt that currently resides in the SPA interior (Fig. 2). It should be noted that ~14% of central SPA has been resurfaced by mare (~17–20 wt% FeO), material that contributes to the observed FeO signature. This contaminating material slightly decreases the apparent FeO content in central SPA to 27 wt%.

The observed FeO content of ~15 wt% in central SPA requires ~50–55 wt% contamination by FeO-depleted

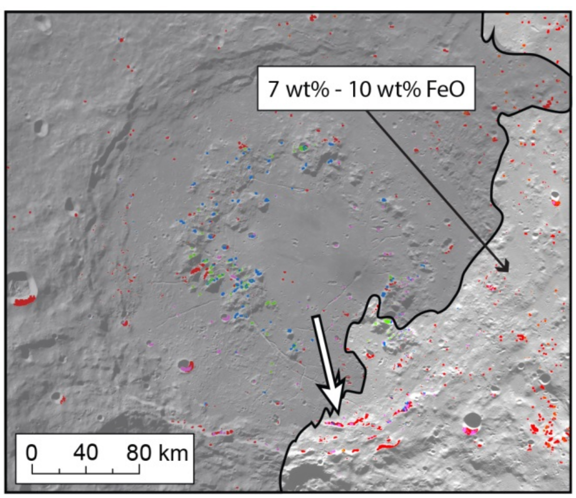

Fig. 1: Schrödinger lies in southwestern SPA. The FeO anomaly that coincides with the SPA interioris exposed in the eastern and southeastern portion of this basin. This FeO-enriched signature is interpreted to represent SPA-derived material, and samples collected within this region may be analyzed to determine the age of the oldest basin preserved on the Moon. Red and pink pixels indicate the presence of pyroxene and plagioclase [10], a signature that is consistent with quenched SPA impact melt [4].

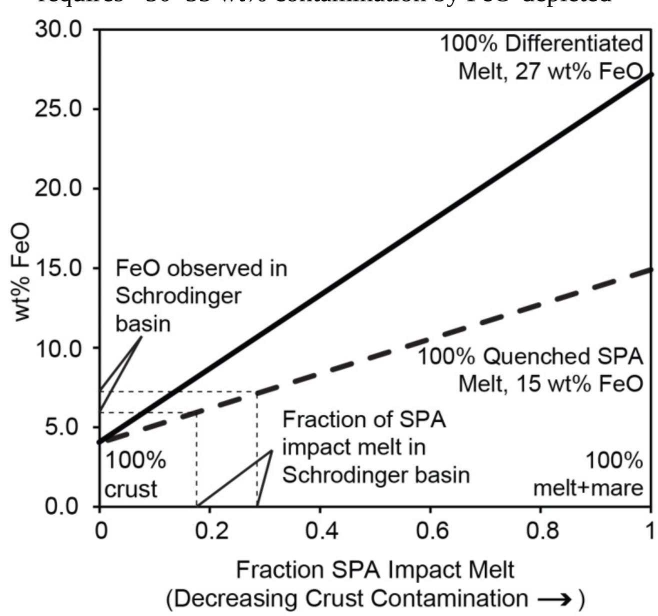

Fig. 2: Fraction of SPA impact melt as a function of FeO content. As FeO-depleted material outside SPA is redistributed within SPA in the form of ejecta of younger craters, the apparent FeO content decreases. This approach allows us to estimate the amount of SPA-derived material preserved at the surface.

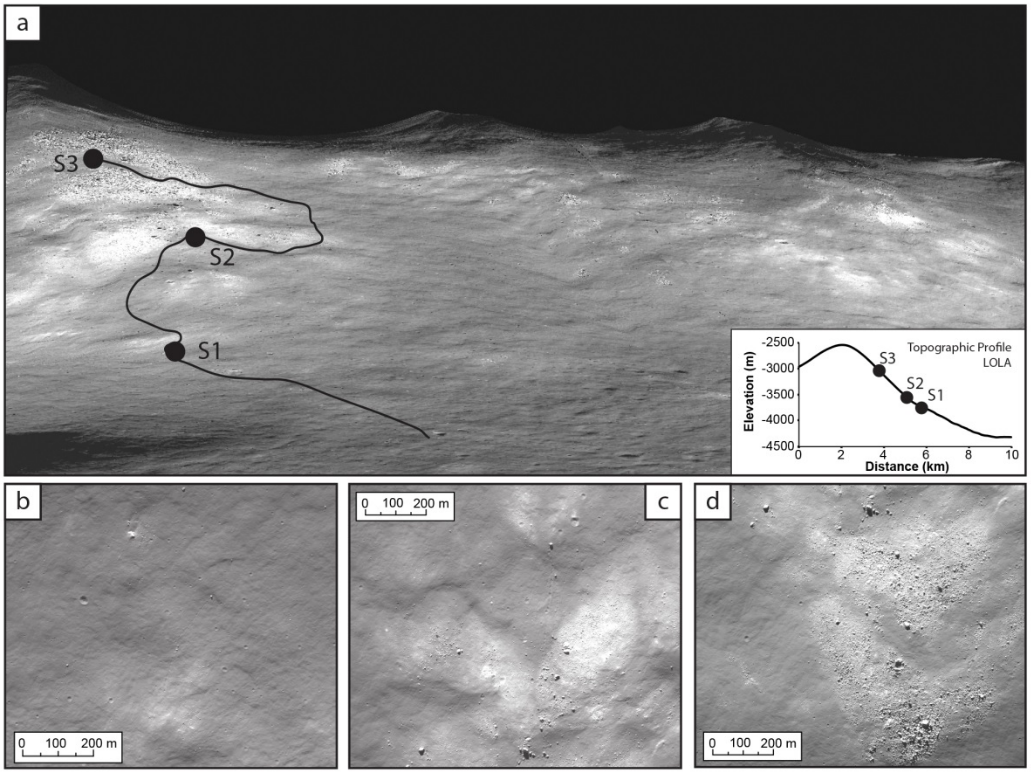

Fig. 3: (a) Perspective view of the pyx- and plag-bearing outcrop observed in a southern wall terrace of Schrödinger (white arrow in Fig. 1). White patches indicate exposed outcrop and speckled terrains indicate the presence of boulders. A ~5 km traverse (avg. slope 10^{o}) is plotted with three stations where SPA impact melt might be sampled. (b) Station 1, 600 m above the surrounding plains (see topo inset in a) has small rocks and boulders, (c) Station 2, 900 m above the plains, has more substantial outcrops and boulders with tracks, and (d) Station 3, 1500 m above the plains, contains large boulders that could be sampled to complete a cross sectional analysis of the terrace. LROC NAC images.

materials, indicating that ~45–50 wt% of the regolith is currently composed of predominantly differentiated SPA impact melt with some (14%) mare materials. The observed FeO content within southeast Schrödinger basin (~7 wt%) is consistent with ~20–30 wt% quenched SPA impact melt remaining in the local regolith (dashed lines in Fig. 2). These percentages represent a mimimum estimate for how much SPA-derived material is preserved within Schrödinger as determined by FeO content. Based on these results, regolith and, potentially, pyx- and plag-bearing outcrops within the FeO-enriched regions of Schrödinger basin contain SPA impact melt.

Analyses: Using LROC NAC images, we investigated the terrace in the south wall of Schrödinger (Fig. 1) to identify possible sources of the observed FeO-enriched, pyx- and plag-bearing signatures. Analyses indicate that outcrops and boulders contribute to these signatures and, thus, we have designed a traverse to sample those potential SPA-derived materials (Fig. 3).

The suggested 5 km traverse (Fig. 3a) directs a rover from a landing site on level, smooth plains on the basin floor to outcrops of rocks likely to contain the chemical and mineralogical signature of SPA impact melt. Three prospective stations represent locations where sampling and additional geologic investigations could be performed. Station 1 is located at an elevation ~600 m up a slope of ~9° from the adjacent plains (Fig. 3b). This site is characterized by a small outcrop and nearby boulders that appear to have slumped from the adjacent terrace. Station 2 is located ~1.2 km up a slope of ~15° from Station 1 (Fig. 3c). This site contains a much larger group of outcrops with boulders that left tracks in the loose regolith. Station 3 is located ~2 km up a slope of ~11° from Station 2 (Fig. 3d). This site is characterized by large boulders (diameter ~50 m) atop expansive outcrops. Samples collected at these stations would generate a stratigraphic sequence of the terrace, comparing rocks near the top of the terrace with those at the base. Additionally, targeted analyses of the rocks collected at all sites can provide insight into the age and composition not only of SPA but also of Schrödinger, effectively bracketing the epoch of large basin formation on the Moon.

Concluding Remarks: Rocks identified in this study represent material exposed during the Schrödinger-forming impact event, an event that likely penetrated into and redistributed material formed during the SPA-forming impact event. Sampling SPA material within Schrödinger is attractive for other reasons too. Because it is a relatively young basin with spectacular rock exposures, missions to Schrödinger can also recover samples that address a broad range of lunar science and exploration objectives (e.g., [1,2,11]).

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