SCIENCE-RICH MISSION SITES WITHIN SOUTH POLE-AITKEN BASIN, PART 2: VON KÁRMÁN CRATER. J. F. Snape[1], A. L. Fagan[2], M. E. Ennis[3], J. N. Pogue[4], S. Porter[5], C. R. Neal[6], and D. A. Kring[7]; [1]Department of Earth Sciences, University College London, UK j.snape@ucl.ac.uk; [2]Department of Civil Engineering and Geological Sciences, University of Notre Dame, Notre Dame, IN, USA abacasto@nd.edu; [3]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, USA mennis2@utk.edu; [4]Earth and Planetary Sciences Department, University of California, Santa Cruz, CA, USA james.n.pogue@gmail.com; [5]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA simon.porter@asu.edu; [6]Department of Civil Engineering and Geological Sciences, University of Notre Dame, Notre Dame, IN, USA neal.1@nd.edu; [7]Lunar and Planetary Institute, Houston, TX, USA Kring@lpi.usra.edu.

Introduction: The National Research Council (NRC) identified eight major concepts and generated a prioritized list of 35 scientific goals for NASA's Vision for Space Exploration and its implementation through the Constellation Program [1]. While most of those concepts can be investigated across the Moon, we studied sites where they can be addressed in the South Pole-Aitken (SPA) Basin. SPA Basin is potentially the largest impact feature (~2500 km diameter) in the solar system [2] and covers most of the southern farside. SPA Basin is both topographically and compositionally distinct from the rest of the Moon and is the oldest identifiable impact structure on the surface [e.g., 3]. Our study suggests that nearly all of the NRC's science goals can be addressed within SPA. We also identified three particularly productive sites for lunar surface studies: Schrödinger Basin, Antoniadi Crater, and Von Kármán Crater, the first two of which are described elsewhere [4,5]. We outline science opportunities within Von Kármán Crater here.

Von Kármán Crater and Mare Fill: Von Kármán is a pre-Nectarian, 180 km diameter crater centered at ~44.8°S, 175.9°E [6], which places it within the estimated dimensions of the SPA transient crater [e.g., 7, 8] and makes it a promising location for sampling SPA-derived impact melt. Von Kármán Crater is substantially filled with mare basalt flows, although a small portion of a central uplift appears to protrude near the center of the mare. Kaguya crater counts suggest the mare is ~3.35 Ga [9], which is an Imbrian age consistent with previous mapping [10, 2].

Assessing the Lunar Interior: Using a dual-layered crust-moho depth model [11], and Kaguya (SELENE) topographic data, a map of crustal thickness was generated. There appears to be significant crustal thinning beneath SPA (Fig. 1). Using scaling relationships [12], the approximate depths of impact melting and source depth of central peaks within SPA were calculated (also shown in Fig. 1). These results suggest the Von Kármán impact event may have created a bulk melt representative of the entire crust and exposed the crust-mantle boundary in uplifted material.

Thorium and potential KREEP: Although concentrations of thorium within the SPA Basin are significantly lower than those observed in the Procellarum KREEP Terrain [13], some regions of relatively elevated Th are observed in Apollo and Lunar Prospector gamma ray spectrometer data [14,15]. The main Th-rich region is located in the NW portion of the SPA Basin with the highest values (~3-3.5 µg/g) at Birkeland (~32°S, 174°E) and Oresme V (~40.5°S, 165.5°E) craters. The anomaly is thought to be either antipodal ejecta from the Imbrium Basin [e.g., 16] or indigenous in origin [e.g., 17]. Because Th is typically used as a tracer for KREEP material, the Th anomaly within the SPA Basin may be a key location for understanding the nature and extent of the KREEP layer. Although Von Kármán Crater is located within this anomalous region (Fig. 2b), the mare appears to bury the source of that Th signature. Smaller craters within Von Kármán may, however, penetrate the mare surface and expose the Th-rich material.

Achievable NRC [1] Concepts and Goals in Von Kármán:

- Constrain lunar bombardment history by determining the age of Von Kármán (and possibly SPA) impact melt samples (Concept 1)
- Study the lunar interior by examining a crater that provides a cross-section of the crust and potentially exposes the moho (Concept 2)
- Study the variety, age, distribution, and origin of lunar rock types by obtaining relatively Th-rich, FeO-rich, mare, and impact melt samples from 4 out of the 5 geologic epochs (Fig. 2c) [2, 10] (Concept 3)
- Quantify variability in origin, composition, and age of a farside mare basalt (Concept 5)
- Examine the melt sheet to determine the existence and extent of differentiation (Concept 6)

Potential Landing Sites: We identified three potential landing sites within Von Kármán Crater. All three sites (Fig. 2) occur on the smooth, mare-flooded crater floor. Traverse stations are limited to radii of 10 km around the sites, reflecting current walk-back safety limits for crew during Extra Vehicular Activity (EVA) [18]. At any of these sites, a local geophysical network could be deployed to aid in the investigation of origin of basin ring origins, further enhancing the goals of Concept 6.

Site #1. The first site is located in the SW corner of the Von Kármán Crater where two types of mare may be sampled, as well as ejecta from an Orientale secondary impact crater [10]. Station 1a is located at the base of mare dome material (Imd), which is interpreted as being basaltic intrusions or extrusions [10]. Station 1b is on a smooth portion of mare material (Im_2, [10]). Station 1c is at the edge of the mapped ejecta of an Orientale secondary impact crater (Ioc, [10]); it is also adjacent to part of Von Kármán's interior wall where upper crustal stratigraphy may be observed and samples of impact melt collected.

Site #2. The second site is located in the central portion of Von Kármán Crater near an area of raised relief, which may contain remnants of a central peak. Station 2a is adjacent to a mounded feature mapped as Nectarian crater material (Nc, [2]). Station 2b samples ejecta from a fresh, Copernican crater that displays higher FeO values than the rest of the mare on the basin floor. This crater may have sampled some relatively Th-rich (~1.5-2.5 µg/g) material that the mare appears to have masked. Although the ejecta blanket does not appear particularly unique in UV-VIS spectral data, in spectral ratio maps, it displays a much greener tone than the surrounding mare indicating the presence of high-Ca pyroxene and/or olivine [19]. Station 2c is located in mapped pre-Nectarian crater material (pNc, [10]).

Site #3. A third potential landing site is located in the SE portion of Von Kármán, again mostly on the mare material (Im_2, [9]). Station 3a provides easy access to mare samples from a different location (Im_2, [9]). Station 3b is adjacent to the crater's wall and affords a possible location to examine stratigraphy and search for impact melt. It also lies on top of a mapped unit of Copernican-aged crater ejecta (Cc, [10]).

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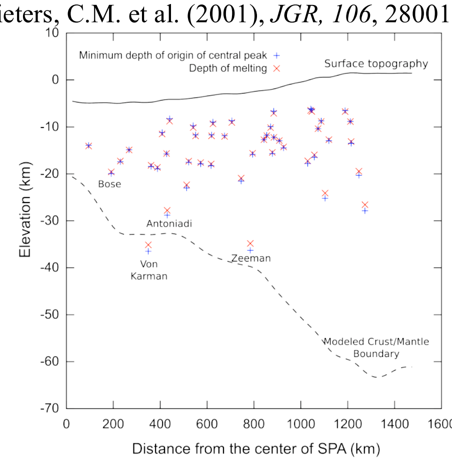

Fig. 1: Radially averaged crustal thickness profile for SPA. Solid line represents the averaged topography of SPA; dashed line represents the depth of the moho. The depths of origin for crater central peaks and depths of melting [12] have been superimposed on this profile and adjusted for the radially averaged surface elevation.

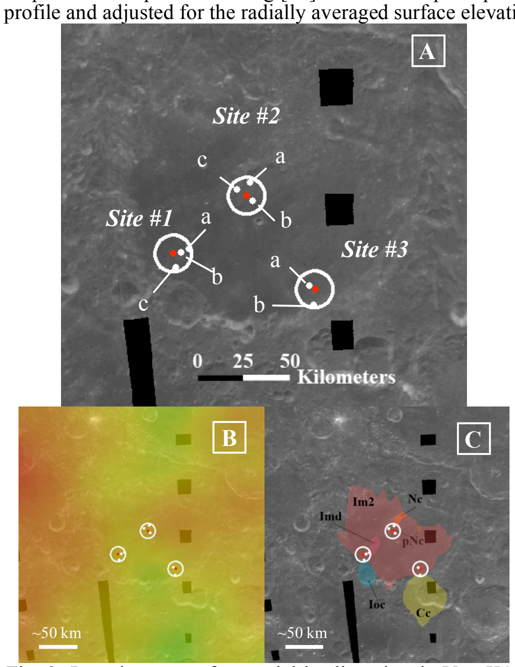

Fig. 2: Location map of potential landing sites in Von Kármán: (a) underlain by black and white Clementine topography; (b) underlain by Clementine topography and Lunar Prospector Th; (c) underlain by Clementine topography and geologic units [2, 10].