

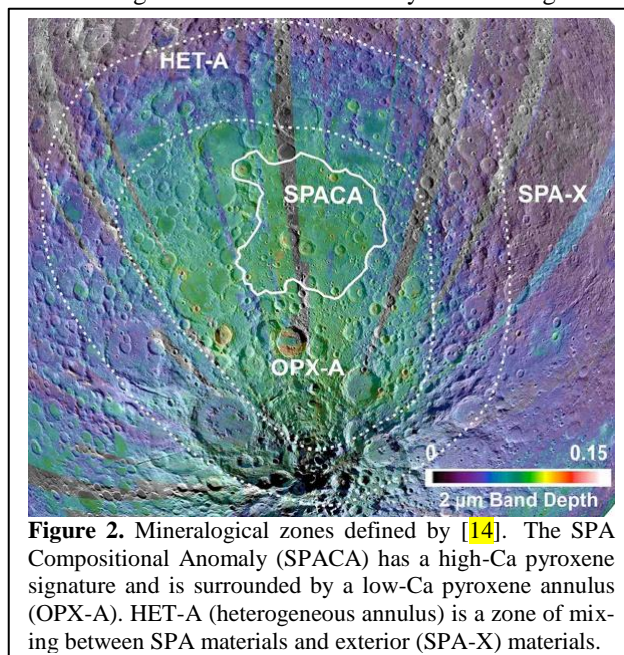
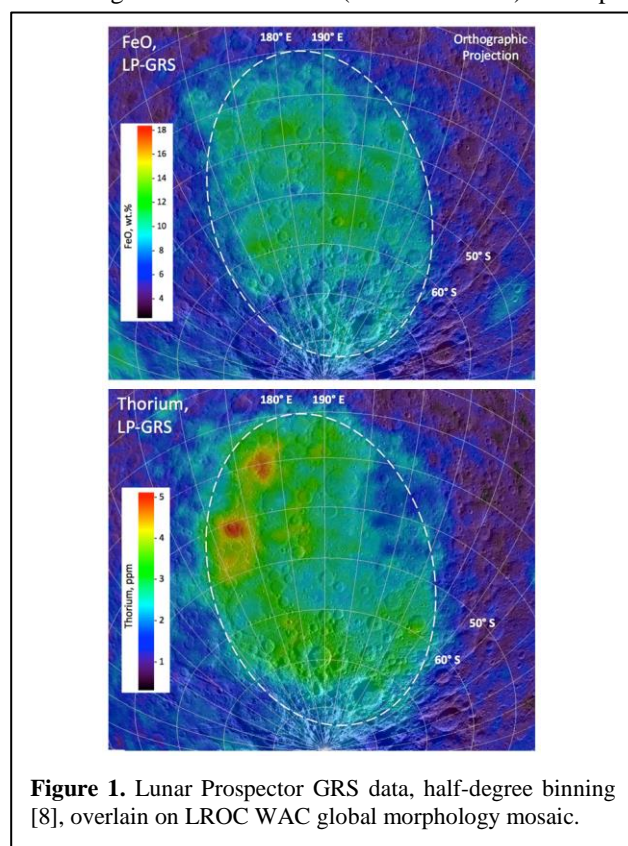
SELECTING AND CERTIFYING A LANDING SITE FOR MOONRISE IN SOUTH POLE-AITKEN BASIN. B. Jolliff¹, R. Watkins¹, N. Petro², D. Moriarty², S. Lawrence³, J. Head⁴, C. Pieters⁴, J. Hagerty⁵, R. Fergason⁵, T. Hare⁵, L. Gaddis⁵, and P. Hayne⁶. ¹Department of Earth & Planetary Sciences, Campus Box 1169, Washington University in St. Louis, One Brookings Dr., St. Louis, MO 63130; ²Goddard Space Flight Center, Greenbelt, MD; ³Johnson Space Center, Houston, TX, ⁴Brown University, Providence, RI, ⁵US Geological Survey, Flagstaff, AZ, and ⁶Jet Propulsion Laboratory, Pasadena, CA. (bjolliff@wustl.edu)

Introduction: MoonRise is a New Frontiers mission concept to land in the South Pole-Aitken (SPA) basin, collect samples, and return the samples to Earth for detailed mineral, chemical, petrologic, geochronologic, and physical properties analyses to address science questions relevant to the early evolution of the Solar System and the Moon. Science associated with this mission concept is described elsewhere [e.g., 1-7]; here we discuss selection of sites within SPA to address science objectives using recent scientific studies (orbital spectroscopy, gravity, topography), and the use of new data (LRO) to certify safe landing sites for a robotic sample return mission such as MoonRise.

Scientific Site Selection: Owing to impact mixing, rock components of SPA regolith are expected to include: (1) original SPA impact-melt rocks and breccia (key to determining the age of the impact event and what materials were incorporated into the huge SPA impact-melt sea); (2) impact-melt rocks and breccia from large craters and basins (other than SPA) that represent the post-SPA late-heavy bombardment interval;

(3) volcanic basalts derived from the sub-SPA mantle; and (4) older volcanics or “cryptomare” (ancient buried volcanics excavated by impact craters) to determine the volcanic history of SPA basin. All of these rock types are sought for sample return.

Existing orbital, chemical, and mineralogical data guide our approach to scientific site selection and allow selection of an appropriate landing site. FeO and Th data from the Lunar Prospector gamma ray spectrometer revealed an elliptical geochemical anomaly ~1200 km across, corresponding to the SPA basin interior [8; Fig. 1]. Within this context, mineralogical data (Moon Mineralogy Mapper, Chandrayaan-1) indicate several concentric zones within SPA that correspond in part to differentiation of the SPA impact melt sheet and its excavation by subsequent large impacts into SPA, and volcanic rocks that have erupted into the deepest parts of the basin [9-11; Fig. 2]. Coupled with studies that predict the makeup of regolith at a given location on the basis of ballistic mixing of ejecta from large craters [12,13], we use these criteria to focus on a region in the interior of SPA between 45-60°S and 175-200°E. Large, post-SPA impacts have excavated SPA “substrate” – mainly the upper layers of SPA impact melt, distributing these materials laterally and mixing them



into the megaregolith in the basin interior. Subsequent small impacts further mixed this material, generating a regolith rich in original SPA materials as well as impactites from subsequent large impacts. Relatively smooth inter-crater plains in the basin interior also provide access to ejecta from small impacts into cryptomare and nearby mare surfaces. All of these materials are of interest to address SPA sample return science objectives.

Within the interior of the basin, numerous areas exist that would be of specific interest based on local geology and the likelihood of returning samples that can address a number of science objectives. For example, E-SE of Bhabha crater, the surface consists of inter-crater plains that likely contain ejecta from a number of craters including Bhabha, Bose, and Stoney, mare and cryptomare deposits from the local vicinity and north of the site, and possibly material from the enigmatic, potentially volcanic construct “Mafic Mound” to the south [15] (Fig. 3). Other areas of special interest are located south and west of Bose crater, and as far south as 60°S latitude in the area of the “Constellation Interior” site [16,17].

Landing Site Safety Assessment. Science-rich landing sites for MoonRise occur in many locations within the SPA basin, and currently available imaging is sufficient to select and certify safe landing sites.

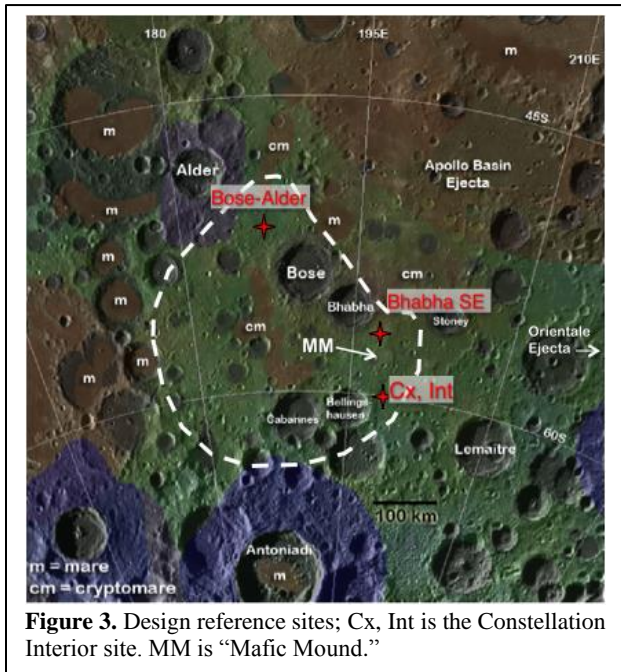


Figure 3. Design reference sites; Cx, Int is the Constellation Interior site. MM is “Mafic Mound.”

Topography. Digital terrain models derived from LROC Wide Angle Camera (WAC) [18], SELENE Terrain Camera [19], and LROC Narrow-Angle Camera (NAC) geometric stereo images [20] provide topographic context at all necessary scales. Full coverage of

the basin exists for WAC-LOLA and SELENE-LOLA DTMs. At the lander scale, DTMs derived from NAC geometric stereo provide slope and surface roughness data needed to certify a landing ellipse as safe. NAC DTMs undergo a meticulous production process [20], and DTMs are then subjected to rigorous evaluation similar to the process for Mars landing sites [21]. NAC DTMs provide slope data at a 2 m baseline; examples of these products are shown in Fig. 4.

Boulder Hazards. Boulder size-frequency distributions are determined using NAC images to identify boulders >1 m [22]. Abundances of rocks are estimated using Diviner data [23]. Apollo landing sites provide validation sites for all of these methods.

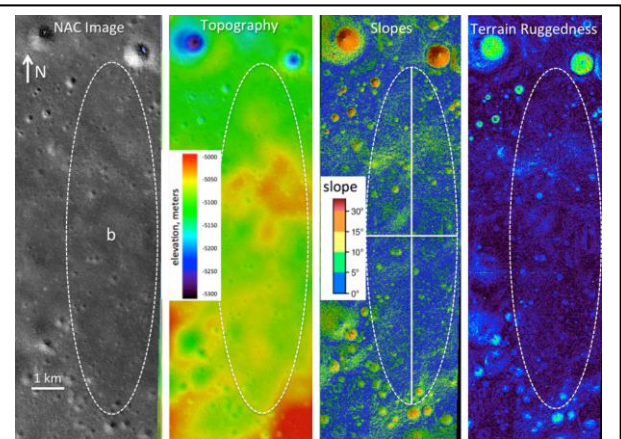


Figure 4. Terrain visualization products for Bhabha East Plains site. NAC DTM undergoes rigorous validation similar to that used for landing sites on Mars. In landing ellipse b, 99.98% of all slopes are less than 15°.

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