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Introduction: The SpaceIL mission is a lander named Beresheet originally conceived as a contender in the Google Lunar X-Prize competition with an objective of landing on the Moon, transmitting images and collecting information on the surface. In addition to a suite of cameras, the mission has integrated a scientific payload consisting of a small Lunar Retroreflector Array (LRA, provided by NASA Goddard [1]) and a 3-axis, fluxgate magnetometer (SILMAG, provided by UCLA [2]). Correspondingly, the science mission of SpaceIL consists of detailed characterization of the landing site, measuring the crustal magnetic anomalies to constrain their possible origin and longevity of the lunar dynamo, and localization of the lander using ranging to the LRA.

Landing Site: Located in the northeastern part of Mare Serenitatis and West of the main Posidonius crater, the area of the three optional landing sites (primary site and two backups, shown in Fig. 1, provisionally named Posidonius 1,2,3) is composed of mare material (mapped units Im1-2/Ipm1-2). The detailed characteristics of the regions are typical of ancient mare surfaces on which successful landings have been made (most recently Chang'E 3 and 4). The surface is regionally smooth (Fig. 1a), low-sloped (Fig. 1b), has a low abundance of rocks with a few scattered small craters. The age of the surface in the landing region (~3.3-3.5 Ga; [3]), together with its magnetic properties [4], offers the possibility of gaining important new insights into the history and origin of the magnetic field (e.g., [5]).

Early geologic mapping from Earth-based telescopic observations and Lunar orbiter images suggested that the low-albedo mare deposit annulus was younger (Eratosthenian in age) than the basin interior (Imbrian in age) [6-8] but more detailed geologic mapping and the results of the Apollo 17 mission [9-11] showed that the dark annulus (and the pyroclastic deposits in southeast Serenitatis) were in places older than the Mare Serenitatis interior. This was further clarified by the Apollo Lunar Sounder Experiment ALSE carried on the Apollo 17 mission [12, 13]. Subsurface reflectors revealed that the dark annulus dipped underneath the central Imbrium-aged mare fill (e.g., [14, 15]). Previous studies [16, 17] mapped the relationships between the broad units in the mare stratigraphy and the array and sequence of tectonic features in Serenitatis and other major basins. They outlined the detailed chronology between the loading and flexure of the basalts in Mare Serenitatis and the evolving, and in creasing, thickness of the elastic lithosphere.

The landing sites described above resulted from various engineering constraints which imposed thermal,

(a) (b)

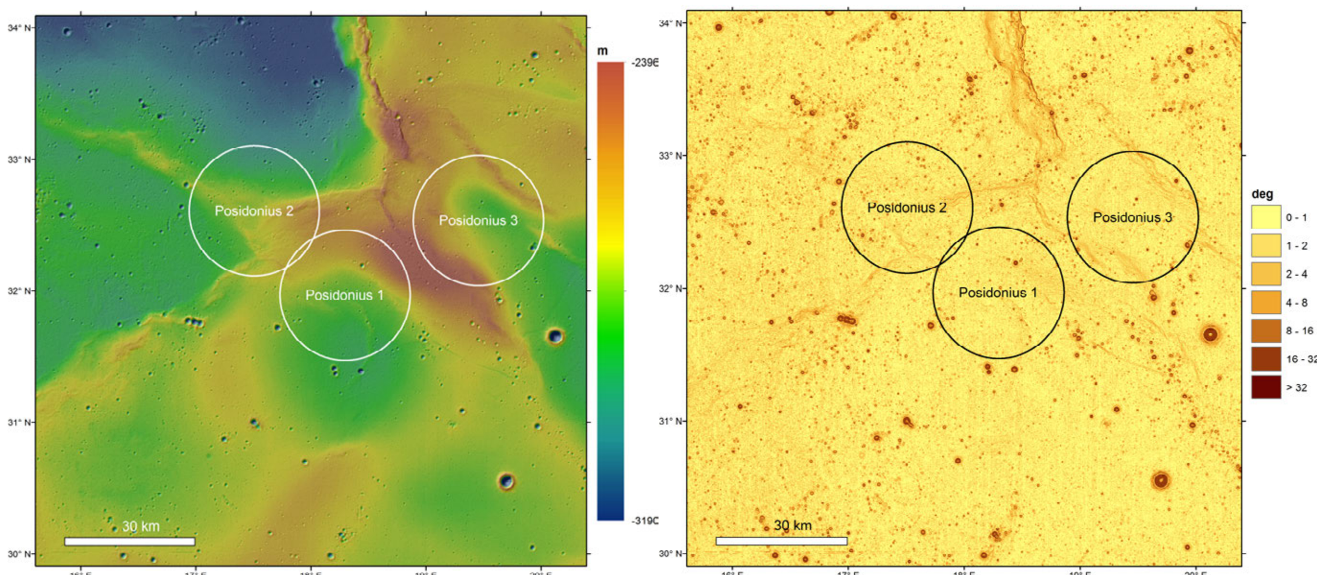

Figure 1: Topogrphy (a) and surface slopes (b) of the planned SpaceIL landing site in Mare Serenitatis, near Posidonius crater.

communication, and navigation requirements and limited the possible landing regions on the Moon. These resulted in shifting the search to the Northern midlatitudes (from previous candiates, see [18]). Subsequently, quantitative criteria were employed in evaluating landing site safety for the sites presented here. Specifically, limitation on the topographic variations within the 30 km dimeter landing ellsipse were placed using combined LOLA and Selene data sets [19]. Rock abundance based on Diviner thermal measurements [20] extrapolated using observed particle size distribution [21] were used to estimate the 10 cm scale rocks. LOLA altimetry [22, 23] was used to estimate surface slopes and roughness. High resolution topography was employed using stereo-derived DTMs based on pairs of LROC images [24].

Magnetic Field Investigation: Orbital measurements of the magnetic field from Kaguya and Lunar Prospector [4] guided the selection of the final sites to a location West of Posidonius crater, where the magnitude of the mangetic field reaches 8-10 nT, as measured from orbit and modeled as the surface field. SpaceIL will acquire three-axis field measurements during landing, which should enable reconstruction of the crustal field variations and finer scales as the spacecraft approaches the ground. SILMAG data may be recorded in two modes: 10 Hz and 0.625 Hz, the latter representing 16-measurement averages of the former. Data acquisition is planned during orbit and landing trajectory, providing a unique data set at low altitude. Below 10 km altitude, high resolution measurements are available only from the Lunokhod 2 rover (though these data are no longer publicly available and were only the subject of a brief publication [25]).

We plan to use these data to associate the anomalies with geologic features on the surface, and thus probe the genesis of the remnant magnetization. A relation between magnetization and local wrinkle ridges would be consistent with the hypothesis that the Serenitatis mare are uniformly magnetized with an intensity higher than typical Apollo mare basalts but only producing surface fields at physical breaks where the field lines can emerge due to edge effects.

The estimated age of the flows at the SpaceIL landing site [3] is just in the window during which the high-field epoch is thought to have declined based on Apollo paleomagnetic measurements dynamo [26, 27]. In particular, the timing of the end of the high-field epoch is not well-constrained due the lack of sampled units with ages between 3.56 (Apollo 11 high-K basalt) and 3.3 Ga (Apollo 15 basalts). Thus, constraining the paleointensity from measurements of remnant magnetic fields at the landing site could help constrain the timing of the dynamo's decline [5]. Further, if it can be shown that crustal anomalies are indeed associated with physical disruption of the mare stratigraphy, this could reconcile the apparent discrepancy between the weak crustal magnetism observed from orbit and significant paleomagnetism of Apollo samples in the Imbrian and later epochs.

Finally, if vector magnetic anomalies can be associated with bedrock exposures, these measurements can address the possibility of True Polar Wander on the Moon. Such bedrock could be exposed in the walls of craters or rilles or associated with the wrinkle ridge structures at the proposed landing sites.

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