IDENTIFYING POTENTIAL SAFE LANDING SITES FOR ESA/ROSCOSMOS' LUNA 27 MISSION. S. J. Boazman[1], D. Heather[1], E. Sefton-Nash[1], C. Orgel[1], B. Houdou[1], X. Lefort[1] and The Lunar Lander Team[1], [1]ESTEC, ESA, Noordwijk, Netherlands, (Sarah.Boazman@esa.int).

Introduction: The region surrounding the lunar south pole is an area of recent interest due to the potential volatiles and water ice present [e.g. 1,2,3]. The south polar region has not been explored by previous missions and therefore sampling the lunar surface to further the understanding of the geology of the south pole is of interest. Future missions including NASA's Artemis program and ESA/ROSCOSMOS' Luna missions seek to further understand the geology and volatiles present as well as developing a sustainable mission architecture.

The European Space Agency (ESA) and Russian Space agency (ROSCOSMOS) have a joint mission the Luna 27 lander, which will study the composition of the lunar soil and volatiles [4]. Onboard Luna 27 there is a drill called PROSPECT, which will reach depths of 1 m, sampling the lunar subsurface [4,5]. These samples will be analyzed in the lander's onboard laboratory. To ensure the volatile-rich samples can be collected of the lunar surface, which yield the most scientific return, the potential landing sites are being investigated using remote sensing methods [6]. This study investigates eight landing sites selected on the basis of their potential scientific interest (Figure 1), identifying areas that are safe for landing. Future work will further investigate the scientific potential of these landing sites.

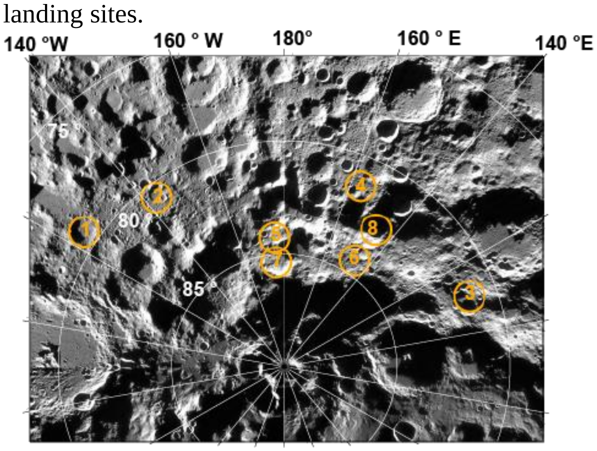

Figure 1: South pole WAC mosaic with the eight landing sites highlighted by the orange circles which have a 20 km radius.

Datasets and Methods: First the locations of the eight potential landing sites were mapped on the WAC mosaic of the south pole. We used the LOLA 30 m/px digital elevation model (DEM) to create elevation maps and hillshades of each of the eight sites using geographical information software: ArcPro.

We made slope maps of the region, using LOLA 30 m/px and classified the slope maps to show areas of less than 10° as green and areas greater than 10° as red. Areas in red are not safe to land and this is defined by the requirements of the PILOT landing system. Areas safe to land were identified at each of the landing sites (Figure 2). The areas identified must be at least 20 by 20 m to cover the size of the lander. A second slope map was created with safe landing areas (slopes < 10°) classified in 2° intervals to show the areas which have the shallowest slopes and therefore safer to land (Figure 3).

Results: Each of the eight landing sites contained safe areas to land based on the slopes present and sites 1, 2, 4, 6 and 8 had large (> 500 m^2) areas classified as safe (Figure 2).

Site 3 has large craters scattered across the surface which have walls with slopes greater than 10°. These crater walls may present a hazard to landing, although the largest of the craters has a flat crater floor with slopes less than 2°. At site 5 there is a large crater (~20 km diameter) to the bottom right of the site that has a steep crater wall and rim, creating a topographic ridge in south east of the potential landing site (Figure 2, 3). This ridge should be avoided as a landing area. Site 7 similarly has a steep topographic ridge to the south of the potential landing site (Figure 2, 3), which again should be avoided as a landing area. In comparison, site 8 contains a large flat area in the centre with slopes of 0-2°, which would be an ideal safe landing area. Site 1 covers a large (~40 km diameter) crater. The centre of site 1 has shallow slopes with majority of the crater floor less than 4°. Site 2 similarly has a large (~13 km diameter) crater with a shallow crater floor with slopes less than 4°. The crater floors in site 1 and 2 could both be a safe landing site for Luna 27.

Site 4 and 6 show the most varied topography and areas of shallow slopes less than 4° neighbor areas with slopes of greater than 14°.

Conclusions and Future work: Each of the 8 potential landing sites have areas with slopes less than 10° , potentially meeting the safety criteria in regard to the slopes and therefore would be safe for landing Luna 27. Site 1, 2 and 8 showed the largest areas where there was shallow slopes less than 4° and therefore may be safer landing sites. This initial investigation has started to explore the candidate landing sites for the Luna 27 mission.

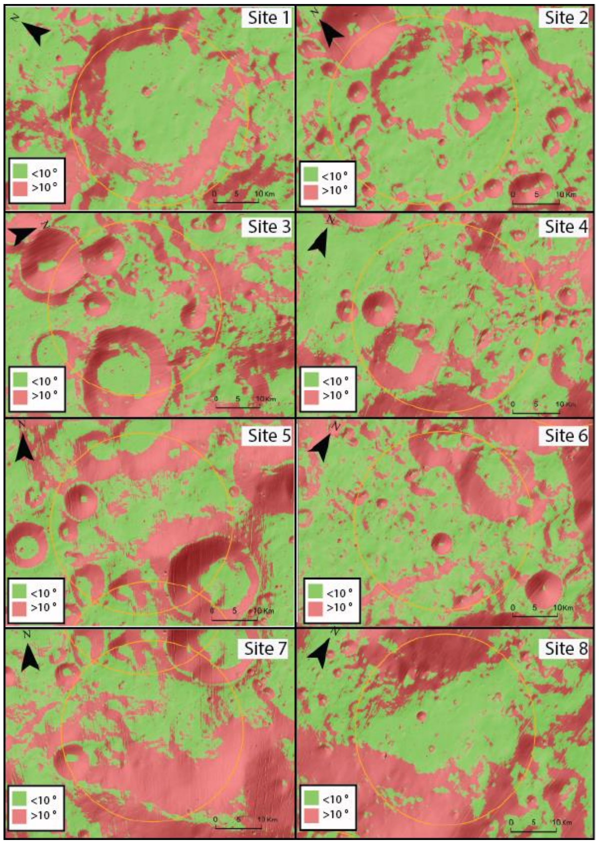

Figure 2: Slope maps of the eight landing sites made with LOLA (30 m/px) DEM overlaid on LOLA (30m/px) hillshade. The orange circles (20 km radius) highlights the landing sites. Areas in green highlight safe landing areas. Areas in red are greater than 10° and are not safe to land. Note each of the eight sites contain areas safe to land.

Future work will continue to investigate these eight potential landing sites by exploring the surface roughness; identifying craters and boulders, which could present a hazard to the lander. We will explore the illumination conditions and Earth visibility at each of the landing sites. Additionally, we will use thermal maps to monitor the thermal stability of the lunar soil [7]. We will use multiple datasets, including NAC images, Diviner, KAGUYA and M^3 data to explore the scientific potential of the landing sites. In particular understanding the composition of the lunar soil and if there is water ice present for sampling with the PROSPECT drill.

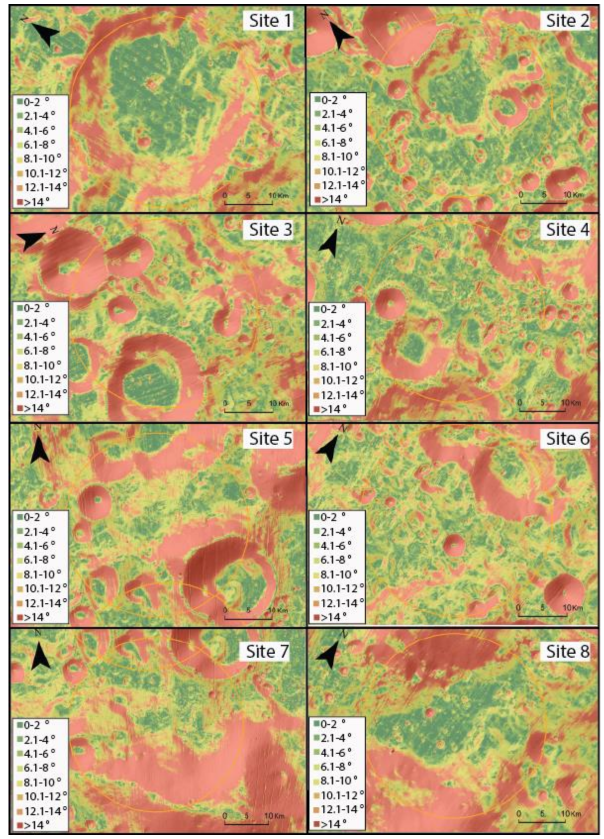

Figure 3: Slope maps of the eight potential landing sites created using LOLA 30m/px DEM. Slope maps have been classified in 2° intervals to show the areas with the shallowest slopes, which are therefore the safest landing sites.

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References:

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