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Candidate landing sites and possible traverses at the south pole of the Moon for the LUVMI-X rover

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Lunar volatiles, such as water, are a crucial resource for future exploration, and their exploitation should enable the use of the Moon as a platform for even more remote destinations. As water is most likely to be found in the form of ice at the lunar poles (where surface temperatures can be as low as 40K, i.e. below the H2O temperature of sublimation in vacuum, 110K), multiple upcoming missions target the south pole (SP) cold traps. PSRs (Permanently Shadowed Regions) are especially cold enough to capture and retain volatiles but present challenging access conditions (rough topography, low illumination, low temperatures, limited Earth visibility).

Funded by the EU program Horizon 2020, Space Applications Services developed the LUVMI-X rover (LUnar Volatiles Mobile Instrument eXtended), aimed at sampling and analysing lunar volatiles in the polar regions, including within a PSR. The LUVMI-X nominal payload includes an instrumented drill, the Volatiles Sampler (VS), along with a mass spectrometer, the Volatiles Analyser (VA), for surface and subsurface volatile detection and characterisation. A LIBS and a radiation detector are also included. Deployable and propellable surface science payloads are in development for inaccessible sites (e.g., some of the PSRs). This solar-powered rover has an autonomy of one or two Earth nights and can drill down to 20cm in the lunar regolith. The goal of this paper is to find suitable landing sites & traverses' paths for this rover project, that are both scientifically interesting and technically reachable.

Available remote sensing imagery for the lunar SP was downloaded from the PDS or corresponding instruments' websites and added into a Geographic Information System (GIS). LUVMI-X scientific objectives and technical specifications were then translated into a list of criteria and computed in our GIS using reclassifications, buffers, and intersections. Using our GIS, reclassified data were overlaid with different weights to define and rank areas meeting the compulsory criteria. A global analysis was led to select the landing sites, followed by a local analysis (based on higher resolution data) for the establishment of traverses.

The global GIS analysis allowed us to identify six regions of interest (ROI), which were compared with previous SP ROI from the literature (Lemelin, 2014; Flahaut, 2020). The identified ROI were further ranked based on areas and statistics on Sun and Earth visibilities, Diviner average surface temperatures, and H/water ice signatures (LPNS, LEND, M3).

A prime ROI located between Shackleton and the Shoemaker/Faustini ridge was selected for traverse analysis. Four landing ellipses of 2x2km were located and ranked inside the ROI. Way Points (WP) were then identified to include the following scientific interests in each traverse: a boulder casting shadows, a PSR to throw a propellable payload in, an accessible PSR to go into, etc. As several WP are possible, Earth visibility was used to select the best ones. WP were then connected by using slope maps (LOLA DEM at 5m/px: avoid slopes over 20°), Earth & Sun visibilities (avoid no-go zones) and the LROC NAC mosaics at 1m/px (avoid boulders and craters), constituting a tentative traverse.