POTENTIAL LANDING SITES NEAR LUNAR SOUTH POLE FOR DETECTION OF LUNAR OH AND H_2O AND ITS CORRELATION TO SURFACE COMPOSITION. S. A. Sathyan[1], M. Chowdhury[2], and M. Bhatt[1], [1]Physical Research Laboratory (sachana@prl.res.in), [2]Onshore Construction Company Pvt. Ltd., Powai, Mumbai- 400072.

Introduction: Lunar south pole is a special environment in regard to its enriched H_2O and other volatiles as it hosts more number of permanently shadowed regions (PSR) in comparison to the lunar north pole [1-5]. It is a prime focus region for future orbiter and lander missions like Artemis, VIPER and LUPEX. Numerous scientific instruments orbiting the Moon now and the last two decades have significantly advanced our understanding of the polar OH/H_2O distribution [1-7]. The characterization and quantification of OH/H_2O and minerals are greatly dependent on proper instrument calibration, spatial and spectral coverage. For reducing uncertainties, integrated multi-wavelength approach is required. Moreover, the compositional dependency on H_2O ice accumulation, retention, loss and the processes operating in and around PSRs is important to be carried out using high resolution data-sets recently made available [8].

The objective of this work is to study some of the important landing sites considered for future landing missions in detail by integrating geomorphology and spectroscopic information and prioritize the sites based on scientific importance and landing feasibility.

Selected lunar south polar sites: A total of four sites are selected (Fig. 1) which are located in between De-Gerlache and Shackleton craters along the connecting ridge which belongs to the outer rim of the South Pole Aitken basin. All these sites are in illuminated area that satisfies the limits imposed by illumination conditions as it is the most concerning factor for a landing mission at lunar poles along with other technical feasibility factors like slope, elevation and roughness. Additionally, the sites have been considered based on their proximity to PSRs.

Data Sets and Methods: Our detailed maps are an outcome of using various data-sets as individual layer of information. We used all publicly available higher level data products and prepared mosaic of the selected sites. The Moon Mineralogy Mapper (M^3) of Chandrayaan-1 [6], is being used to understand mineralogy and its association to OH/H_2O abundance. Lunar Reconnaissance Orbiter (LRO)-Diviner Lunar Radiometer Experiment DLRE Minimum, Maximum and Annual average temperature data [10] have been used for locating cold traps. LRO Wide Angle Camera (WAC) and Narrow Angle Camera (NAC) images [9] have been used for understanding geological context. LRO derived 5 m Digital Elevation Model (DEM) used for deriving the topographic parameters; slope, aspect, roughness and geomorphology [13] along with polar illumination maps from [12]. We have derived a trafficability map by integrating the topographic parameters that can be useful in traverse planning of future mission's rovers.

These four landing sites were evaluated critically in terms of topography as well as their volatile exploration possibilities by formulating a PSR map of much finer resolution than currently available and carrying out a proximity analysis of PSR's to these proposed landing sites. The variation in depth to diameter (d/D) of craters as a function of latitude (0-90°S) was also studied by adopting the method from [14] by keeping the diameter of craters constant for the entire latitudinal range.

Results: We have integrated outcomes of already available OH/H_2O map, high CPR maps from Mini SAR and Mini RF and hydrogen abundance map from LPNS [6, 11, 3, 7], with newly derived information in this study to prioritize the sites based on high probability of OH/H_2O exposures. The d/D values derived showed a decreasing trend towards south pole reaching a minimum d/D value 0.06 for craters in latitudes above 85°S. This decreasing depth of craters towards poles can be attributed to ice deposition within the crater [14]. The observe d/D ratio trend are used to identify craters with very low d/D ratio in the selected sites. The detailed topographic analysis using high resolution DEM favors site C1 (Fig.1) as the most flat and safe site for landing as it has more area with less slope (<8°), good illumination and low surface roughness. However, the integrated analysis of M^3 and topographic data suggest the site D near to De-Gerlache as the most interesting site considering the expected scientific outcomes. The site maintains a lower thermal regime (50K) where we can expect CO_2 ice exposures along with OH/H_2O ice exposures [17, 18]. Additionally, the site D (Fig.1) satisfies all the technical constraints required for a suitable landing site. Fig.1 (a and b) shows representative reflectance spectra and corresponding continuum removed spectra extracted from all considered sites. The continuum is removed using [16] method. All the sites show an absorption around 2.8 micro m which is due to presence of OH/H_2O. We have carefully identified several clean M^3 spectra with absorption bands present at lower wavelength region (below 1 micro m) and a wide but weak absorption band around

2 micro m. We found that mineralogically, site D is diverse in comparison to all other sites considered. The newly reported hematite [15] deposits are also within the close vicinity of the site D. We have located several minor PSRs based on their low d/D ratio near to site D that can be explored using a rover.

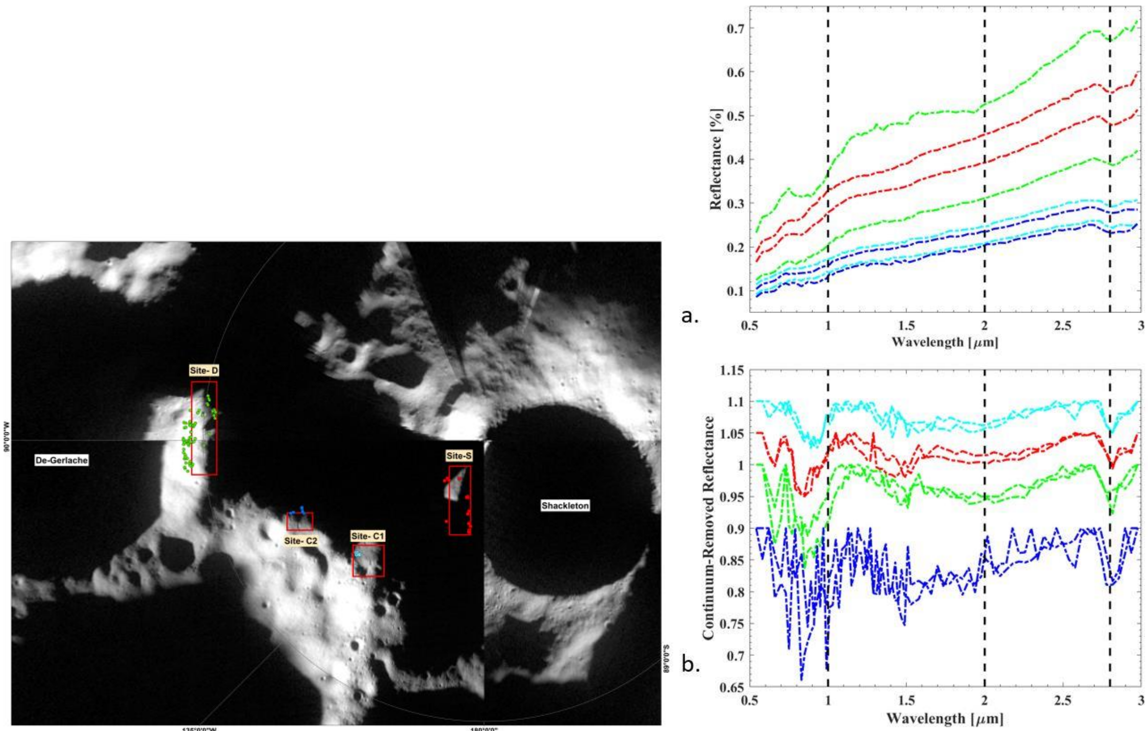

Fig1. Four landing sites overlaid on LROC WAC [9] mosaic. The representative M3 spectra plotted in right and color coded to site locations shown in left figure. The continuum removed spectra are plotted with offset for clarity. The dashed black lines are at 1, 2 and 2.8 micro m.

Summary: A detailed study on various remote sending datasets were conducted to establish volatile rich regions in the proximity of the four proposed landing sites. Based on both technical and scientific constraints, site-D comes out to be the best landing site that can be utilized to explore the interior of De-Gerlache crater. Work is under progress for mapping minerals using M³ for these sites and we also plan to incorporate Imaging Infrared Spectrometer (IIRS) and Dual Frequency Synthetic Aperture Radar (DFSAR) datasets of Chandrayaan-2 to our study in near future.

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