BOULDERS DISTRIBUTION AT THE PROPOSED LUPEX LANDING SITE NEAR LUNAR SOUTH POLE USING ORBITER HIGH RESOLUTION CAMERA (OHRC) IMAGE. A. K. Dagar[1] (adagar@sac.isro.gov.in), R. Nagori[1], R. P. Rajasekhar[1], S. Bhattacharya[1], V. T. Bickel[2], [1]Space Applications Centre, Indian Space Research Organisation (ISRO), Ahmedabad – 380015, India, [2]Center for Space and Habitability, University of Bern, Switzerland.

Introduction: The Lunar Polar Exploration (LUPEX) mission is a joint collaboration between Indian Space Research Organisation (ISRO) and Japan Aerospace Exploration Agency (JAXA). It will consist of a lander and a rover, which will be provided by ISRO and JAXA, respectively. The primary objective of the LUPEX mission is to detect the presence of water and quantify its concentration in the upper regolith layer. It will characterize the nature and form of water, for which it has various instruments ranging from a thermo-gravimeter, mass spectrometer, optical spectrometer to neutron spectrometer. The in-situ measurements obtained from this mission will also act as ground truth for the orbiter-based instruments. LUPEX is planned to be launched in 2025 using H3 rocket by JAXA [1]. The potential landing site for this mission is near the Shackleton crater at the lunar South Pole. This region is also among the priority landing site for the Artemis mission [2]. In the present study, we have analysed the distribution of boulders over a portion of the Shackleton de Gerlache ridge using a high spatial resolution image from Orbiter High Resolution Camera (OHRC) on-board Chandrayaan-2. The information about the boulder distribution is necessary from the perspective of hazard avoidances in case of landing and roving [3][4]. Also, boulders make an ideal target for sample collection for further analysis.

Observations and Analysis: A very high spatial resolution image (~0.25 m), centred at 89.2836° S, 140.556° W, was acquired by OHRC over the Shackleton de Gerlache ridge under very low illumination conditions. Figure 1a shows the location of OHRC image (bounded by red box) overlain over the Lunar Reconnaissance Orbiter (LRO) Wide Angle Camera (WAC) mosaic [5] of Shackleton crater and de Gerlache ridge. The spatial distribution of mapped boulders is shown as green dots on the OHRC image in figure 1b. The boulders were manually mapped as circles (for methodology see [3]).

As seen from the Figure 1, the boulders are distributed all over the region, and especially concentrated around the craters. Boulders have also been mapped in the same region by [6], though using a comparatively coarser resolution LRO Narrow Angle Camera (NAC) images. While we have mapped a large number of boulders using OHRC image as evident from Figure 1b, the study in [6] shows an absence of the mapped boulders in the same region (as seen from figure 5c and 5d in [6]). The absence of boulders may be due to insufficient spatial resolution or improper lighting conditions for mapping such small features.

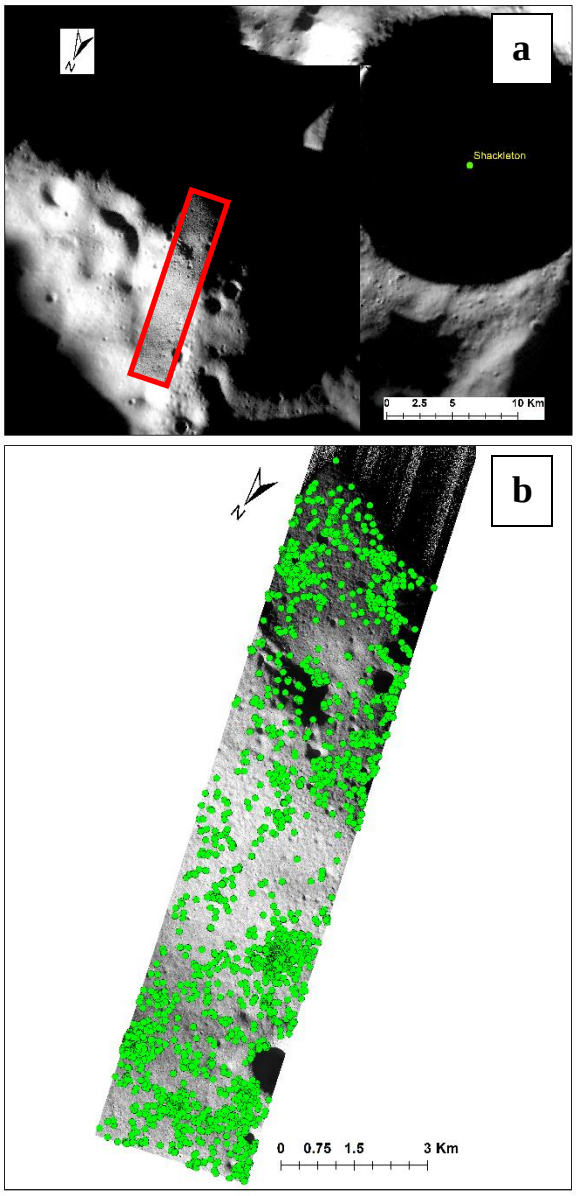

Figure 1. (a) OHRC image (bounded by the red box) overlain on the LRO-WAC mosaic near the Shackleton crater. (b) The OHRC image with the mapped craters (green dots) overlain on it.

Results: A total of 5186 boulders were mapped in the region with a minimum, maximum and average size of 0.65 m, 7.94 m and 1.48 m, respectively. Figure 2 shows the histogram of the mapped boulders size. It is evident from the figure that over 99% boulders have a size < 4 m. Only a few of the larger boulders are mapped in this region. Figures 4 and 5 shows the frequency and cumulative frequency of the mapped boulders. A high is observed in the frequency as well as cumulative frequency distributions between 4-6 m, which indicates an unexpected increase in the number of boulders in this size range. The areal density of boulders is ~116 per square km.

Conclusion: More than 5000 boulders, in the size ranging from 0.65 m to 7.94 m, were mapped in the selected region near the South pole, which is among the sites proposed for the landing of future ISRO-JAXA mission LUPEX and, also the Artemis mission of NASA. Over 99% boulders were estimated to be < 4 m and ~ 80% are smaller than 2 m size. The mapping of the boulders and their spatial distribution is an essential input for the safe landing and trafficability. Also, boulders make an excellent target for sampling.

References: [1] Ohtake et al. (2021) *LPSC LII*, #1840. [2] Artemis III Science Definition Team Report, *NASA/SP-20205009602*. [3] Dagar et al. (2022) *Icarus*, *386*, 115168. [4] Nagori et al. (2024) *PSS*, *240*, 105828. [5] Speyerer E. J. (2011) *LPSC XLII*, #2387. [6] Boazman et al. (2022) *PSJ*, *3*, 275.

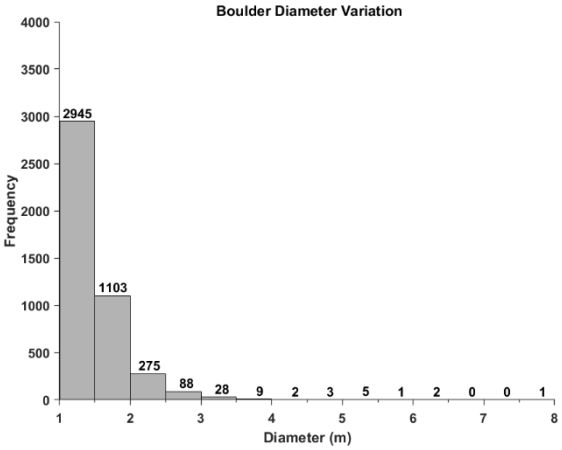

Figure 2. Histogram of the boulder diameters.

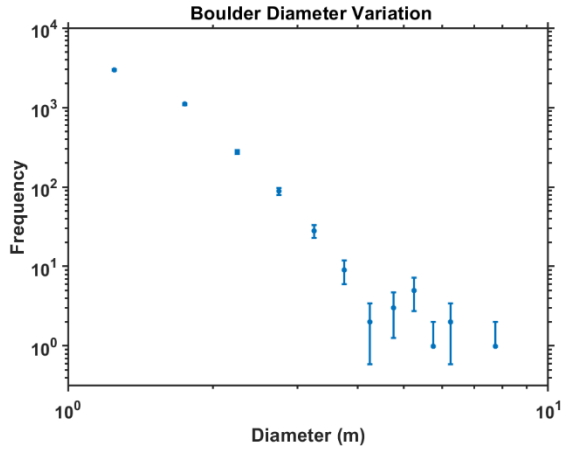

Figure 3: Size Frequency Distribution of the boulders.

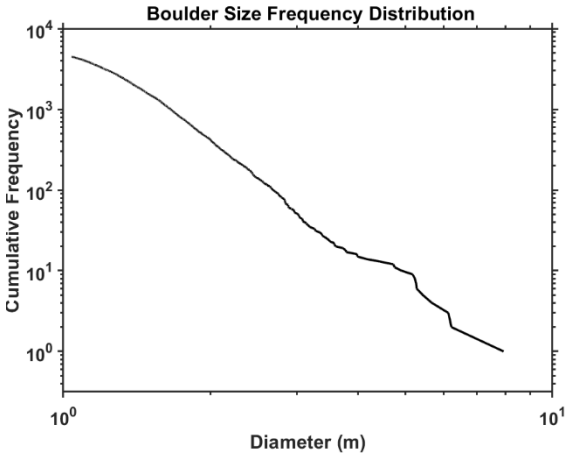

Figure 4: Cumulative Size Frequency Distribution of the boulders.