AMUNDSEN CRATER, SOUTH POLE MOON: POTENTIAL LANDING SITE TO EXPLORE POSSIBLE FLOOR INTRUSION AND MULTIPLE PSR. S. Vijayan[1], K.B. Kimi[1], P. Achintya[2], Harish[1], S. Tuhi[3], V.J. Rajesh[2], B. Sivaraman[1], and Anil Bhardwaj[1]. [1]Planetary Science Division, Physical Research Laboratory, Ahmedabad, India. [2]Department of Earth and Space Sciences, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India. [3]College of Engineering, Anna university, Chennai, India. vijayan@prl.res.in

Introduction: The lunar south pole is one of the potential regions for explorations by upcoming future missions. The ample presence of volatiles in the permanently shadowed region (PSR) made this region an interesting location. Along with the PSR regions, a few craters on the south pole region like the Schrödinger [1] basin and Antoniadi [2,3] crater have infilled lava material and possible intrusion from the subsurface. On the contrary, the nearside of the Moon has several numbers of craters floor infilled and intruded with lava material through the impact fractures [4] or due to pressurized magma chamber [5-7]. However, there is no evidence of the crater floor uplifted due to intrusion near the polar regions. In the process of lava infilling and magma intrusion, there is a possibility of volatile release [5,8]. Thus, it brings a need to explore locations with possible intrusion within the floor near the polar region and their associated volatiles.

Amundsen crater ~103 km in diameter with a few km deep is explored [9,10] and suggested a site for exploring the PSR (Fig. 1a). This study brings out the notable geological activity within the Amundsen crater and how this crater can be elevated to potential locations for a future landing mission. This crater will satisfy the goal for the exploration of ISRU of Moon by: a) to understand the transport, retention, alteration and loss processes of volatile from last 4 Ga, b) explore the possibility of volatile from endogenic process, c) explore the compositional state of volatiles, which infers multiple source and time, d) explore multiple PSR within accessible range and infer their possible variations, and e) explore the possible intrusion within the crater closer to the poles and analyze their role in PSRs.

Amundsen floor modification: Near the south pole the Amundsen crater floor uplift is spread on an average of ~53 km. The topographic profile extracted along with multiple directions, excluding the peak and rim, shows an uplift or dome-like structure. Fig. 1b shows the three profiles taken along the floor with typical uplift of more than ~150 m. The PSR on the eastern wall flank region is located partially within this uplift region. Our observation suggests that this floor uplift is not related to deposits of slumped material from the wall to the floor region. The floor uplift is comparable to other craters on the Moon [11].

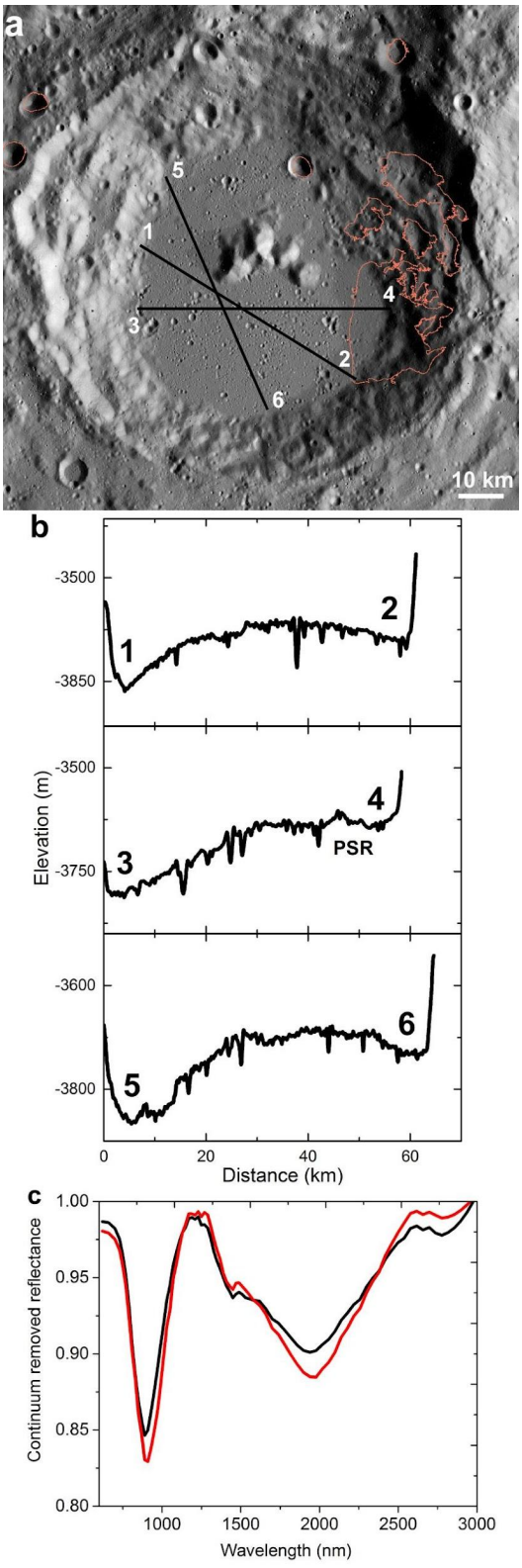

Fig.1. *a) LRO-WAC and LOLA blended image of Amundsen crater with PSR regions overlaid. b) The topographic profiles taken along three sides suggest possible uplift within the crater. The PSR present on the eastern side of the crater floor is partially located within this uplifted region. c) The Chandrayaan-1 M^3 derived spectra indicates presence of pyroxenes.*

Around the south pole, there are no craters with such uplift. The floor of the Amundsen crater doesn't contain fractures. However, the western floor hosts a wrinkle-like structure. The uplift is mainly towards the eastern side of the crater floor. Further investigation on this uplift will unravel the intrusion close to the polar region.

[12] and [13] studied the intrusion within the crater floor and tried to estimate the role of elastic thickness and flexural parameters on floor fracture craters. A preliminary analysis of these parameters over the Amundsen crater revealed that the uplift within the floor does not satisfy the condition set by [13]. However, we interpret that the wider crater walls and the small floor uplift like Amundsen will need more precise parameters to bring out their floor uplift.

The Chandrayaan-1 M^3 [14] derived spectra from the western wall of the crater suggest the presence of pyroxene minerals. The spectra shown in Fig.1c have diagnostic absorption before 1 and 2 μm. However, most of the spectra from other parts of the crater lack significant reflection due to their close location to the polar region.

Amundsen PSR: Within this crater, there are three potential PSR regions that are within the 25 km range. These PSRs are 1) formed within a small impact crater, 2) large PSR formed within the flanks of the eastern wall of the crater, and 3) another on the sloped wall of the crater. Apart from this, Lemelin et al., 2014 [10] suggested that there will be possible micro PSR regions that can be explored by insitu mission. Most of the accessible PSRs are located within the uplifted floor region. Recently [15] reported the presence of CO_2 ice within the Amundsen crater. Thus, this crater will be a potential test bed to explore volatiles and their source. PSRs are observed within a few small craters apart from the larger PSR at the eastern wall flank. These small craters are likely to be formed at different periods, and hosting the PSR region will lead to exploring any possible differences within the PSR region. This location will also be suitable for the mission, which needs to land on the non-PSR region and want to explore the PSR region. The multiple spatially distributed PSR locations will provide a diverse thermal environment and the floor diverse temperature regimes.

Discussion: The Amundsen with possible uplifted floor and located closer to the south pole brings the need to explore their cause for uplift and their possibility of any volatile release during the uplift or intrusion [5]. The PSR located close to this uplift, whether received any volatiles is still a quest. In such a case, apart from the exogenic volatiles, the search for PSR with endogenic volatiles will lead to understanding the lunar source for polar volatile evolution and its regime.

[16] derived ages for the PSR and non-PSR regions, finding ~4 Ga. This suggests that the possible intrusion occurred over this period, and the PSR are located within the uplifted part. Thus, PSR within the walls is formed post the transient crater formation. The uplift within the floor will be followed after that, and therefore it is still in quest, whether any volatile release during this upliftment process can be trapped in the PSR regions. Head and Wilson, 2017 [8] suggested floor uplift due to laccolith/sill intrusion release gas/foam. But the alteration during uplift within the floor needs detailed exploration for any volatile release. This open-ended question and exciting activity within the Amundsen crater will propose it as one of the future lunar sites to be explored.

The presence of the Amundsen crater near to the south pole, floor uplift with convex-up topography and situated within the SPA basin likely favor it as one of the potential sites to explore the multiple geological activities within a location. A hybrid origin provides an exceptional opportunity for future landing missions to explore.

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