DETECTION OF NEW POTENTIAL SITE OF LAVA TUBE IN MARIUS HILLS REGION BY THREE COMPONENT DECOMPOSITION TECHNIQUE OF LRO Mini-RF DATA. Ankita Vashishtha[1] and Dr.Shashi Kumar[2], [1]Indian Institute of Remote Sensing, Dehradun, India (ankita_vashishtha@yahoo.co.in), [2]Faculty in Indian Institute of Remote Sensing, Dehradun, India (shashi@iirs.gov.in).

Introduction: Planets that are devoid of atmosphere like Earth's Moon are constantly exposed to the solar wind, Galactic Cosmic Radiation (GCR) and meteorites. Settling a permanent human base on the lunar surface is an important upcoming mission[1]. A lava tube could be a potential site for such a base settlement. The lava tube is subsurface channels in the lunar surface which are conduits through which once volcanic lava flowed [2]. When lava ceased to flow, these structures became a conduit shaped tubes with an opening at the one end. These structures may behave like a shield to protect from meteor bombardment. They may also shield from solar wind weathering and more harmful Galactic Cosmic Radiation (GCR) [3]. These lava tubes maintain a constant temperature inside and may provide excellent shielding against a highly varying temperature on the lunar surface. Lava tubes could act as a potential site for the base settlement of future manned missions. Moreover, due to the presence of relatively stable temperature and shielding from solar wind weathering in lava tubes, the possibility of the presence of lunar volatile material is more feasible [2].

Radar remote sensing is an important technology in the detection of these subsurface features. Due to the penetrating capacity of a longer wavelength SAR system, sub-surface information retrieval through scattering could be acquired. Moreover, high-resolution images provided from LRO NAC strengthens the existence of potential site of lava tubes.

In this study, an attempt is made to study the backscattering response of the LRO Mini-RF data and to explore the potential site of a lava tube in the Marius Hills region.

Marius Hills Region: Marius Hills region is an important Lunar Maria region consisting of a set of volcanic domes. It is situated near the crater Marius in the Oceanus Procellarum region on the Moon. This region is known to be formed of the highest concentration of volcanic features on the Moon [5]. The presence of famous skylight had already been confirmed in the Marius hills. However, due to the presence of a vast volcanic feature, there is a probability of finding more intact lava tubes in the Marius Hills region [4].

Methodology & Observation: During the preliminary analysis of the LRO Mini-RF dataset of the potential site in the Marius Hills region, a subsurface feature is prominently visible in stokes parameter images. Circular Polarization Ratio (CPR) may be defined as the ratio of the intensity of the same sense polarized to the opposite sensed polarized waves i.e $(S_1-S_4)/(S_1+S_4)$, where S_1 and S_4 are first and fourth stokes parameter. Further analysis has been done by evaluating the CPR image and Cloude decomposition technique [6]. CPR image shows a value greater than one, which indicates enhanced volume scattering in the region. This enhanced volume scattering is an indication of the presence of an intact lava tube [7]. Moreover, high values of CPR indicate high same sense polarization which is an indication of the presence of lava tube.

On performing the Cloude decomposition technique, the Marius Hills region is characterized by a diverse scattering mechanism. In the Cloude decomposition image, the subsurface feature shows enhanced volume scattering [6] and evidence indicates a continued channel connecting the rille feature with the nearby crater. In order to confirm the absence of any surface feature on the marked location, the LRO NAC image is also referred for conclusive evidence. The cloude decomposition clearly splits the received intensity into three components namely, P_D which is the dihedral component, P_V which is the volume component and P_S which is the surface scattering component [6]. Cloude decomposition technique is superior to Eigen value-based H-Alpha decomposition because angle Alpha can't cover the random scatters in the target area completely [6]. That's why Cloude decomposition is a preferred decomposition technique for the detection of subsurface features like lava tubes. The images of the LRO NAC and Cloude decomposition technique are as given below:

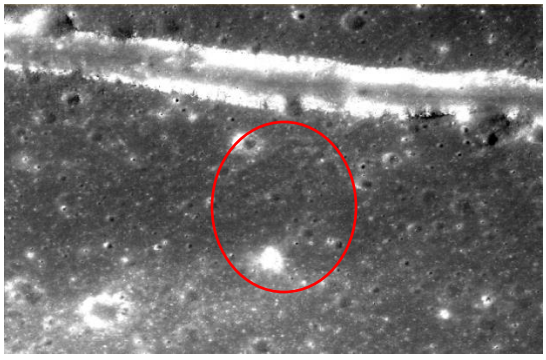

fig 1: LRO NAC image for a potential site. The image clearly indicates the absence of any surface feature.

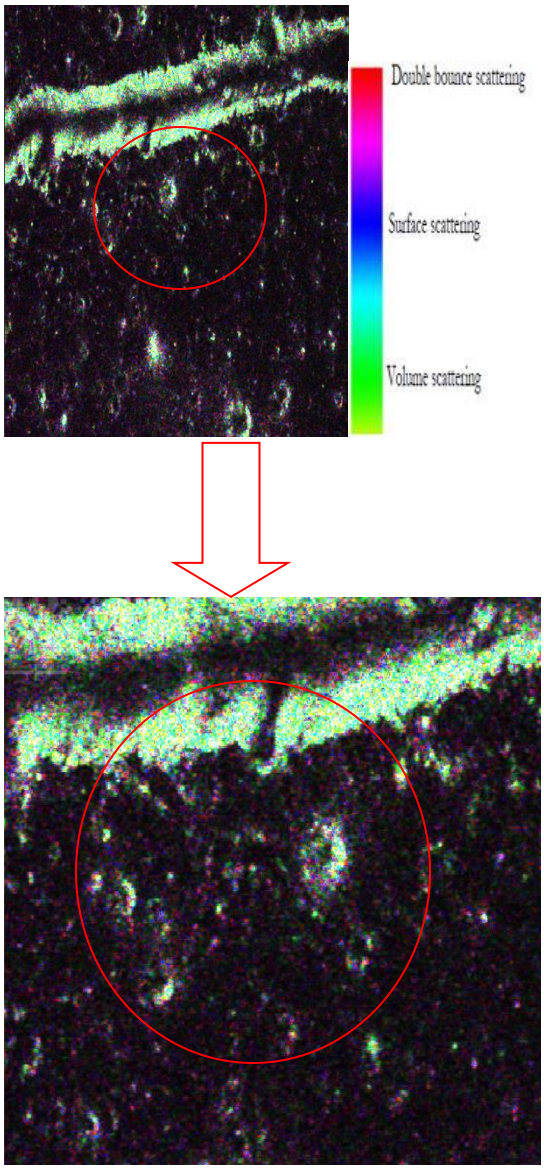

fig 2: Cloude Decomposition RGB composite.

Conclusion: SAR sensor has the capacity to retrieve the subsurface structural property which is similar to the shape of a channel in this study and as identified from the SAR data shows a structure of a lava tube.

References: [1] Loic Chapaz (2017) *GRL*,10.1002,p 1-8 [2] Coombs C.R.and Hawke B.R. (1992) NASA CP-3166, vol. 1, p 219-229. [3] Spudis P. D. et al. (2010), Geophys. Res. Lett., 37, L06204[4] Ronald Greely (1971) ,NASA,p 289-313,[5] Bruce A Campbell (2009) GPR, JE003253,Vol.114, p 1-10 [6]S.R Cloude (2012) IEEE, Vol.9, p 28-32,[7]Shaswat Shukla(2019),LPI-2019,p 1-2