PRE-BASALTIC MORPHOLOGICAL MAPPING OF ARCHIMEDES CRATER USING GRAIL DATA.

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Introduction: Mapping of surface and subsurface structures / features of the moon will help us to understand origin and evolution of the lunar surface. In this context, data from the Gravity Recovery and Interior Laboratory (GRAIL) of NASA's lunar science mission is used to depict the pre-basaltic morphology of Archimedes crater and its structure before mare emplacement. It gives new perspective in the field of lunar geosciences and exploration. Subsurface structures could help researchers to understand the formation of the complex catering process on the Moon and other planets. The present study is induced by very flat and smooth nature of the Archimedes crater floor due to completely filling of mare basalt. The analysis of GRAIL bouguer and free air gravity anomaly data in GIS revealed that the Archimedes is a multi ring complex crater.

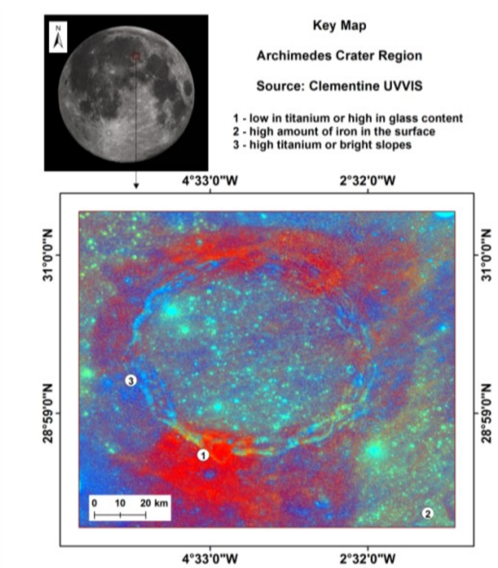

Figure 1. Key map of study region and RGB color composite map of Archimedes crater region using Clementine UVVIS data.

The Archimedes crater is located in the eastern margin of the Imbrium basin (Fig. 1). Color composite derived from Clementine UVVIS multispectral data exhibits the compositional and mineralogical diversity of the Archimedes crater region using band ratio technique of the 750/415 nm band in red-channel, 415/750 nm for the blue channel, and 750/1000 nm ratio to the green channel. The red color in the composite image represents areas that are low in titanium or high in glass content (1), the green channel is susceptible to the high amount of iron in the surface (2), and blue color reflects the surfaces with high titanium or bright slopes (3) [2,3].

Morphology: Initially, the surficial morphology of the crater has been visualized using Lunar Orbiter Laser Altimeter (LOLA) Digital Elevation Model (DEM) of Lunar Reconnaissance Orbiter (LRO) mission with 118 m spatial resolution and LRO WAC image (Fig. 2). The complex craters generally characterized by their terraced and irregular rims, or by zones of broad-scale (inward) slumping, and by an uplifted central peak or peak extended beyond as ring from relatively broad flat floor [4] and at the largest sizes, one or more exterior or interior rings may appear [5]. Archimedes is a complex crater with a diameter of 83 km having flat and smooth crater floor (3) due basaltic fill (Fig. 2).

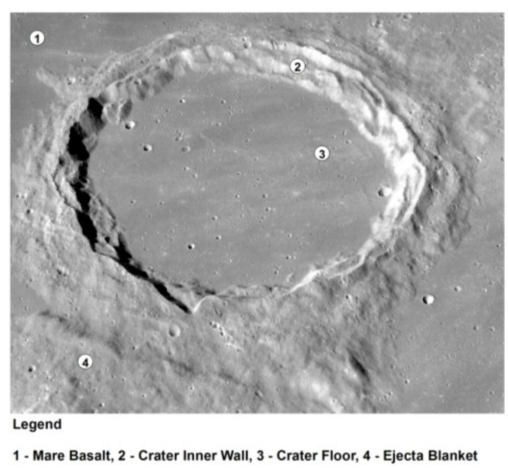

Figure 2. 3D Visualization of topography and morphology of the Archimedes crater region.

The diameter of Archimedes is the largest of any crater on the Mare Imbrium basin. As the crater fall in the eastern part of the Imbirum, the crater surrounded by the mare basaltic region (1). The rim has a significant outer rampart brightened with ejecta (4) and the upper portion of a terraced inner wall (2, Fig. 2), but lacks in the ray system. The interior of the crater lacks a central peak, and is flooded with lava flows. It is devoid of significant raised features, although there are a few tiny meteor craters in the crater floor [6].

Subsurface features: Pre-basaltic morphology of the Archimedes crater is mapped using the bouguer and free air gravity data of GRAIL, NASA. The analysis of bouguer gravity anomaly of Archimedes crater shows that the presence of interior rings below the basaltic flow (Fig. 3). As bouguer data represent the regional gravity variation, the subsurface multi rings of the crater could not able to interpret precisely. But exhibit the pattern of multi rings to some extent only. The profile along A-A[1] shows that the all the rim and rings of the crater have similar gravity anomalies. So, at the next stage, free air gravity anomaly data taken for mapping the subsurface features as it is reveal more on local variations.

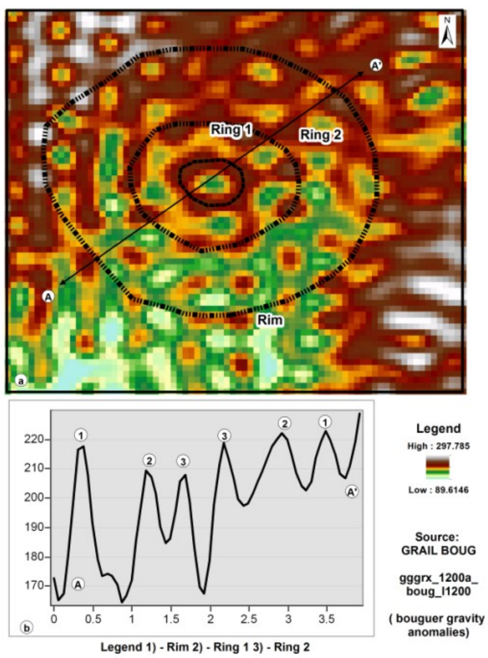

Figure 3. (a) Bouguer gravity anomaly map (1200 spherical harmonics), (b) bouguer gravity profile.

The visualization of free air gravity data in 3D GIS environment shows that the crater is a multi ring crater (Fig. 4).

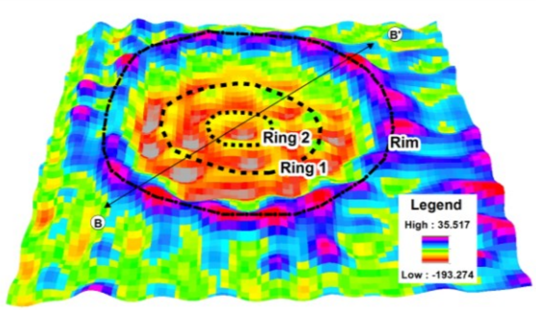

Figure 4. GRAIL free air gravity anomaly (1200 spherical harmonics) data of map shows the multi ring structure.

Generally, rim and interior rings are exhibiting higher gravity when compare to surrounding region. The circular and concentric high gravity anomalies within the crater floor clearly shows presence of multi rings below the basaltic fill in subsurface. The Gravity profile drawn along B-B[1] shows that the outer rim have very high gravity (1)anomalies when compare to interior rings (2 &3, Fig. 5) . The visualization of gravity data in 3D GIS environment clearly explaining the Archimedes crater is a multi ring crater.

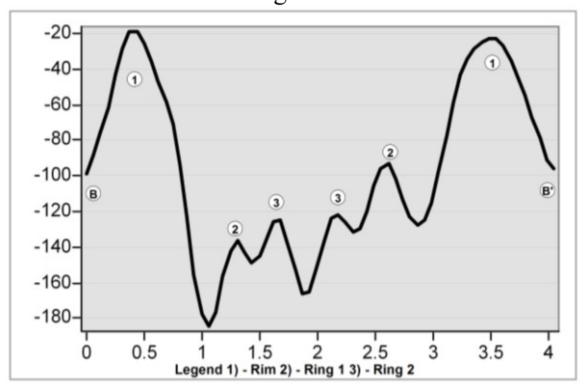

Figure 5. Free-air gravity profile showing the multi ring and rim.

Conclusions and Summary: The present research study revealed that the ability of GRAIL gravity data in mapping the pre-basaltic morphological and structural features of lunar surface and help us to understand the crater forming mechanism and surface process of moon much deeper. In this study we conclude that Archimedes is formed as complex crater with multi ring after that that mare basaltic lava have filled and modified the Archimedes crater morphology.

References: [1] Zuber Maria, et al. "Gravity field of the Moon from the Gravity Recovery and Interior Laboratory (GRAIL) mission." Science 339.6120 (2013): 668-671. [2] Lucey, P. G., Blewett, D. T., Taylor, G. J., & Hawke, B. R. (2000). Imaging of lunar surface maturity. JGR Planets, 105(E8), 20377-20386. [3] Tompkins & Pieters, (1999). Mineralogy of the lunar crust: Results from Clementine. Meteoritics & Planetary Science, 34(1), 25-41. [4] Pike (1977). Apparent depth/apparent diameter relation for lunar craters. In LPSC, (Vol. 8, pp. 3427-3436). [5] Wieczorek, M. A., & Phillips, R. J. (1999). Lunar multiring basins and the cratering process. Icarus, 139(2), 246-259. [6] Kumaresan & Saravanavel (2019). Compositional and Mineralogical Characteristics of Archimedes Crater Region Using Chandrayaan-1 M^3 Data. In LPSC, (Vol. 50).