ANALYSIS AND CLASSIFICATION OF OPPENHEIMER CRATER AS A CLASS FLOOR-FRACTURED CRATERS

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Introduction

The paper presents the study of Oppenheimer Crater using Miniature-Radio Frequency SAR (Mini-RF) and Lunar Orbiter Laser Altimeter data (LOLA). This combined study uses variations in crater morphology and regional distribution to explore the reason behind formation mechanisms. The distribution of crater features from Electrical and Physical parameters differentiate materials within ejecta deposits and helps in knowing the surface topography and scattering behavior [1]. Complex morphology of the Crater has been analyzed in paper. The paper points out the importance of SAR and LOLA data by classifying Oppenheimer Crater to one of the FFCs subclasses. We propose this tendency to be supportive in knowing the mode of evolution, formation of features and also in classifying the crater classes.

Study Area

Oppenheimer crater (205 km diameter, 35.4S, 166.0W) is located within the farside South Pole Atiken Basin [2]. Its floor is composed of plains and three smaller craters. Crater consist of rilles that are typically less than a km wide parallel to the crater walls. There are dark mantle deposits (low albedo material) which are basically the pyroclastic deposits[3].

Datasets and its Analysis

Using datasets from the Mini-RF and LOLA detailed study of electrical and physical parameters of crater and its systematic classification of FFC is carried out using the methodology given by Schultz [4]. Mini-RF active sensor which transmits RCP and receives linear horizontal and vertical polarization in PDS format[5]. Received backscattering coefficient values are used to analyze the scattering behavior using m-chi decomposition.

m-Chi [6] decomposition of SAR data is based on m (the degree of polarization) and chi (the Poincare ellipticity parameter). m-chi can easily differentiate materials within ejecta deposits and their relative thicknesses. m-chi decomposition consist of the three types of scattering i.e. surface scattering, double bounce and volume scattering. In m-chi blue color indicates single bounce scattering (If an incident wave, with a particular polarization, has a simple interaction with a target i.e. lunar regolith), red corresponds to double bounce that might occur between two surfaces at an angle to one another (due to presence of bedrocks beneath the surface) and green color represents the randomly polarized constituents or volume scattering (the incident wave undergoes many bounces before returning to the radar.).

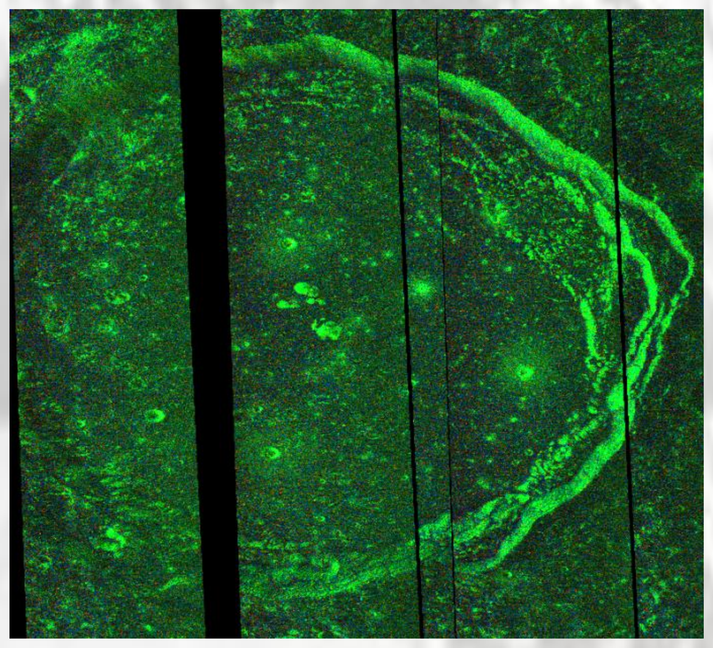

Fig. 2.Illustrates the m-Chi decomposition of Oppenheimer crater. SAR data strips have been mosiacked using ISIS software.

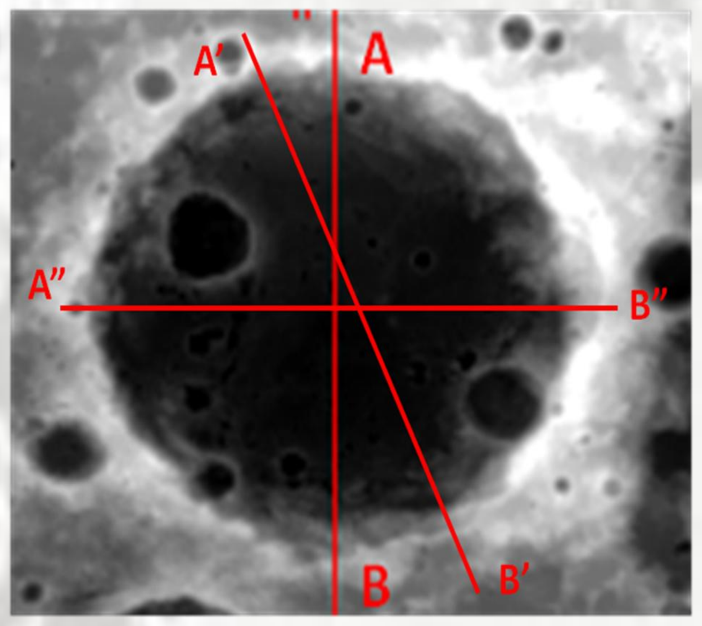

Fig. 3. The line of transect has been made over Oppenheimer Crater along the diameter from point A to B using GRDEM LOLA data

LOLA [7] PDS data utilized at a resolution of 16-pixels-per-degree.The GDR (Gridded Data Record) data products contain the binned, interpolated altimetric measurements, as well as albedo, roughness, and surface slope both in cylindrical and polar projections. The physical parameters like height, slope, roughness can be calculated using LOLA data. GDRDEM data (Gridded Data Record-Terrain Shape Map) from LOLA is calibrated using scaling factor and offset value from .lbl file associated with the .img & .jpg2000 data files. Analysis includes horizontal, vertical and diagonal transect liens as marked in figure 3. Here a line of transect along the crater's diameter from A to point B i.e. AB transect line have been taken for analysis.

Given the precision of LOLA data, 16 m spatial resolution detailed crater floor depth measurements have been made. Vertical, horizontal and diagonal depth profiles have been taken from rim crest to rim crest and these data have been compiled to make a depth frequency plot with bin value of 100m as shown in figure 5.

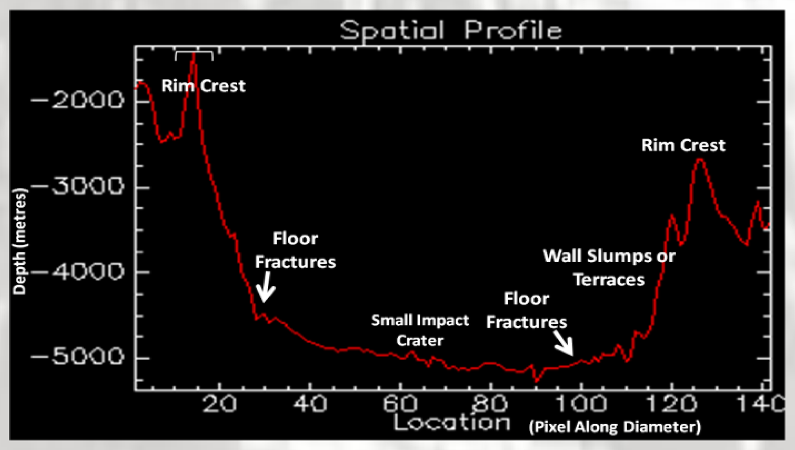

Fig. 4. Depth v/s Diameter distribution over the Transect AB on Opppenheimer Crater

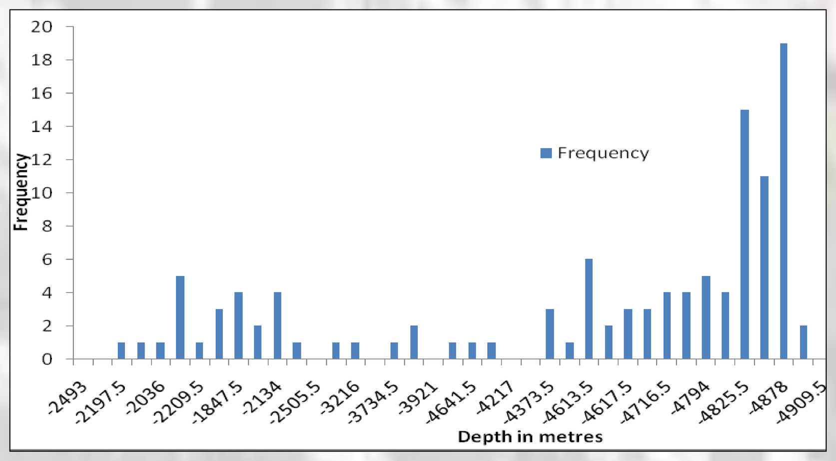

Fig. 5. Plot of frequency of floor depth over complete Oppenheimer. It shows highest frequency of 4878 meter depth on the crater floor.

Results & Discussion

Pyroclastic material and plains on Oppenheimer's floor shows surface and double bounce scattering. Eroded rim crest and ejecta exhibits dominant volume scatter from surface and subsurface layer. In-between gaps of wall terraces are featured by double bounce mechanism as bedrocks and lava deposits beneath and above the surface respectively. LOLA analysis shows the depth distributions along the transect line. It demonstrate the wall slumps or terraces at the degraded rim crest and small impact deposits in central region, with flat plate-like floor while moving along the crater diameter. Volcanic reruptions might have caused the pyroclastic deposits near the crater rim. Lava material from impact phenomenon and volcanic activities have marked the crater floor the number of small impacts, multiple rilles inside secondary craters, fractures, ejecta deposits making irregular crater floor with eroded rims.

Many lunar craters are classified under population of Floor-Fractured Craters (FFC) [8] and mapped according to their distribution on the Moon. The population of FFCs was categorized according to the classes outlined by Schultz. He classified FFC into 6 types based on their crater depth, most notably their fractures and shallow floor. The fractures can be radial, concentric, or polygonal. [8].Oppenheimer is a FFC crater yet its category is not defined. SAR and LOLA analysis will help classifying the crater's category& fitted into FFC classification. Figure 5 highlights the characteristics and distribution of oppenheimer crater similar to the Class 5 FFCs.

Generally class 5 is distinguished by a flat plate-like floor, radial or polygonal fractures, and an old, degraded appearance. FFC includes large craters diameters between 50 km and 300 km with an average of 140 km with deep floors, central peak complexes, and extensive wall terraces[9].

The study area is a large crater with 208Km diameter, radial or polygonal fractures, degraded crater walls.. Apart from the defining characteristics mentioned above, pyroclastic deposits occur along the edge of the crater wall, plain crater floor classify the crater as Class 5 FFC crater. For example craters of Class 5 includes Von Braun, Alphonsus and Lavoisier D etc. Analysis establishes that the Oppenheimer Crater fulfils some of subclass characteristics of FFC subclass category5. As the crater is having degraded rims with wall slumps, polygonal fractures, patches of pyroclastic deposits, plain floor, secondary craters with Rilles, Graben and deep floor.

Conclusion

Mini-RF image data reveal the presence of distinctive floor fracturing associated with the crater floor. The radar backscattered images at every pixel helps in understanding the scattering phenomenon of the target on lunar surface. Thus from the above analysis Oppenheimer crater can be considered as class 5 FFC category. Future work will include the classification of FFC crater under under suitable class and their detailed study of physical and electrical properties of the lunar in order to understand phenomenon behind the surface features.

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