Geomorphologic mapping and morphometric analysis of a complex Copernican crater: Aristarchus

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Abstract: This study aims to analyze the morphological features of the Copernican crater Aristarchus, which is located on the near side of the Moon. Geomorphological mapping has been carried using high resolution data of Narrow Angle Camera (NAC) and Wide Angle Camera (WAC). The fine-scale morphologies of units were mapped using NAC mosaic. Lunar Reconnaissance Orbiter (LRO) Lunar Orbiter Laser Altimeter (LOLA) – SELENE Kaguya TC DEM merge 60N60S (59m) is used to generate elevation graphs for calculating morphometric parameters. The average diameter of the Aristarchus crater is 41.33 km. The average height of a prominent central peak is ~0.85 km. It has been interpreted that the Aristarchus crater formed due to the impact of ~3 km diameter bolide on Aristarchus Plateau and Ocean Procellarum.

Introduction: Aristarchus (23.7°N, 47.5°W) is asymmetrical, lunar impact crater located in the northwest part of the Moon's near side [1]. The western part of the crater impacted into the southeastern edge of the Aristarchus Plateau, whereas the eastern part of Aristarchus impacted into the Ocean Procellarum that surround and embay the plateau [2]. It lays east of the crater Herodotus and southeast of Vallis Schroteri. The crater is particularly interesting due to its anomalous brightness and pre-impact conditions relative to the others of similar age and size. Its complex and diverse geology has made it of interest as an important investigation.

Data and Methodology: LRO NAC [3] images were used for morphological feature identification and mapping. Geomorphologic mapping of crater interior was carried out using 1.41 m/pixel NAC mosaic, having similar illumination conditions to avoid the misinterpretation of albedo conditions of morphological units. The morphological units were mapped on a scale of 1:12,000, except melt ponds and cooling cracks which were mapped at the scale of 1:5,000. The mapping was carried using the shapefile tool in the ArcGIS 10.5 software. The area of each unit was calculated using geometry attributes (measure tool). We used LRO LOLA – SELENE Kaguya TC DEM merge 60N60S (59m) [4] to acquire the morphometric parameters such as the height of the central peak, crater diameter, rim height, crater depth and floor diameter. The elevation graphs along four different topographic sections were generated using 3D analysts tools, such as interpolate lines and profile graph in ArcGIS.

Results: The Aristarchus crater exhibits morphological features such as a central peak, isolated mounds, diverse floor units: hummocky and smooth, melt ponds, cooling cracks, crater wall, fault scarps and fault line as mapped in Fig. 1. The topographic section passes through the central peak of the crater along AA', BB', CC' and DD' in W-E, N-S, SW-NE and NW-SE respectively (Fig. 2). The total area of crater floor including the central peak is approximately 296.61 km^2. The basal area of the central peak is ~5.97 km^2. The average height of the central peak from the deepest point of the crater floor is 0.85 km. In the case of Aristarchus, the northern part and east of central peak are hummocky in nature with a basal area of ~78.42 km^2, covered in large hills and hummocks having mammillary or bulbous appearance [2]. The area covered by isolated mound is roughly 22.77 km^2. A major part of the crater floor exhibits smooth texture which measures to 189.45 km^2 in area. The smooth crater floor is covered by the melt features such as cooling cracks. These cracks are parallel to the crater wall appearing to be concentric features. The cooling cracks are significant feature formed either on the contraction of impact melt or melt draining into subsurface cracks [2]. Melt ponds are low albedo smooth impact melt deposits, using accumulated at a depressed region flowing from high elevation under the influence of gravity while still in the molten state [5]. The major melt ponds are mapped among the wall terraces in the eastern portion. The total area of all melt ponds measures up to 29.89 Km^2. The morphometric estimated values derived from topographic section (Fig. 2) are as following, the average rim-to-rim diameter is 41.33 km, average crater depth (below the pre-existing surface) is 3.87 km, average rim height (above the pre-existing surface) is 2.35 km and the wall-to-wall crater diameter is 18.09 km. The transient cavity that formed during the initial stage of the Aristarchus cratering process could be 36.6206 km wide. The estimated diameter of projectile that resulted in the formation of the Aristarchus crater as ~3.0015 km using the equation from [6].

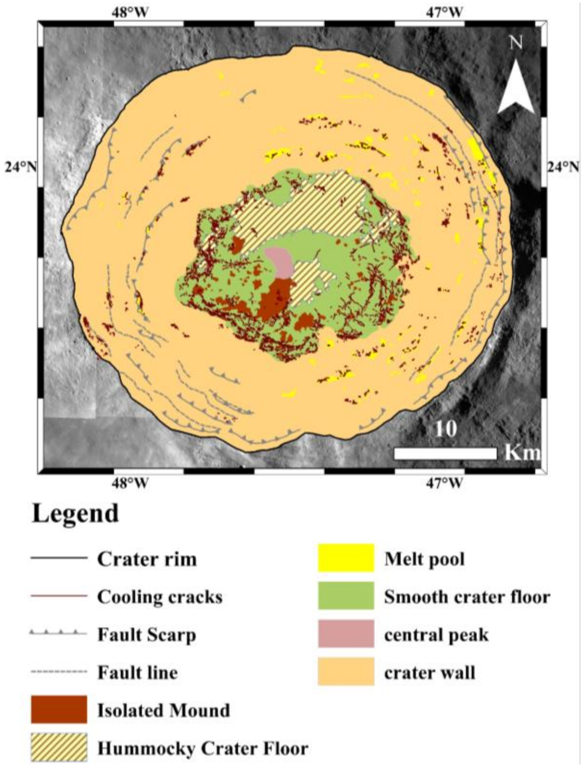

Figure 1: Morphological map of the Aristarchus crater.

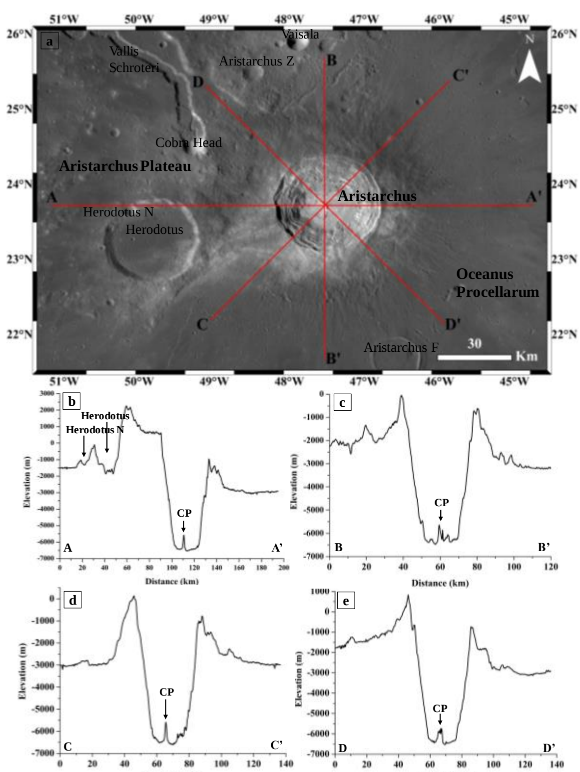

Figure 2: (a) The topographic sections AA', BB', CC' and DD'. Elevation graphs of the topographic sections, (b) AA', (c) BB', (d) CC', (e) DD'. (Here, CP= central Peak).

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