GEOMORPHOLOGIC SKETCH MAPPING OF A FRESH LUNAR CRATER EIMMART A

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Abstract #1948

Take-home message

– Eimmart A is one of the youngest 5–10 km-diameter craters.

– Sampling its eastern rim could provide impact ages from the Nectarian Crisium basin up to the latest Copernican, plus Imbrian mare.

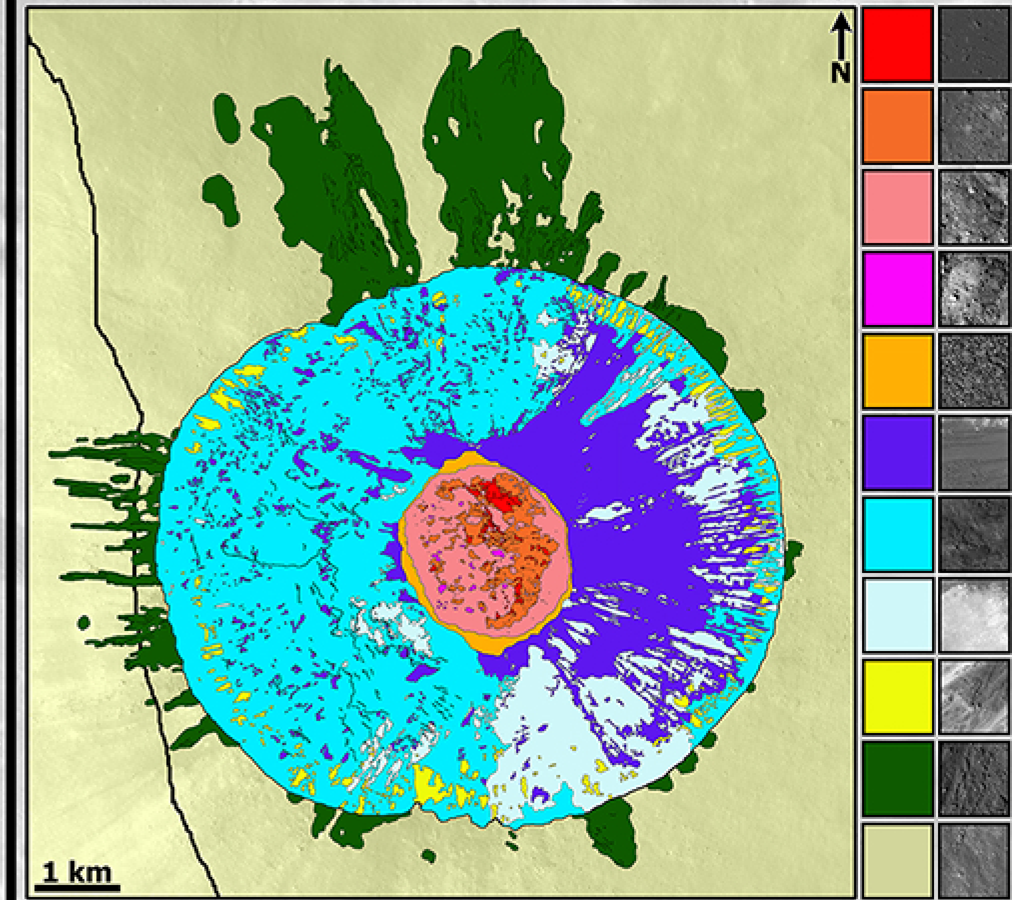
– Topography governs the impact melt distribution inside, but not outside the crater.

Introduction

The dazzling [1] Eimmart A (24.1°N, 65.7°E) is a 7.3 km-diameter simple crater on the NE rim/ring of the Crisium basin (Figs. 1 and 2). It has been considered a potential source of the first identified lunar meteorite ALHA 81005 [2–5], and spectral studies have shown that Eimmart A exhibits the strongest 1 µm absorption feature observed on the Moon [3–5]. It is also extremely fresh: No primary impact craters postdating Eimmart A have been identified in LRO NAC (Lunar Reconnaissance Orbiter Narrow Angle Camera) images inside the crater [6]. Here, we present the main results of geomorphologic sketch mapping of this unique crater, and briefly discuss the opportunities it presents for lunar exploration and sample return.

Fig. 1 (left). Eimmart A is located on the northern shore of Mare Crisium. Image: LRO / Virtual Moon Atlas [7].

Geomorphologic sketch map of Eimmart A



Legend	Unit name: Description. >Interpretation.
(red)	Smooth floor A: Dark, fractured, smooth. >Clast-poor impact melt rock.
(orange)	Smooth floor B: Dark, fractured, fairly smooth. >Clast-poor impact melt rock, more clasts and/or thinner than A.
(pink)	Hummocky floor: Brighter, few fractures. >Clast-rich impact melt rock.
(magenta)	Bright floor: Small, bright domes. >Very large breccia clasts not covered by melt.
(light orange)	Boulder ring: Boulders between wall and floor. >Coarse talus.
(purple)	Dark wall: Streaky, low albedo. >Mixed talus, including mare basalts.
(cyan)	Intermediate wall: Medium albedo, streaky, lobate features in W. >Mixed talus, probable impact melt lobes in the W.
(light cyan)	Bright wall: Streaky, high albedo. >Freshest and/or least mafic mixed talus.
(yellow)	Outcrops: Wedge-shaped "bumps" near rim crest. >Bedrock exposed or at most very thinly veneered by talus.
(dark green)	Veneer, ponds, flows: Fairly low albedo, smooth, fractured, flow features common. >Ejected clast-poor impact melt rock.
(beige)	Proximal ejecta: Rough, fairly high albedo. >Continuous impact melt-poor ejecta, grades to discontinuous ejecta.

Fig. 3. Geomorphologic sketch map of Eimmart A. Thin black lines on the floor denote cooling fractures, those on the W wall depict lobate features, interpreted as probable impact melt deposits, and those on the flanks denote distinct flow features of ejected impact melt. The thick black line in the W marks the approximate location of the Eimmart rim crest. Legend box widths 132 m. Mapping based mostly on LRO NAC images M152451994LE & RE, M152445210LE & RE, M174841114LE & RE, M1098408548LE & RE and M192532183RE in simple cylindrical projection, with additional input from Kaguya Terrain Camera imagery. Compare with Figs. 4 and 5.

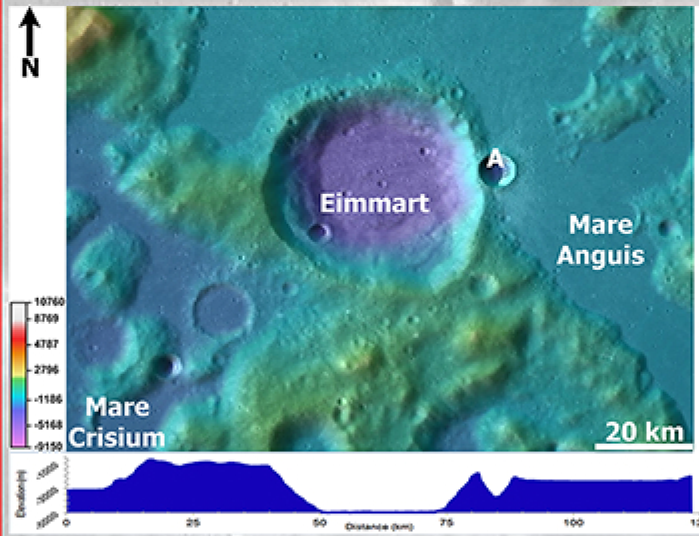


Fig 2. Eimmart A was formed partially on Imbrian–Eratosthenian Mare Anguis and partialy on the rim of the Nectarian Eimmart crater, while Eimmart itself lies on the rim/ring of the Nectarian Crisium basin [8–11]. West–east topographic profile across the center of the image shown at the bottom. How did Eimmart avoid becoming fully flooded? Data: LRO ACT-REACT QuickMap.

References: [1] Pickering W. H. (1914), *Astronomische Nachrichten, 196*, 413–418. [2] Treiman A. H. and Drake M. J. (1983), *GRL, 10*, 783–786. [3] Pieters C. M. (1986), *Rev. Geoph., 24*, 557–578. [4] Pieters C. M. (1993), in Pieters C. and Englert P. (Eds.): *Remote Geochemical Analysis*, 309–339, Cambridge Univ. Press. [5] Blewett D. T. et al. (1995), *GRL, 22*, 3059–3062. [6] Johnson K. E. and Kramer G. Y. (2014) *LPS XLV*, Abstract #2725. [7] Legrand C. and Chevalley P. (2013), *Virtual Moon Atlas 6.1*, https://www.ap-i.net/avl/en/start [8] Wilhelms D. E. (1987) *The Geologic History of the Moon*, USGS Prof. Paper 1348. [9] Swindle T. D. et al. (1991), *PLPSC, 21*, 167–181. [10] Spudis P. D. (1993), *The Geology of Multi-Ring Impact Basins*, Cambridge Univ. Press. [11] Casella C. J. and Binder A. B. (1972), *Geologic Map of the Cleomedes Quadrangle of the Moon*. Map I-707 (LAC 44), USGS.

Summary and conclusions

1) Ejected impact melt is found mostly on the N and, to a lesser degree, on the W flanks. Factors other than pre-existing topography control the highly asymmetric distribution. An oblique impact from the S(E) is a possibility.

2) On the crater floor, impact melt is concentrated on the E, clearly controlled by the topograpic gradient.

3) Mare Anguis basalts are excavated on the E wall, while on the W and S walls Eimmart and Crisium materials are present.

4) Eimmart A's eastern, near-equatorial location would be suitable for a relatively low-cost sample-return mission, particularly one launched from the Earth's eastern hemisphere (cf. Luna 20 and 24).

5) Sampling Eimmart A would, among other benefits, be likely to provide the age of one of the youngest km-scale Copernican craters and one of the major Nectarian basins (currently poorly known Crisium), thus clarifying the impact flux through much of the lunar history.

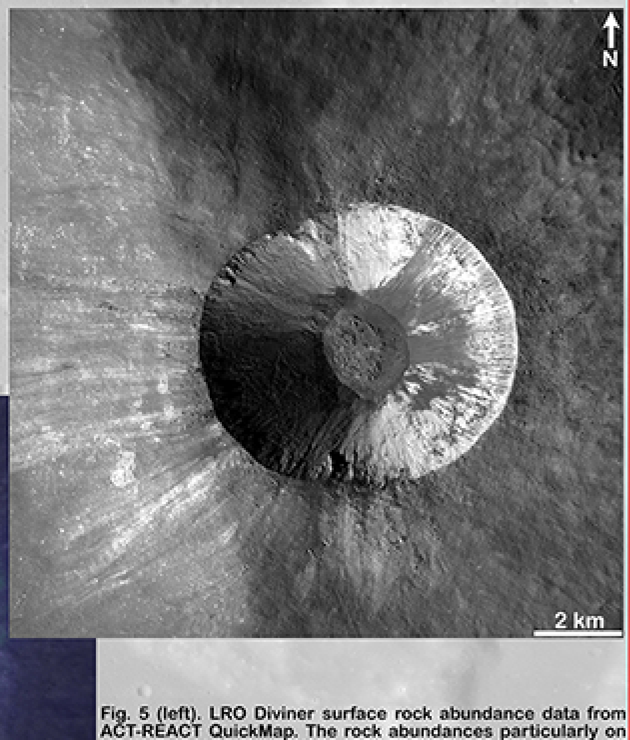


Fig. 4 (right). A mosaic of LRO NAC images M1098408548LE & RE in simple cylindrical projection. Dark wall material can almost solely be found on the E wall, i.e. on the side of the Mare Anguis basalts. Smooth floor material is concentrated on the E floor due to the tilting of the crater towards E (see Fig. 2). Note also the massive outcrop protruding inwards from the S wall. Compare with Figs. 3 and 5.

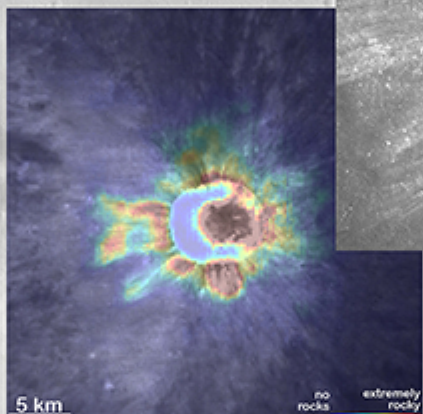


Fig. 5 (left). LRO Diviner surface rock abundance data from ACT-REACT QuickMap. The rock abundances particularly on the floor and the S and W flanks match with NAC observations, whereas the E wall is not rocky but dark, implying some imperfections in the Diviner rock abundance algorithm. Compare with Figs. 3 and 4.