

INFILLED CRATERS: LAVA MODIFIED IMPACT CRATERS. K. B. Kimi^{1,2}, Harish^{1,2}, S Vijayan¹.

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Introduction: Lunar impact craters floors containing lava infilling are globally spread and appears flat in the visible imagery. Such infilled craters are evidence of endogenic crater floor modification [1,2]. It provides a window to understand the post crater modification and extent of lava infilling.

We present the first mapping of such craters and their diagnostic characteristics. We have identified 329 infilled craters with enclosed rims, extending from ~4 km up to ~270 km crater diameter, and based on the characteristic, infilled craters are categorised into five classes (Figure 1). Our study aims to understand the extent of lava infilling and associated infilled craters morphology.

Data and Methods: We used LRO-WAC image ~100 meters/pixel [3] for exploring and identification of infilled craters. Further LRO-NAC of spatial resolution ~0.5m/pixel [3] and CH2-TMC2 of spatial resolution ~5m/pixel [4] images were used to confirm the identified infilled craters. For topography analysis, SLDEM2015 [5] of spatial resolution ~59 m/pixel with vertical resolution ~3-4m is used upto 60°N/S and above 60°N/S, LOLA [6] of spatial resolution ~118m/pixel and vertical resolution ~1m is used.

Distributions: The global distribution (Figure 1) of infilled craters shows that ~70% of the infilled craters are located on the nearside and ~30% on the farside. They are predominantly located on the periphery of the lunar mare/mare-filled impact basins, some within the mare/mare-filled impact basins and a few on the highlands. Clusters of infilled craters are observed in the north-western region of the Oceanus Procellarum, the Mare Australe, the superposed regions of Mare Crisium and Mare Smythii, and between Mare Nectaris and Mare Fecunditatis. The superposed regions of Mare Nectaris and Mare Fecunditatis host all the five types of infilled craters classes.

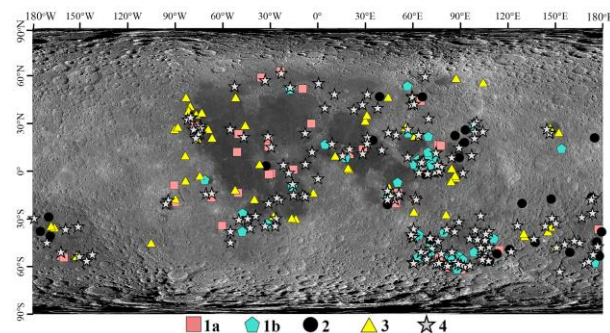


Figure 1: Global distribution of infilled craters

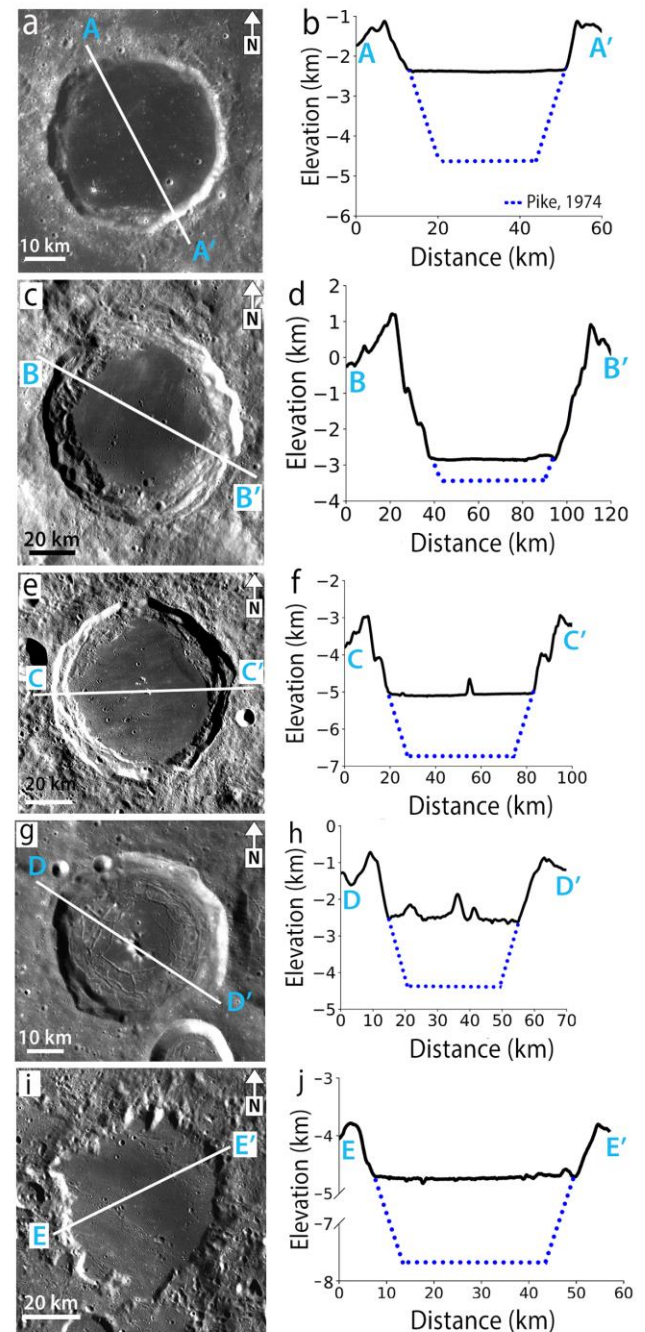


Figure 2: Examples for infilled craters with different classes and its profile: a) Billy crater (Class 1a) c) Lomonosov crater (Class 1b) e) Maksutov crater (Class 2) g) Lavoisier E crater (Class 3) i) Nishina crater (Class 4).

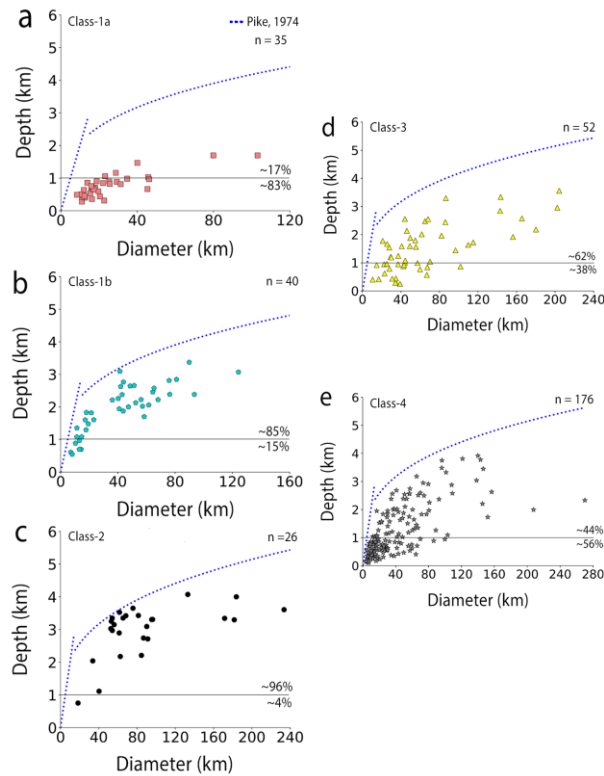


Figure 3: Depth to diameter plot of different infilled craters classes along with expected crater depth calculated using empirical relationship (blue dotted line) [7].

Infilled craters classes: Identified infilled craters are categorized into five classes based on the characteristics: crater floor topography, crater wall, central peak, and fractures. An example illustrating the characteristics of each infilled craters class are shown in figure 2. **Class 1a** infilled craters have nearly flat floors —lack central peaks and fractures (Figure 2a). **Class 1b** infilled craters have nearly flat floors, wide walls and lack central peaks and fractures (Figure 2c). Craters of this class have wider crater walls than class 1a. **Class 2** infilled craters have nearly flat floors, wide crater walls, central peaks and lack fractures. The most notable feature in this class is the central peak (Figure 2e). **Class 3** infilled craters have fractured floors with few wide crater walls, and approximately 35% contain central peaks. Some crater floors of this class have mare deposits only adjacent to the fractures. Fractured floors are the most distinctive feature in class 3 (Figure 2g). **Class 4** infilled craters floors vary from flat to non-flat floors and lack fractures. Approximately 11% of the craters from this class have central peaks. Some of these craters floors are heavily mantled by ejecta, con-

tain slump materials, and some craters rims are highly degraded by subsequent impact cratering (Figure 2i).

Infilled Craters Depths: The obtained crater depth and diameter plot (Figure 3) show that all the infilled craters have crater depths less than expected crater depth calculated using empirical relationships [7]. The maximum crater depth observed within identified infilled crater is ~4 km (Diameter(D) ~133 km, class 2), the minimum is ~97 m (D ~7 km, class 4), and an average is ~1 km. Approximately 83% of infilled craters in class 1a has crater depth less than 1km, followed by classes: 4(~56%), 3(~38%), 1b (~15%), and 2(~4%). This suggests that the lava infilling varies within the craters, and enclosed/unbreached rims suggest infilling in craters directly from the subsurface source.

Discussion: Infilled craters have diverse crater floor morphology ranging from nearly flat to non-flat floors (convex up/down); few of them have fractures and central peaks. Infilled craters in classes 1a, 1b, 2 and a few from class 4 have nearly flat crater floors appearing in visible imagery. Class 3 and few from Class 4 have non-flat floors resulting from upliftment [8] and subsidence [9]. Due to lava infilling and magma intrusion, all infilled craters have shallower crater depths than the un-modified craters. Infilled craters in class 1a has the shallowest crater depth, followed by class 1b and class 2. However, infilled craters in classes 3 and 4 do not follow any sequence. Infilled craters classified in classes 1a, 1b, and a few from class 3 and 4 have extensively mare filling resulting in shallower crater depth and buried central peaks. Infilling varies within the craters and among the regions, resulting in different crater morphology of the identified infilled craters. They are predominantly located on the periphery of the lunar mare/mare-filled impact basins.

Overall our study demonstrates variation in infilled crater morphology due to variation in the extent of lava infilling/magmatism.

References: [1] Schultz, P. H. (1976) The Moon 15, 241–273. [2] Schultz, P. H. and Orphal, D. L. (1978) Meteoritics 13, 622–625. [3] Robinson, M. S. et al. (2010) Space science reviews 150, 81–124. [4] Chowdhury, A. R. et al. (2020) Current Science 118, 566. [5] Barker, M. K. et al. (2016) Icarus 273, 346–355. [6] Smith, D. E. et al. (2010) Geophysical Research Letters 37. [7] Pike, R. J. (1974) Geophysical Research Letters 1, 291–294. [8] Jozwiak et al. (2012) Journal of Geophysical Research: Planets 117. [9] Head, J. W & Wilson, L.(2017) Icarus 283, 176–223.