

## Introduction

Martian meteorites are the only rock samples from Mars that are currently accessible for research in Earth-based laboratories [1]. The meteorites are derived from the near-surface units adjacent to their source craters. These source craters eject material beyond the martian escape velocity during formation from random, hypervelocity impact on the planet's surface [2]. Specific source craters for any of the martian meteorites are unknown. This study uses results from a queried database to constrain potential source craters based on parameters such as ejection age, petrology, preservation, and crater diameter [3, 4, 5]. Preliminary results indicate a number of candidate source craters that require detailed mapping to better understand their morphology, relative age, and volcanic context [5].

## Background

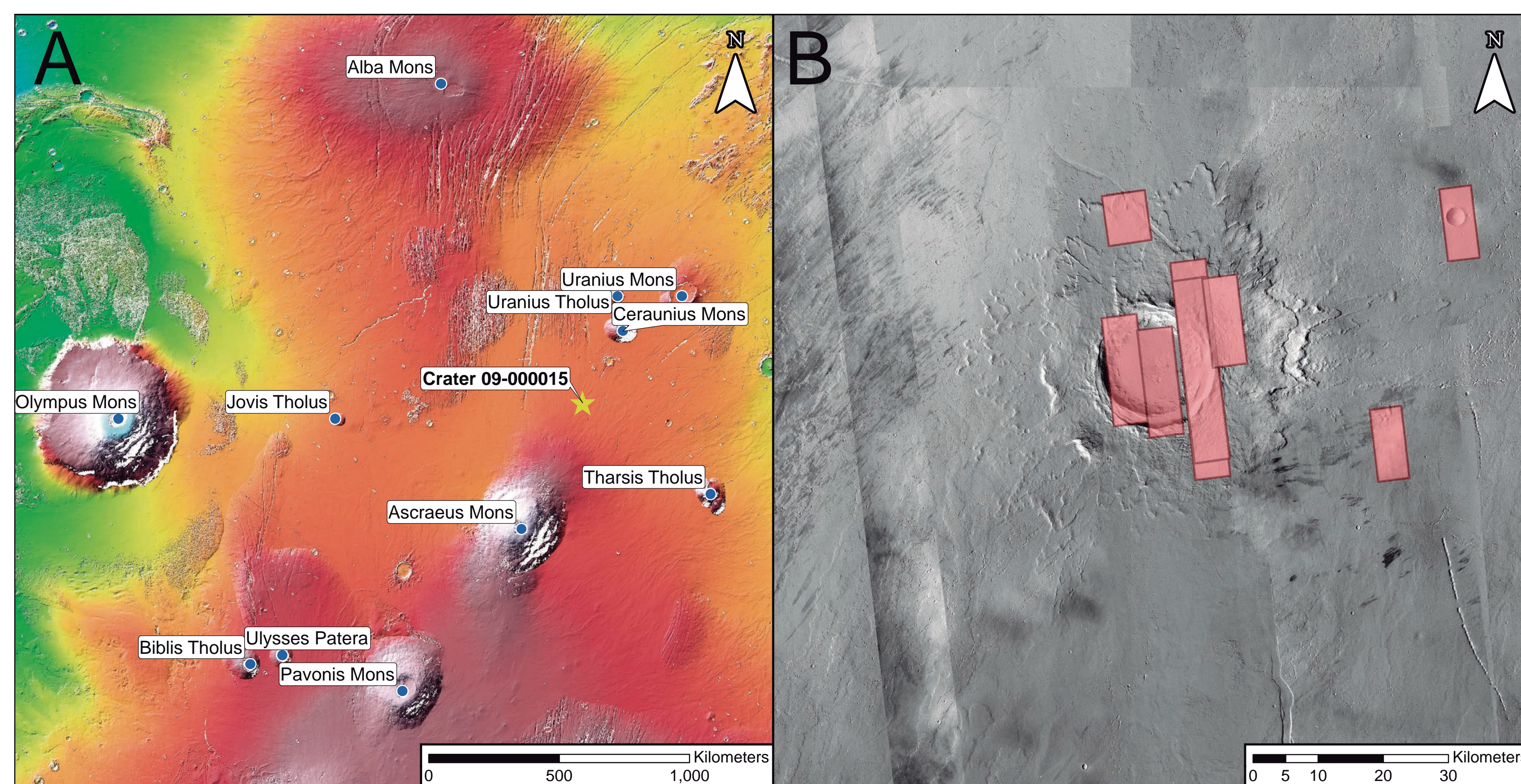


Fig. 1. (A) Approximate location of map for crater 09-000015 [6] and nearby landmarks with a MOLA colored hillshade base image. (B) Areas in nearby proximity of crater 09-000015 [6] with HiRISE coverage at ~25cm/pixel available as of January, 2019 outlined in red. Base map is a CTX mosaic at ~6m/pixel. Image credits: NASA and NASA/JPL/MSSS/The Murray Lab.

Crater 09-000015 [6] is a complex crater ~400 km northeast of Ascaeus Mons in the Tharsis region and is ~19.6 km in diameter (Fig. 1A). This crater is one of the candidate source craters for Zagami, Tissint, Chassigny, and/or NWA 8159, the four igneous martian meteorites presently involved in this study [5]. Data from these meteorites require source crater diameters  $\geq 2.5$  km, igneous source terrain, Amazonian crystallization ages, and ejection ages of <20 Ma [5]. Therefore, a source crater must occur on an Amazonian volcanic unit, be relatively young, and fall within the range of permissible sizes. Absolute and relative crater ages can be determined using crater counting [7] and preservation of pitted material [4], respectively.

## Mapping

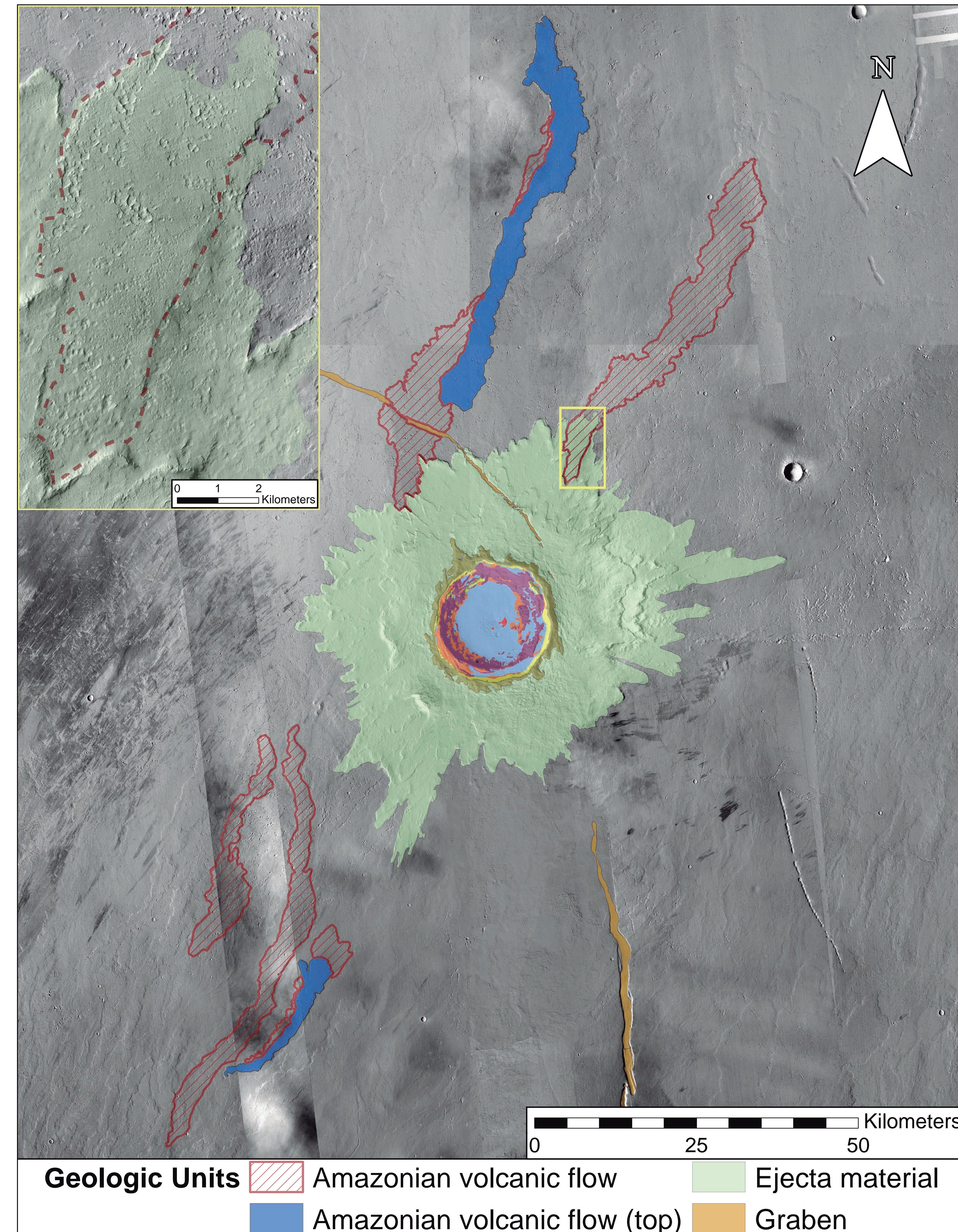


Fig. 2. Mappable lava flows and a significant graben on a CTX mosaic base map at ~6m/pixel. The top-most flows in a stacked sequence are indicated by blue shading. See Fig. 3 for interior unit descriptions. Image credits: NASA/JPL/MSSS/The Murray Lab.

Visible imagery datasets were imported into ESRI ArcGIS and processed to rectify spatial inconsistencies between the datasets. Morphological mapping shows a well defined ejecta blanket with multiple layers that overlie the nearby Amazonian volcanic features (Fig. 2). HiRISE coverage was available for the majority of the crater interior (Fig. 1B) which allowed for creation of a more detailed map (Fig. 3).

## Discussion

Lava flows originating from Ascaeus Mons extend radially outwards towards and beyond the crater (Fig. 2). The flows are upwards of 100 km in length and ~1-8 km wide, gradually increasing in width away from Ascaeus Mons. This trend is likely a result of lower flow velocities occurring as the slope decreases (Fig. 1A). The ejecta blanket superimposes both volcanic flows and an arc shaped graben. Thin ejecta layers allow segments of the flows and graben to still be resolved while completely obscuring others. An example of the latter is that the graben is not observable adjacent to the Eastern side of the crater rim despite trending in that direction. Some flows extend underneath the ejecta indicating pre-impact emplacement (Fig. 2). Overlapping of flows outside the crater and stacked flows in the crater wall exposures are visible.

## Implications and Future Work

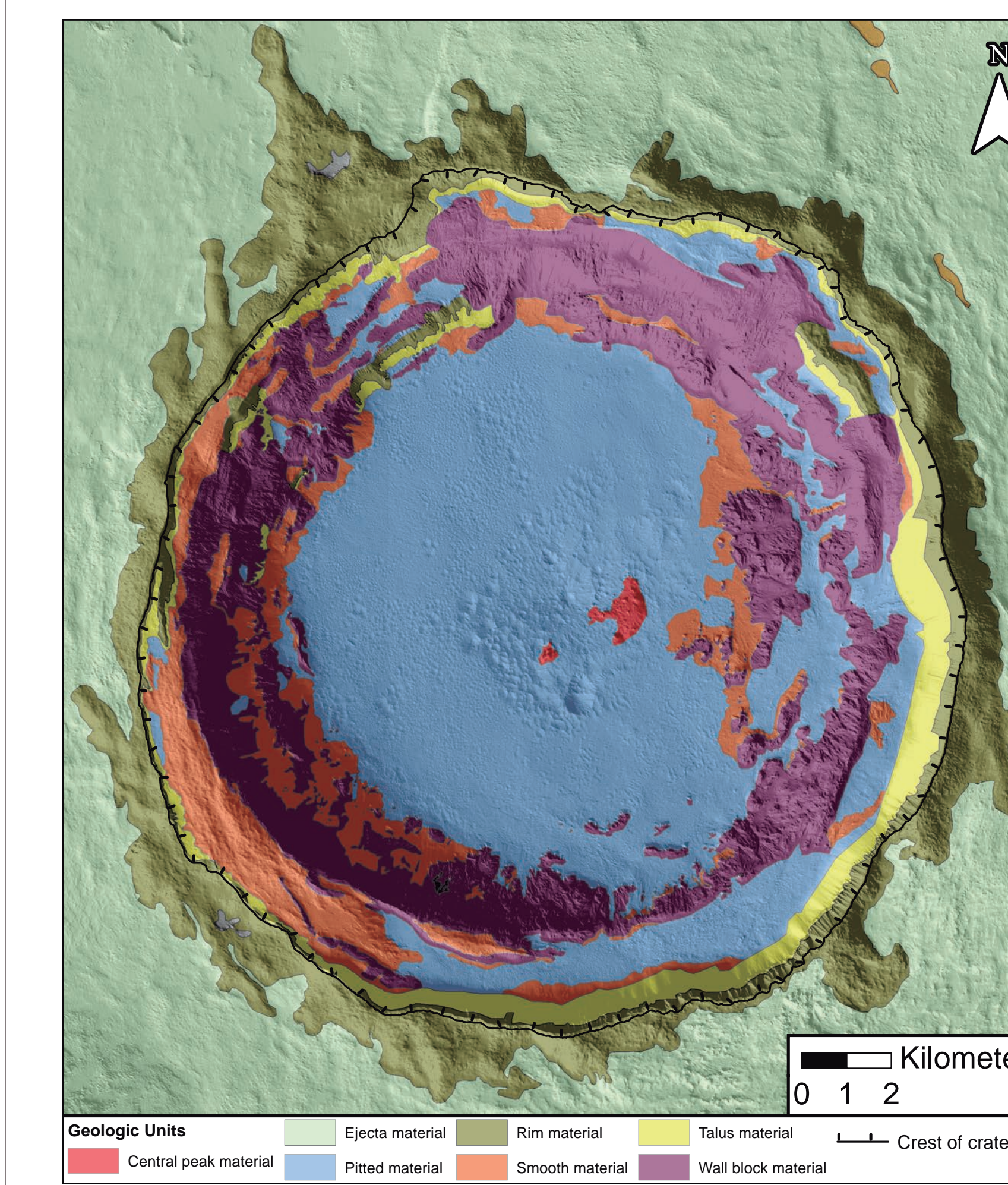


Fig. 3. Interior map of crater 09-000015 [6] showing the primary features. Base map is CTX mosaic at ~6m/pixel. Image credits: NASA/JPL/MSSS/The Murray Lab.

A significant portion of the crater is composed of pitted material, representing melt-bearing deposits (Fig. 3) [4]. Stacked lava flows lend to the idea of grouping martian meteorites together as part of the same ejection event [5]. Mapping of the lava flows, including cross-cutting relationships thickness, and extent is ongoing. Crater mapping will be expanded to include secondary craters, detailed examination of the pitted material, and to search for thermophysical rays [3]. Evaluation of local and regional dust free areas may yield opportunity to implement spectral matching [8].

## References

- Treiman, A. H., Gleason, J. D., & Bogard, D. D. (2000). The SNC meteorites are from Mars. *Planetary and Space Science*, 48(12-14), 1213-1230. [https://doi.org/10.1016/S0032-0633\(00\)00105-7](https://doi.org/10.1016/S0032-0633(00)00105-7)
- Melosh, H. J. (1984). Impact ejection, spallation, and the origin of meteorites. *Icarus*, 59(2), 234-260. [https://doi.org/10.1016/0019-1035\(84\)90026-5](https://doi.org/10.1016/0019-1035(84)90026-5)
- Tornabene, L. L., Moersch, J. E., McSween, H. Y., McEwen, A. S., Piatek, J. L., Milam, K. A., & Christensen, P. R. (2006). Identification of large (2-10 km) rayed craters on Mars in THEMIS thermal infrared images: Implications for possible Martian meteorite source regions. *Journal of Geophysical Research*, 111(E10). <https://doi.org/10.1029/2005JE002600>
- Tornabene, L. L., Osinski, G. R., McEwen, A. S., Boyce, J. M., Bray, V. J., Caudill, C. M., ... Mouginitis-Mark, P. J. (2012). Widespread crater-related pitted materials on Mars: Further evidence for the role of target volatiles during the impact process. *Icarus*, 220(2), 348-368.
- Herd, C. D. K., Tornabene, L. L., Bowling, T. J., Walton, E. L., Sharp, T. G., Melosh, H. J., ... Ehlmann, B. L. (2018). Linking Martian Meteorites to their Source Craters: New Insights. In 49th Lunar and Planetary Science Conference (p. Abstract #2266). Houston: Lunar and Planetary Institute. Retrieved from <http://www.lpi.usra.edu/meetings/lpsc2018/pdf/2266.pdf>
- Robbins, S. J., & Hynes, B. M. (2012). A new global database of Mars impact craters  $\geq 1$  km: 2. Global crater properties and regional variations of the simple-to-complex transition diameter: MARS CRATER DATABASE-RESULTS. *Journal of Geophysical Research: Planets*, 117(E6). <https://doi.org/10.1029/2011JE003967>
- Kneissl, T., van Gassel, S., & Neukum, G. (2011). Map-projection-independent crater size-frequency determination in GIS environments—New software tool for ArcGIS. *Planetary and Space Science*, 59(11-12), 1243-1254. <https://doi.org/10.1016/j.pss.2010.03.015>
- Viviano-Beck, C. E., Morgan, M. F., Núñez, J. J., Mattiella Novak, M. A., Murchie, S. L., & Daubar, I. J. (2017). Fresh Craters as Compositional Probes for Dust-Covered Bedrock in Tharsis and Elysium, Mars. In 48th Lunar and Planetary Science Conference (p. Abstract #2800). Houston: Lunar and Planetary Institute. Retrieved from <http://www.lpi.usra.edu/meetings/lpsc2017/pdf/2800.pdf>