INA: RECENT LUNAR VOLCANISM? C. M. Elder[1], B. L. Ehlmann[2], K. L. Donaldson Hanna[3], and B. D. Byron[1]
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Introduction: Irregular Mare Patches (IMPs) are enigmatic volcanic landforms on the Moon. Crater size frequency distributions, optical maturity, and steep slopes suggest that IMPs are geologically young [1] with crater distributions from the three largest IMPs implying ages <100 Myr [2]. Such recent volcanism cannot be explained by existing thermal evolution models, which predict that a partially molten layer in the mantle could be maintained until 2 Gya with additional heat sources such as the PKT possibly explaining lunar volcanism up to 1 Gya [3]. [4] suggested that IMPs could have formed by the eruption of a very vesicular magmatic foam during the late stages of dike emplacement, resulting in material properties that inhibit typical impact crater formation and lead to inaccurate age determination through crater counting. However, [5] showed that there is not a significant difference in the crater morphology of small craters on Ina's smooth mounds compared to those outside of Ina. Significant questions therefore remain regarding the formation mechanism and age of IMPs.

Science Goals: Two fundamental questions about lunar thermal evolution and lunar volcanism could be addressed at Ina, one of the largest identified IMPs:

1) Is Ina an example of endogenic geologic activity on the Moon within the last 100 Myr?
2) What are the eruption dynamics or compositions that led to the unique morphology of Ina?

These questions are responsive to Visions and Voyages Decadal Survey' key question "How have the myriad chemical and physical processes that shaped the solar system operated, interacted, and evolved over time?" Specifically, it will address the Inner Planets question "What are the distribution and timescales of volcanism on the inner planets?" Additionally, a mission to Ina would be responsive to several goals described in 'The Scientific Context for Exploration of the Moon' report:
3. Key planetary processes are manifested in the diversity of lunar crustal rocks. (b) Inventory the variety, age, distribution, and origin of lunar rock types.
5. Lunar volcanism provides a window into the thermal and compositional evolution of the Moon. (a) Determine the origin and variability of lunar basalts. (b) Determine the age of the youngest and oldest mare basalts. (c) Determine the compositional range and extent of lunar pyroclastic deposits.
6. The Moon is an accessible laboratory for studying the impact process on planetary scales. (c) Quantify the effects of planetary characteristics (composition, density, impact velocities) on crater formation and morphology.

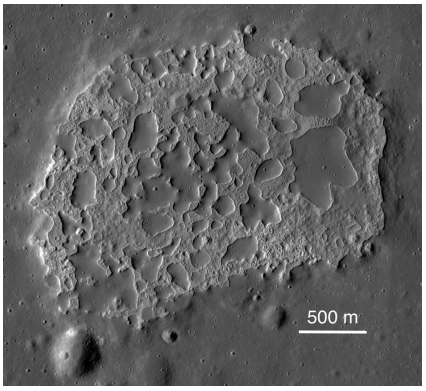

Figure 1: Ina, a cryptic lunar volcanic landform that could have formed within the last 100 Myr. Image credit: [2]

These high-level questions could be addressed through the following science objectives:

1) Determine the age of Ina
2) Determine whether the properties of Ina's smooth mounds are similar to lava flows covered with regolith seen at Apollo landing sites, pyroclastic material, or magmatic foam
3) Determine Ina's composition and whether it is distinct from known mare deposits
4) Determine whether the material at Ina's smooth mounds is crystalline or amorphous
5) Determine the water composition and content of the smooth and uneven terrains of the IMPs

Capabilities: Most of these objectives could be addressed with high TRL instruments on a lander delivered to the largest smooth mound in Ina. The high TRL instruments include a multispectral microimager, a camera, and a point spectrometer. Additional instruments for bulk chemistry or spatially-resolved remote composition would improve discrimination of eruption conditions. Addressing the fundamental question of the formation age of Ina would require either in situ geochronology or sample return. A rover with ground penetrating radar would enhance a mission to Ina by revealing the subsurface stratigraphy of an IMP smooth mound.

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