THE SPAN OF LUNAR MARE VOLCANIC ACTIVITY: ASSESSING THE VERY YOUNG IMPACT CRATER SIZE-FREQUENCY DISTRIBUTION AGES OF IRREGULAR MARE PATCHES. L. Qiao[1, 2], J. W. Head[1], [1]Dep. Earth, Env. & Planet. Sci., Brown Univ., Providence, RI, 02906, USA, [2]Planet. Sci. Inst., China Univ. Geosci, Wuhan 430074, China. Contact: Le_Qiao@Brown.edu, James_Head@Brown.edu.

Introduction: Lunar Irregular Mare Patches (IMPs) [1] are a group of distinctive and enigmatic landforms frequently occuring in nearside mare regions of the Moon [2]. Notable for their unusual "blistered" appearance (bleb-like mounds surrounded by rough and optically fresh floor materials), their formation mechanism intrigued lunar scientists for decades. Recent impact crater size-frequency distribution (CSFD) measurements and morphological analysis of three major IMPs (i.e., Ina (Fig. 1–5), Sosigens and Cauchy-5) interpreted lunar IMPs as small mare extrusions (Fig. 6) within the past 100 Ma, "significantly after the established cessation of lunar mare basaltic volcanism" [2].

The Braden et al. [2] analysis of IMPs means that mare volcanism spans a considerably greater range of ages than thought previously, in contrast to a wide range of data from other sources (summarized in [3]). In this contribution, we reexamine the basis for the very young impact crater size-frequency distribution ages for the three major dated IMPs, Ina, Sosigenes and Cauchy (focusing on Ina; Figs. 1–6), and assess whether there are any reasons to suspect that these ages might be underestimated.

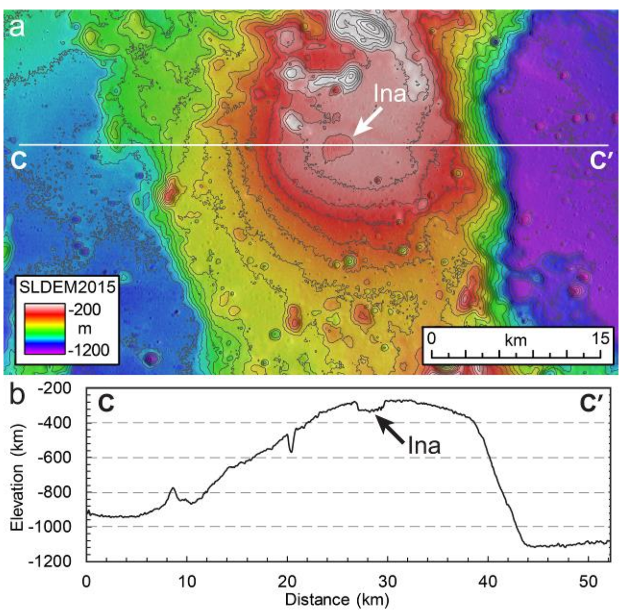

Fig. 1. Topography of the middle portion of Lacus Felicitatis. (a) SLDEM2015 topography overlying Kaguya TC evening mosaic, and (b) SLDEM2015 topographic across the uplifted, middle Lacus Felicitatis.

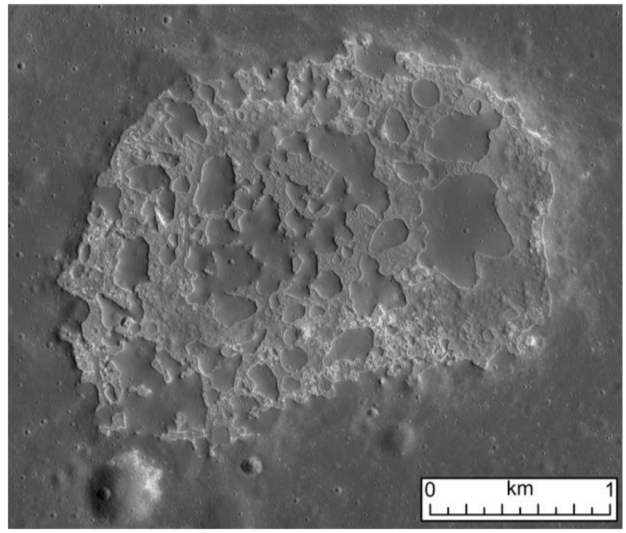

Fig. 2. Image of Ina pit craters, portion of LROC NAC frame M119815703, pixel size=0.48m, incidence angle=~56°.

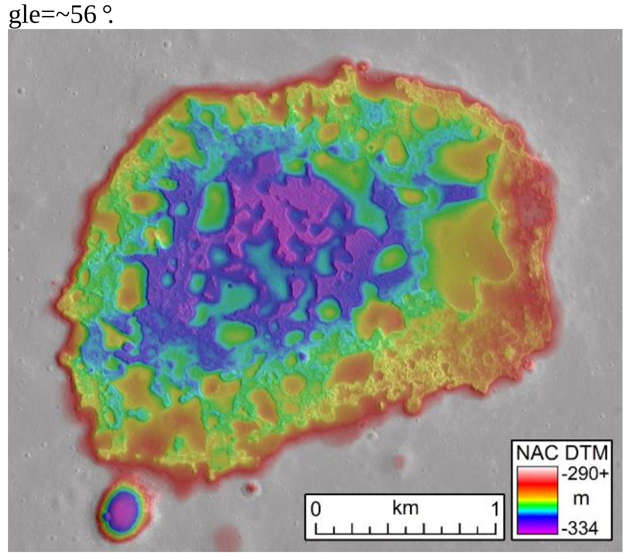

Fig. 3. Topographic variations of the Ina pit crater floor. Color-shaded NAC DTM topography overlain on LROC NAC M119815703.

Issues that are under investigation relative to age of the deposits:

1. Geologic Setting: Ina and Cauchy are situated on top of small (<~30 km diameter) shield volcanoes with ages in excess of 3 billion years. It would be logical that these IMPs formed at the same time as the shield and surrounding area rather than over 3 billion years later. There is no physical basis for assuming that summit vents would be reoccupied after a repose period of >3 billion

years. Perhaps this means that the IMPs date from >3 billion years, coincident with the latest stage of the shield volcano, but that there are other reasons for the extremely young CSFD dates. Below we outline several of these potential reasons.

2. Steep Slopes: Slopes on the mounds (Fig. 3–4) increase toward the mound edges. Could this influence the CSFD? We have performed measurements and analyses to assess this factor.

3. Size of Count Area: The count areas for the IMPs are by definition very small (Fig. 1–2) and thus subject to potential statistical issues. We performed experiments on the sizes of the count areas compared to the exterior regions of the shields and assess this factor.

4. Recognition of Craters: The hummocky terrain associated with IMPs is very rough, a factor that often makes recognition of impact craters difficult. We examine this possibility by assessing the hummocky terrain under a range of illumination geometries.

5. Unusual Substrate Properties: Could the properties of the IMPs, both the mounds and the hummocky terrain, be such so as to influence crater formation and retention? We assess a range of models that might have influenced crater formation and retention and show that this can potentially result in significant undersampling of craters and thus in artificially young CSFD ages.

We will present a synthesis of these results to assess the real ages of IMPs.

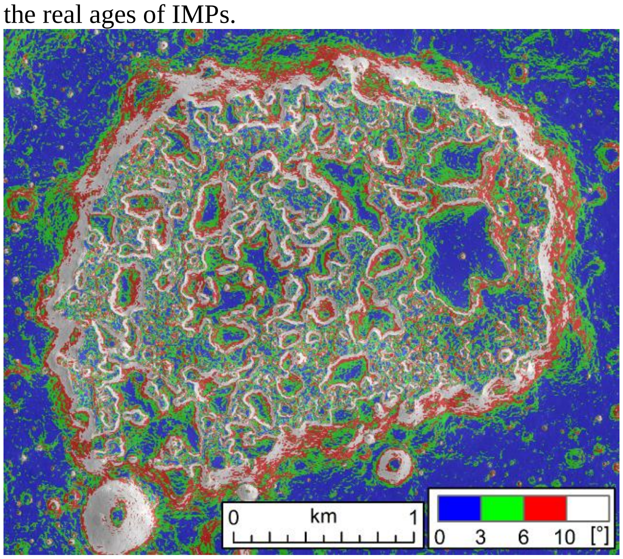

Fig. 4. NAC DTM slope for the Ina pit crater, overlying on LROC NAC M119815703.

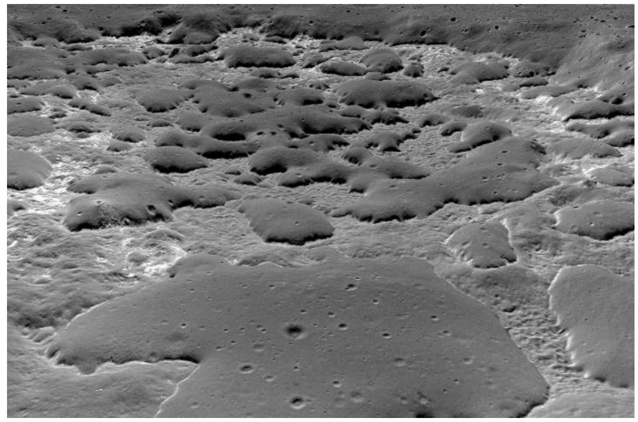

Fig. 5. Perspective view of the interior of Ina, based on LROC NAC frame M119815703 overlaid on LROC NAC DTM. View is looking from east to west across Ina. Vertical exaggeration is ~3.

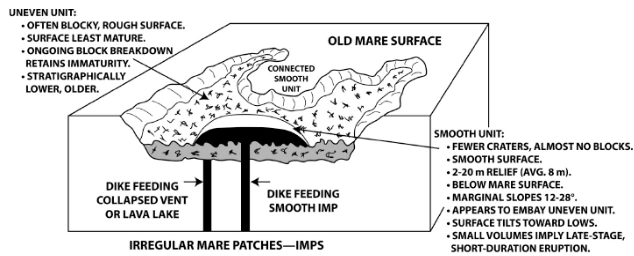

Fig. 6. Block diagrams illustrating lunar IMPs formation mechanism proposed by Braden et al. (2014).

References: [1] Strain and El-Baz (1980), *LPSC XI*, 2437–2446. [2] Braden et al. (2014) *NGEO* 7, 787-791. [3] Head and Wilson (2016) *Icarus*, doi:10.1016/j.icarus.2016.05.031.