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Qiao et al., 2017, Ina pit crater on the Moon: Extrusion of waning-stage lava lake magmatic foam results in extremely young crater retention ages: Geology, doi:10.1130/G38594.1

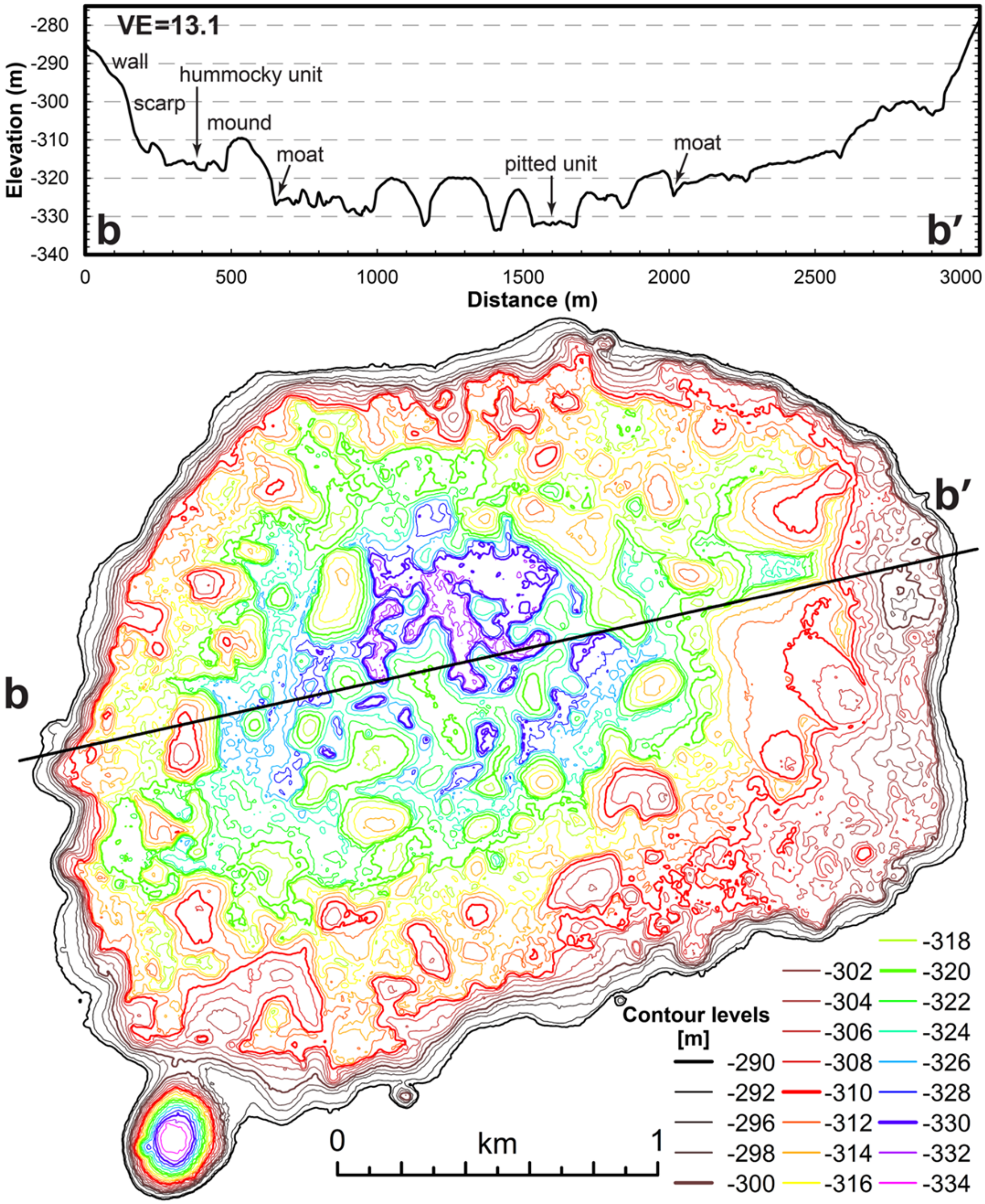

Fig. DR1. Contour map of Ina interior, derived from LROC NAC DTM. Contour interval 2 m, bold contour every 10 m. A W-E NAC DTM-derived elevation profile (b-b') is plotted at the top.

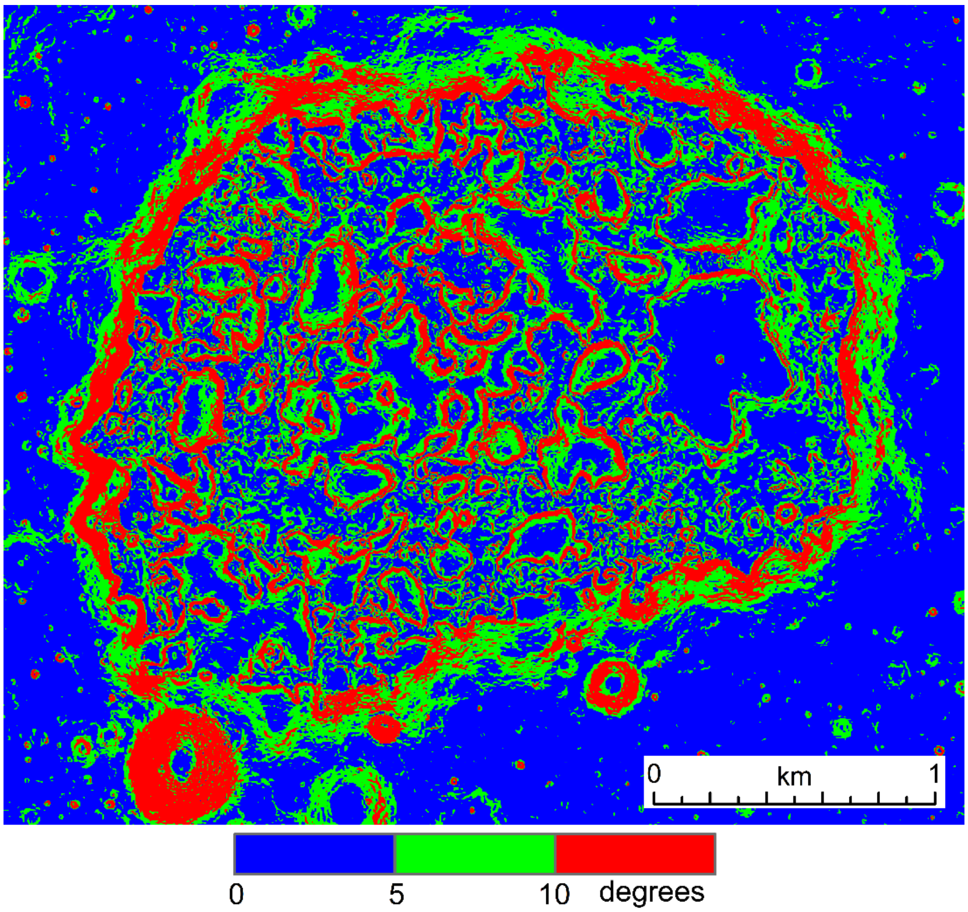

Fig. DR2. Slope map of the Ina interior, derived from LROC NAC DTM, 2 m/pixel, baseline is 6 m.

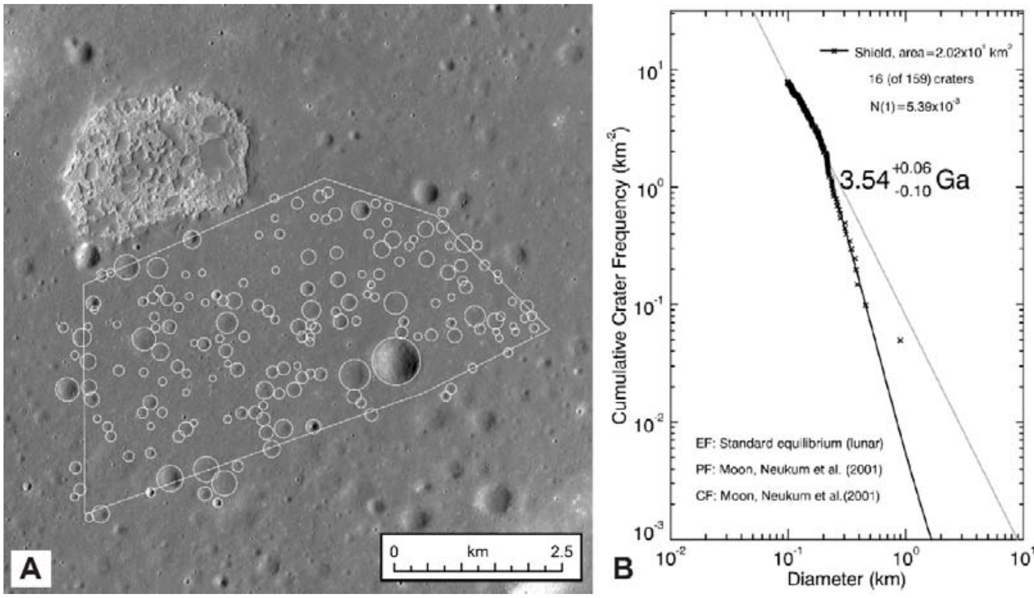

Fig. DR3. Impact crater size-frequency distribution analysis of the flanks of the shield volcano below the Ina pit crater. (A) Impact craters ≥100 m in diameter identified on the flanks of the shield volcano, based on LROC NAC frame M1138873574, 1.2 m/pixel, 66° incidence angle. (B) Cumulative size frequency distribution of crater counts; shows equilibrium population at D≤~220 m. The gray curve is the lunar equilibrium curve. Production function fit for craters ≥ 250 m in diameter gives an absolute model age of 3.54 (+0.06/-0.10) Ga. (Neukum et al., 2001).

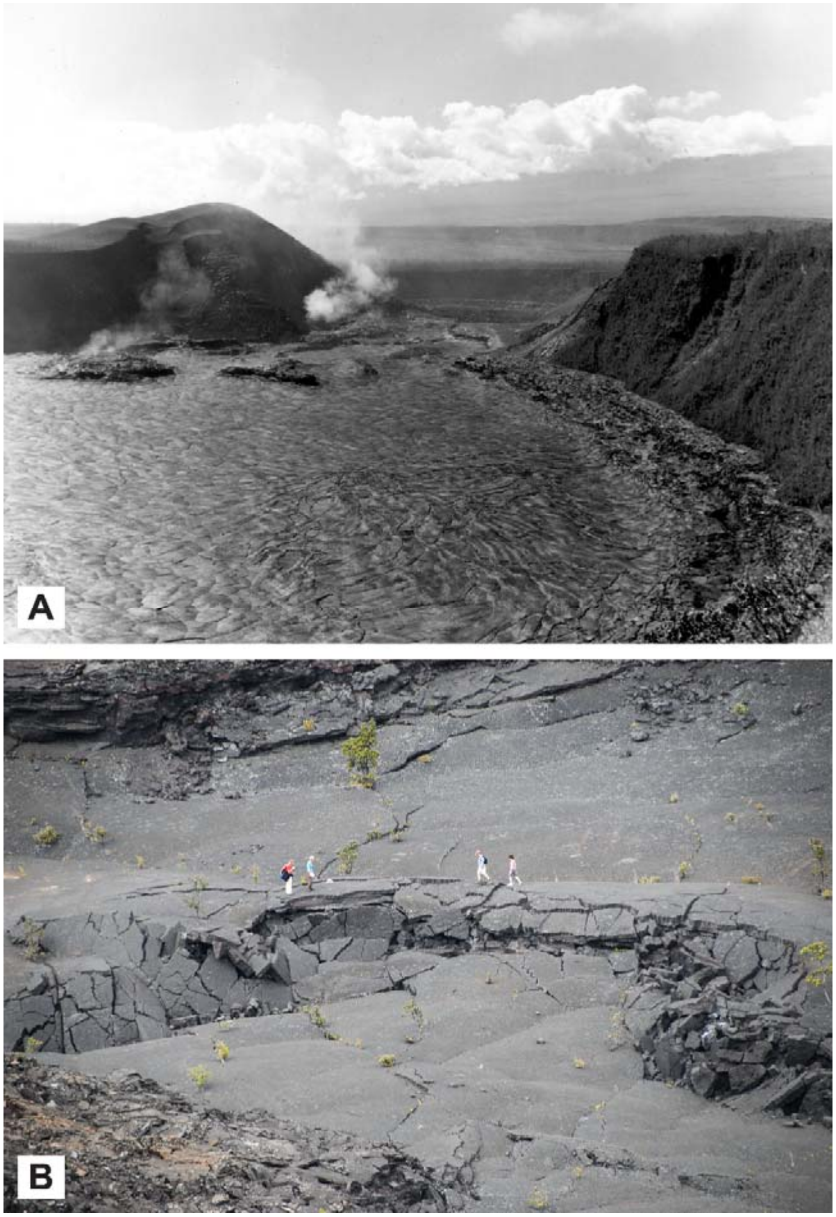

Fig. DR4. Shield volcano summit crater, Kīlauea Iki, Hawai'i. (A) 1959 eruption of Kīlauea Volcano, third phase of activity in Kīlauea Iki Crater. Note the chilled margin and inner scarp with tilted lava plates (right) and the chilled and blistered lava crust. USGS photo. (B) The floor of Kīlauea Iki. Note the draped plate at the edge of pre-eruption topography (top), the chilled marginal terrace, and the pressure ridge (center with hikers on top) formed by deformation of the subsiding rigid crustal layer on top of the lava lake. Note evidence for abundant void space associated with these deformed plates. U. S. National Park Service photo.

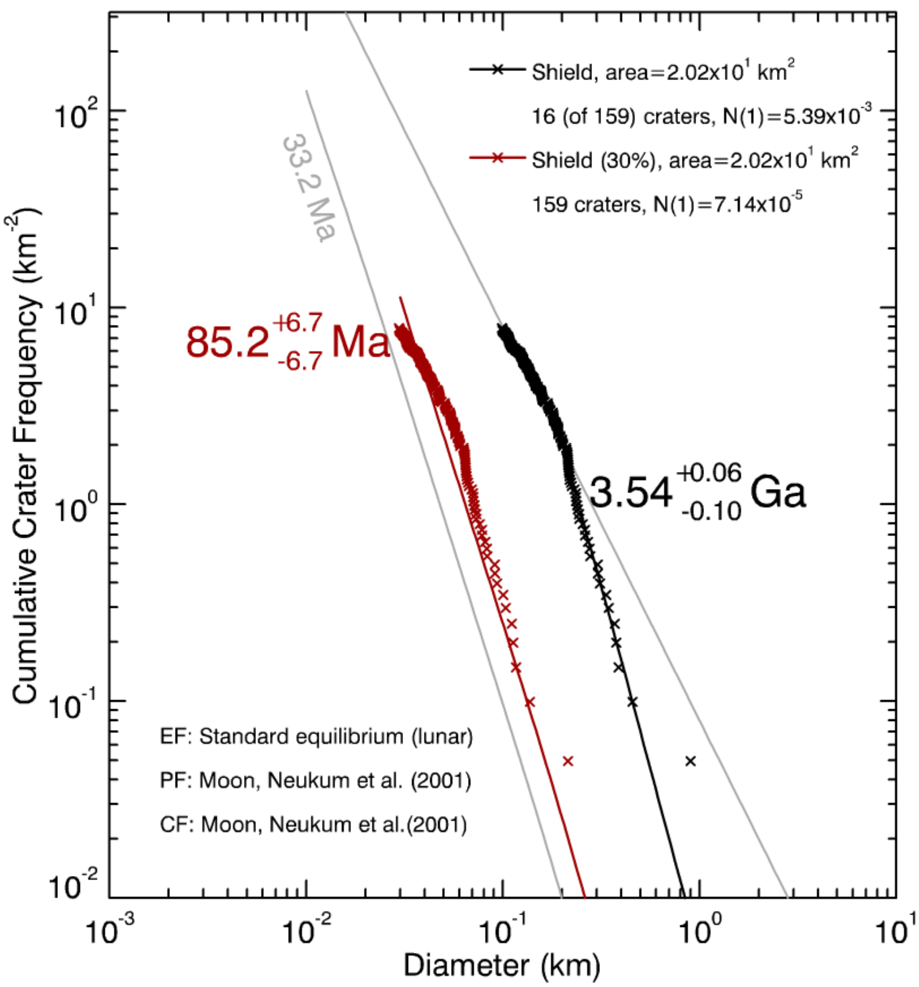

Fig. DR5. The effects of cratering a highly porous target (magmatic foam of the mounds) on the crater retention age. The original crater size frequency distribution of the shield volcano is plotted as black crosses. All the craters counted on the shield are scaled with a diameter decrease by a factor of 3 (plotted as red crosses), which yields a model age of <100 Ma. The gray line in the right is the lunar equilibrium curve, and the left gray line is the isochron for the 33.2 Ma age reported by Braden et al. (2014). The factor of 3 reduction of crater diameters was derived in the following manner: (1) cratering efficiency (excavated mass/projectile mass) on highly porous targets is reduced to ~1% compared with cratering on low-porosity materials (Schultz et al., 2002; Housen and Holsapple, 2003; Poelchau et al., 2013), (2) cratering efficiency (or excavated mass) is proportional to the density of the target materials times the cube of the crater diameter, (3) the density of ~75% porosity target is ~(1 - 0.75)/(1 - 0.12) = 0.28 of typical lunar crust (~12% porosity), (4) ~1% cratering efficiency corresponds to $\sim(0.01/0.28)^{1/3} = 0.33$ scaling of crater diameter.

Fig. DR6. Vesicular basalt 15016 collected by Astronaut David R. Scott on the Plains of Hadley during the Apollo 15 exploration of the Hadley/Apennine region. This highly vesicular basalt is ~3.29 billion years old (Evensen et al., 1973), and shows that extruded lunar basalts can retain significant volatiles in the form of bubbles during their emplacement on the surface. NASA photo.

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