LONAR CRATER, INDIA: AN ANALOG FOR MARTIAN IMPACT CRATERS. A. C. Maloof[1], S. T. Stewart[2], N. Swanson-Hysell[1], K. L. Louzada[2], I. Garrick-Bethell[3], S. A. Soule[4], and B. P. Weiss[3]. [1]Princeton University (maloof@princeton.edu), [2]Harvard University, [3]Massachusetts Institute of Technology, [4]Woods Hole Oceanographic Institution.

Introduction. Lonar Crater (Figs. 1, 2) formed between 15-67 ka in the ~65 Ma Deccan Traps [1-6]. Lonar is a unique Martian analog for studies of ejecta flow dynamics [7], paleomagnetism [8], and impact glasses [9], as it is the only terrestrial crater formed entirely within basalt. We present geologic and topographic maps, derived from field studies in Jan. 2005 and 2006, and describe ejecta features similar to Martian impact craters.

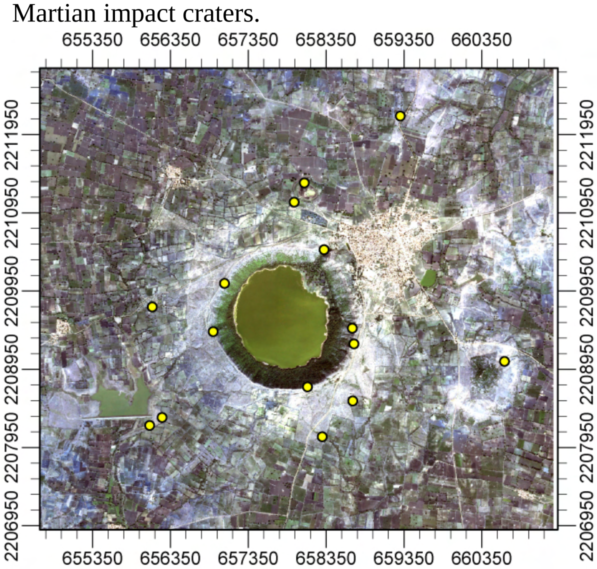

Fig. 1. Satellite image of Lonar Crater, India (Quickbird, pan-sharpened, 4-band). Paleomagnetism sampling sites (○) [8]. WGS84 UTM 43N.

Geology. Lonar crater wall and quarries in the surrounding area expose six 3 to >20-m thick, subhorizontal, pahoehoe-like flows with vesicular flow tops and bottoms and dense interiors (Fig. 3). Although surface textures are rarely preserved, toe-like structures can be found at some flow contacts. The lavas are aphanitic, tholeitic basalts, containing rare plagioclase and even rarer olivine microphenocrysts, both smaller than 1 cm. Alteration of the lavas is most common along the highly permeable pathways at the contact between flows.

The crater is the most significant topographic feature in the region. The regional dip is zero. The crater wall dips between 5 and 25°, with overturn observed in the rim fold. A digital elevation map (DEM) was derived from handheld GPS traverses (Fig. 2). The horizontal and vertical accuracy of the DEM, where coverage exists, is 5 m.

Macroscopic tear faults are not observed in the crater wall. In rare localities, there are normal faults with hanging wall down into the crater with offsets of less than about 10 m (Fig. 3). Layer parallel slip faults are observed within flow 5 along the hinge zone of the rim fold. Magnetic studies show clear progression of deformation from the crater wall to distal ejecta: uplift of the crater wall, rim fold, partially disrupted inverted stratigraphy, and distal conglomerate [see 8].

Continuous Ejecta Blanket. The present day continuous ejecta blanket extends to an average of ~2000 m from the crater center (Fig. 2). Erosion and reworking by fluvial transport and agriculture has removed the distal edge of the S and SW ejecta, mapped in the 1970's by [4, 5], and diminished the presence of impact glass. The continuous ejecta blanket grades irregularly from a proximal structure composed of several-m sized blocks of overturned and disrupted Deccan stratigraphy to a distal structure of unsorted, mm to m-sized clasts in a coarse matrix composed of local and crater-derived materials (bulk density ~2 g cm^{-3}).

Measurements of minimum ejecta thicknesses and stratigraphic relationships indicate that the distal ejecta developed into a ground-hugging, turbulent debris flow (Fig. 4). The ejecta topography, with a circum-rim syncline and accumulation of material at the flow terminus, is similar to layered ejecta structures on Mars. Relationships between ballistic clasts, which penetrated into a muddy histosol that filled local depressions in the pre-impact topography, and the overlying debris flow unit indicate that the ground-hugging flow velocities of the distal ejecta were 10's m/s [7], comparable to post-emplacement flow velocities inferred around Martian craters [10]. The inferred horizontal movement involves >25% of the predicted volume of the ejecta blanket.

Airfall glass is only found on preserved paleosurfaces. Where bedded alluvium is present, airfall glass and ejecta materials have been removed.

Conclusions. Lonar Crater is an excellent site for studies of impact crater formation and deformation, shock magnetization, and fluidized ejecta. The deformation from the crater wall to distal ejecta is illuminated by our paleomagnetic study. The properties of the ejecta blanket demonstrate significant radial mass movement following ballistic emplacement and final structures similar to Martian layered ejecta forms.

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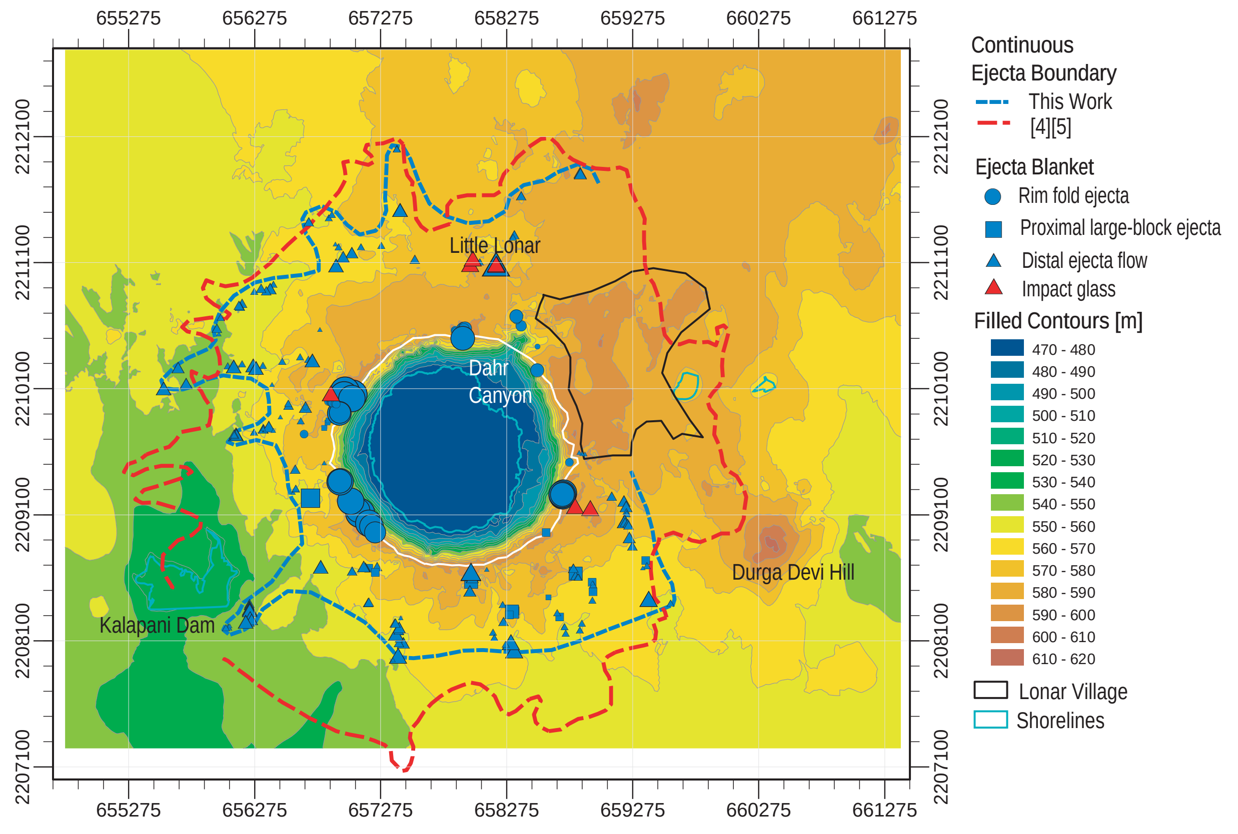

Fig. 2. Digital elevation map for Lonar Crater with locations of ejecta thickness measurements and ejecta boundary.

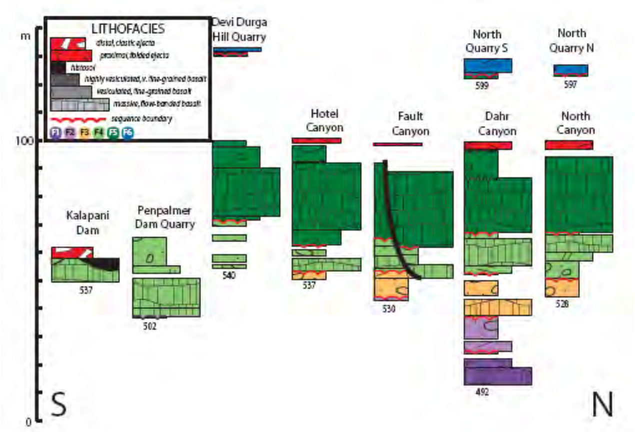

Fig 3. Measured sections of basalt stratigraphy at 10 cm precision in the crater wall and distal outcrops.

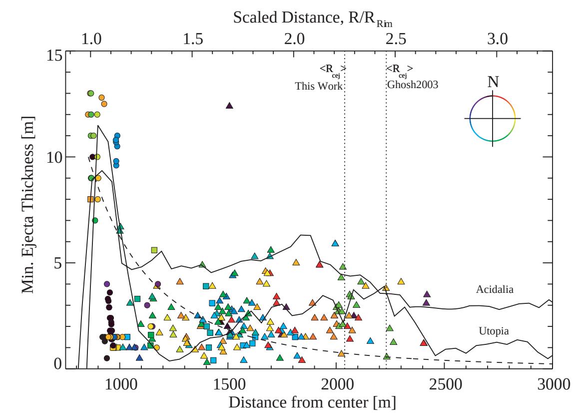

Fig. 4. Minimum ejecta thickness measurements (circles – rim fold; squares – large-block inverted stratigraphy ; triangles – clasts in matrix; color – compass direction), model ballistic ejecta thickness from scaling laws [11] (dashed line), and typical ejecta topographic profiles for fresh Martian craters (solid lines, scaled to Earth, from [12]). Note accumulation of ejecta amounting to ~5 times ballistic predictions at edge of continuous ejecta blanket.

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