A PALEOMAGNETIC STUDY OF LONAR IMPACT CRATER, INDIA. K. L. Louzada[1], B. P. Weiss[2], A. C. Maloof[3], S. T. Stewart[1], and N. Swanson-Hysell[3]. Department of Earth and Planetary Sciences, Harvard University, 20 Oxford Street, Cambridge, MA 02138, [2]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139, [3]Department of Geosciences, Princeton University, Princeton, NJ 08544.

Introduction: Lonar Crater, India formed <42 ka [1] as an impact crater into 5 to 6, 5-40 m thick, basalt flows [2] in the Deccan volcanic province. It is the only known terrestrial crater to have formed entirely in basalt and is therefore an excellent terrestrial analogue for craters on Mars and the Moon. As part of an interdisciplinary project [2-4], we have been conducting a paleomagnetic study of oriented rocks from Lonar to (a) test the hypothesis that shocked rocks contain a shock remanent magnetization [5] or evidence of impact-amplified magnetic fields [6] and (b) determine the effect of shock on rock magnetic properties.

Sampling Sites: 270 oriented samples were collected at 16 sites in and around the crater [3]. The sites are subdivided into four groups: I) flows in the crater wall (2 sites), II) unshocked flows (4 sites), III) ejecta (6 sites) and IV) folded (overturned) flows on the crater rim (2 sites). 34 samples were removed from the dataset because of suspicious local magnetic declinations or thermal demagnetization trends; the majority of these samples were from groups IV (38%) and I (35%) and likely suffered lightning strikes. Where possible, bedding was determined (e.g., using flow-banding).

Results: Two components of magnetization were identified with principal component analyis in nearly all samples. A low-coercity/low-temperature component, *LC/LT*, was easily removed by alternating field cleaning (up to 10 mT) and/or step-wise thermal demagnetization (up to ~200°C). The direction of this component for most samples is close to that of the present-day local field (PLF: D=-0.8°, I=28.0°). Continued heating up to ~515°C uncovered a high temperature component, *HT*, similar to that observed in other studies of Deccan basalts [7,8].

Flows. The mean directions of *LC/LT* and *HT* are shown in fig.1. *LC/LT* in all flows is roughly parallel to the PLF. Averaged over all flows, *LC/LT* is statistically similar to the PLF with 95% confidence. *HT* is reversed to *LC/LT* is offset by ~30° to the East of the Deccan at Lonar (D = 154.9, I = 47.2). Significant scatter between site mean directions within the same flow has been observed and may be due to remaining early or late overprints, e.g. due to later reheating of the upper surfaces by succeeding flows [7]. Our data set is likely too limited to average out secular variation.

Ejecta. *LC/LT* in all ejecta sites fails Watson's randomness test [9] with 99% confidence (fig. 2) and are within 95% confidence identical to the PLF (that is, PLF lies within the ellipse of 95% confidence). Randomness cannot be rejected in the *HT* components of the ejecta with 95% confidence at all but one ejecta site and in the mean of all ejecta samples indicating that the *HT* in the ejecta were acquired prior to deposition.

Crater Rim Folds. *LC/LT* For at each of the four sites is within 95% confidence identical to the PLF. Upon tilt correction, *LC/LT* fails the fold test [10], indicating that the magnetization was acquired after folding. On the eastern rim of the crater the geographic *HT* directions cluster in to two groups corresponding to 1) the slightly tilted flows in the wall of the crater and 2) rim blocks (fig. 3, inset). After tilt corrrection (fig. 3), the estimated precision parameter, k, of *HT* increases by a factor of 4.37 and passes the fold test with 95% confidence. The tilt corrected mean of *HT* lies within ~15° of the mean flow *HT* determined in this study.

Fold tests on the *HT* component at the other three sites fail. However, *HT* passes the conglomerate test before tilt correction, and fails after tilt correction. This indicates that blocks at these sites experienced folding and vertical rotation.

Discussion: It has been suggested that the *LC/LT* component at Lonar is due to shock remanent magnetization (SRM) acquired during impact [5]. However, the fact that *LC/LT* in all groups is statistically similar to the LPF implies this is not the case. If SRM was acquired in the ejecta blocks during ejection and deposition after impact, than we would expect *LC/LT* to be random, which it is not. We conclude that it is a viscous remanent magnetic overprint of the PLF acquired over longer timescales than the impact event. Hence the *LC/LT* component cannot be used to constrain the age of the impact event.

The positive fold test result shows that *HT* was acquired prior to impact. Therefore, paleomagnetism can be used to study impact tectonics. However, the fold is not a perfect cylindrical fold with a predicted horizontal N-S fold axis. The average fold axis is horizontal in the 022 direction, indicating that vertical rotation has occured. Impact related folding may be locally chaotic due to tearing and folding as would be expected in a radial fold.

Changes in magnetic properties of rocks due to shock is being investigated. The presence of the *HT* component demonstrates that the ejecta blanket was not heated above ~200°C.

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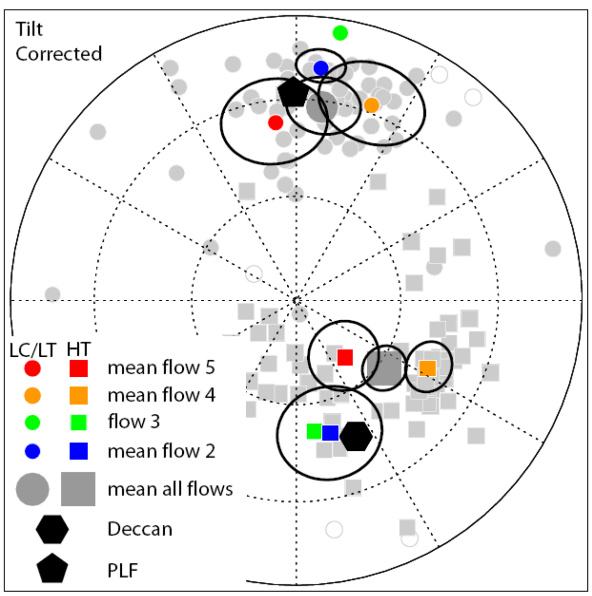

Figure 1. Equal-area plot of all flows color coded by flow number. Open symbols denote upper hemisphere.

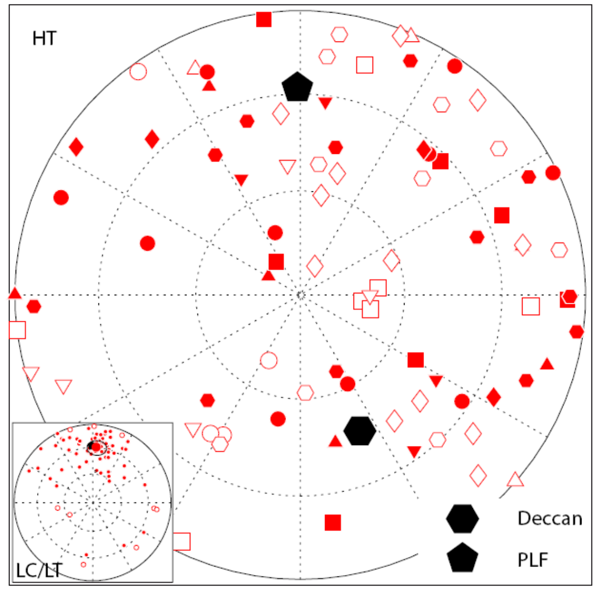

Figure 2. Equal-area projection of all ejecta samples. Symbols denote six sample sites. Open symbols denote upper hemisphere. The insert shows the *LC/LT* component of the ejecta.

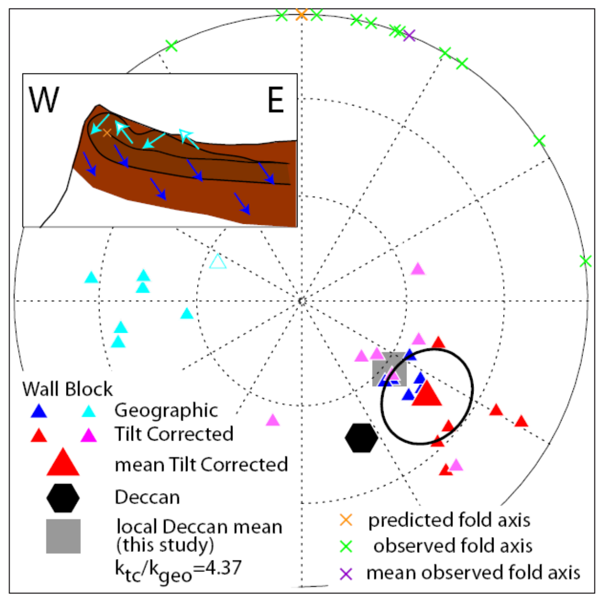

Figure 3. Equal-area projection of the fold on the eastern rim of the crater. Open symbols denote upper hemisphere. The insert shows a schematic of the fold and the geographic directions of *HT*.