IMPACT EJECTA CHARACTERISTICS AND EMPLACEMENT HISTORY AT LONAR CRATER, INDIA: IMPLICATIONS TO TERRSTRIAL PLANETARY PROCESSES.

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Introduction: Impact process is an important event throughout the geological history of terrestrial planet. Impact cratering not only accounts for overall shape of the planetary bodies, but also for astrobiological evolution and potential economic ore deposits. Therefore, the impact structures are always given high priority for selecting past and future landing sites on the planetary bodies like Moon and the Mars.

The presence of impact ejecta is almost common in any impact crater depending upon the physical state of target materials and the degree of preservation. However, the mode of ejecta distribution and its emplacement history remain least understood even for the Earth too.

In this communication, we synthesise our field observations on ejecta characteristics from Lonar crater, India. As most of the ejecta studies on basaltic planets based on remote sensing technique, this study will definitely help to understand and validate the orbital observations on the ejecta emplacement process in other terrestrial planets as well.

Geological setting: The Lonar impact crater in Buldhana District, Central India is one of the few known, well preserved, terrestrial asteroid impact craters on basaltic target rocks [1]. Therefore, the crater is comparable to those formed on rocky planets or planetesimals with basaltic crust. The crater is a bowl shaped, near-circular simple crater having average diameter of ~1.81 km, circularity of ~0.95, and depth of ~135 m [2,3].

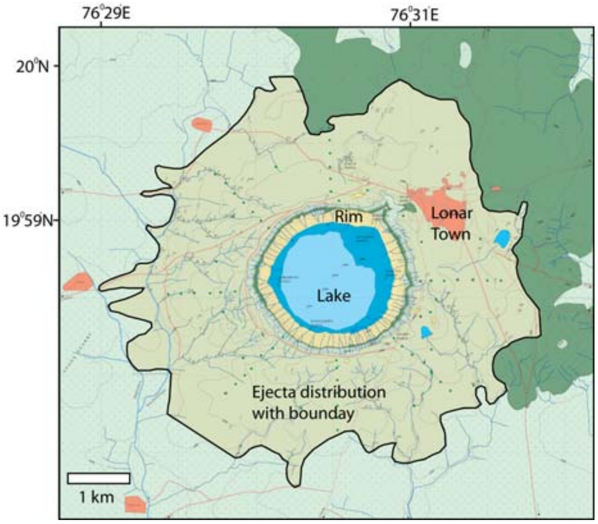

Fig. 1 Ejecta distribution Map of the Lonar crater, India, modified after [4].

Field observations of Impact ejecta: The crater rim is covered by ejecta, which comprises clasts of basalts embedded within fine ejecta (Fig. 1). The ejecta blanket extends outward from the crater rim with a gentle slope of 2–6^{o} for a distance of ca. 700 m from the crater rim. In the western sector, the ejecta cover extends outward for a little more than a kilometer. The impact ejecta (thickness vary from ~15 m to few cm) around the Lonar crater comprises three basic components: (a) the major throw-out ejecta containing unshocked blocks of basalt up to many meters in size, (b) mixed shocked ejecta containing fragments of both unshocked and shocked basalts, and (c) shock-melted glass [4]. The throw-out ejecta forms an almost continuous blanket over the target basalts and extends out around the crater rim up to ca. 1½ crater radii. The mixed shocked ejecta and shock melts are more abundant around the crater within ½ crater radii from the crater rim, where they are more abundant in the upper part of the ejecta [5].

The type section of the thickest proximal ejecta (~15 m thick) we encountered just adjacent (towards south) to the MTDC resort (Fig. 1). Centimeter to meter-sized basaltic clasts are found embedded within the fine materials.

Fig. 2 Proximal ejecta layer of ~15m thickness near MTDC resort, Lonar, India. Large basaltic clasts (B) are also seen.

The shock-melted glass are found as discontinuous layer within the fine proximal ejecta layer in shallow trench, adjacent to the roadside towards further southeast. Approximately 20-25 cm thick glassy impact melt lenses were found sandwiched within the thick proximal ejecta layer (Fig. 3).

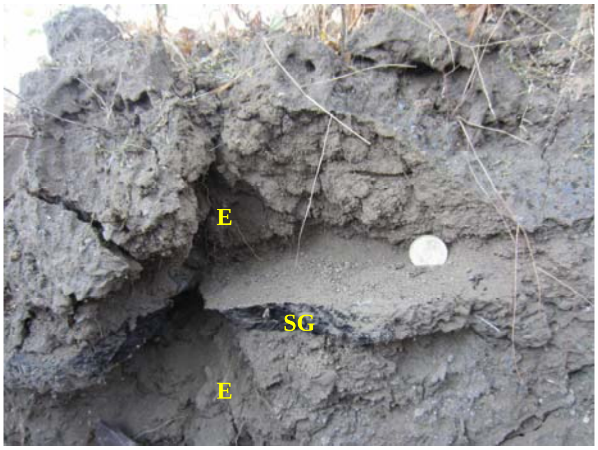

Fig. 3 Discontinuous sheets of shocked glass (SG) within the fine ejecta (E) layers.

The ejecta layers were also found in different wells and querries section along the traverse from rim to Kalapani dam.

The ejecta layers are found progressively thinning towards west and the type section of distal ejecta overlying the histosol is exposed near Kalapani dam (Fig. 4, [6]). Approx 2-3 m thick ejecta are found to overlie the histosol, the latter occasionally show pinch and swell pattern. Basaltic clasts are found equally common within the both histosol and ejecta; however, the size of the clasts are relatively bigger (up to meter scale) within the histosol. A few of these clasts are subrounded to subspheroidal and the rest are angular fragments with an overall poor sorting index. Red clayey materials (Redbole?) are also occasionally noticed within the fine ejecta layers (Fig. 5) .

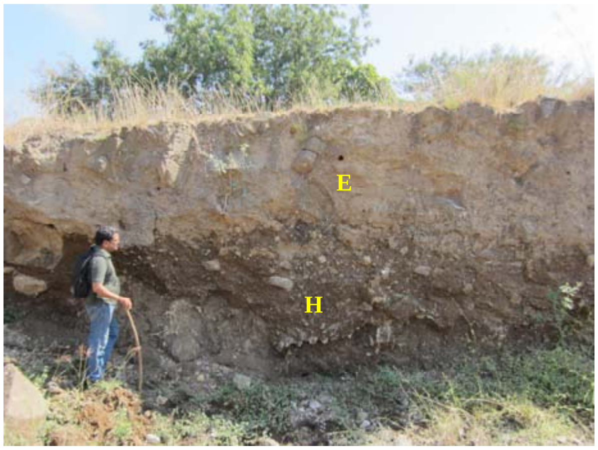

Fig. 4 Histosol (H) is overlained by ejecta material (E) near Kalapani dam, Lonar. The top most part is humus-rich soil.

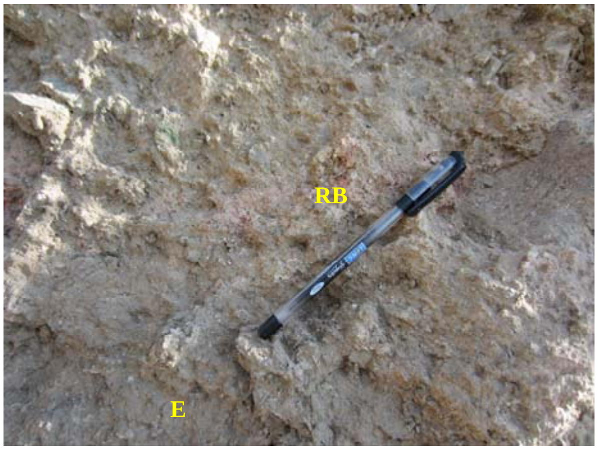

Fig. 5. Clayey material (red colour, RB) within the distal ejecta (E) near Kalapani dam, Lonar.

Discussion: The excellent exposures of ejecta in different sectors make the Lonar crater, an unique site for studying the ejecta emplacement proceses. Continuous ejecta blankets along the raised rim with larger basaltic clasts suggest they are least modified due to post impact process. The existence of ejecta blanket far beyond the crater rim implies ballistic sedimentation as the most viable process for ejecta emplacement. The presence of shock induced impact-melt/ shocked glass found only within the subsurface proximal ejecta layers accounts for smaller volume of melt generated due to impact and likely to aerodynamically (i.e. solidified during flight) blown up to proximal zone. Abundance of angular to subangular basaltic clasts within the fine ejecta layers further invokes very short time span between the impact event and the time of ejecta emplacements. Presence of relatively low proportion (<10%) of subrounded to rounded clasts indicates the subdued role of ground hugging process. Post crater modification by the erosional processes also could be important factor for desired changes in clast morphology.

It is hard to discriminate geochemically the five lava flows out of six flows exposed in and around Lonar. This also hinders to identify and quantify the secondary or local component that incorporated within the primary ejecta materials.

References: [1] Fredriksson, K. et al. (1973) *Science*, *180*, 862-864. [2] Ray, D. and Misra, S. (2014) *EMP*, *114*, 59-86. [3] Ray, D. et al. (2016) *MAPS (under revision)*. [4] Ghosh, S. and Bhaduri, S.K. (2003) *Ind. Min.*, *57*, 1-26. [5] Wright, S.P. (2008) *Large Meteorite Impacts and Planetary EVolution*, Abstract #3099 (CD-ROM). [6] Maloof, A.C. et al. (2010) *GSAB*, *122*, 109-126.