SHOCK METAMORPHISM OF FRESH AND ALTERED BASALT PROTOLITHS FROM LONAR CRATER, INDIA: WHY ARE SNC'S ALWAYS "FRESH" AND CLASS 2?

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Introduction: The study of shock metamorphism on basaltic minerals [1-3] is of much interest given that our only ~55 samples of Mars are shocked basalts. Identifying the source craters/regions of SNC meteorites [4] is also of interest as we have no sample return and hence no geologic context to compare to the increasing amount of remote data being returned from orbiters. This is a quandary as all ~40 shergottites have been shocked ~25-45 GPa, yet all remote data is of pixels of primarily unshocked basalt. Further, the finding of alteration minerals on Mars [5-6] has implications for water in the geologic history of Mars, and thus upcoming missions such as MSL [7]. Deccan basalt has been called an excellent analog for Surface Type 1 (basalt) found in the equatorial regions of Mars [8]. Comparisons to and implications for shergottites and data from Mars orbiters and Rovers are noted. For this study, from a previous classification [9], Class 1 (<20 PGa), Class 2 (20-40 GPa), Class 3 (40-60 GPa), Class 4 (60-80 GPa), and Class 5 (>80 GPa) shocked basalt, or "impact melts" of both fresh and altered basalt, along with one soil protolith, have been found, and petrographic and BSE images will be shown.

Deccan and Lonar background: Prior to impact, Deccan basalts primarily composed of labradorite and augite erupted ~65 Ma. Aqueous alteration that we attribute to groundwater in the lower 3 of 6 flows resulted in chlorite, serpentine, celadonite, hematite, zeolite, and silica being deposited in the basalts. Impact ~570 ka [10] produced impactites from a wide range of shock pressures [9] of both fresh and altered protoliths.

Petrography and BSE images: Class 2 shocked basalt show intense shattering and fracturing of clinopyroxene grains, and labradorite has been converted to maskelynite [2, 9]. These data are comparable to the petrography of shergottites [*e.g.*, 11]. Petrographic images of impact melts exhibit schlieren and flow features similar to lechatelierite from Meteor Crater and other terrestrial impact melts. Classes 3 and 4 show flowing and vesiculated plagioclase glass, respectively (NOT maskelynite). New finds related to Mars alteration include 1.) melt glass "encasing" the alteration minerals listed above to preserve their pre-impact (groundwater) alteration now accessible as breccia clasts in the ejecta, and 2.) only Class 2 rocks with altered protoliths acquire "decompression cracks", as there was no melting to accommodate the change in volume as seen in higher classes.

Implications: We receive a biased samling as only fresh, Class 2 shocked basalts are ejected off Mars. The melting of higher shock classes and/or the "decompression cracking" of altered basalts must decrease the particle velocity term in the Huguenot equations, and hence the Martian escape velocity of 5.0 km/s is not reached. These materials likely remain on Mars to be found by future rovers.

References: [1] Stöffler (1971) *JGR 76*, 5541-5551 [2] Stöffler (1972) *Fort Min 49*, 50-113 [3] Stöffler (1974) *Fort Min 51, 256-289* [4] Hamilton et al. (2003) *MaPS 38*, 871-885 [5] Ehlmann et al. (2010) *GRL* [6] Glotch et al. (2010) *GRL* [7] Mahaffey (2008) *ISSI*, Vol 25, 255-268 [8] Bandfield et al. (2000) *Science 287*, 1626-1630 [9] Kieffer et al. (1976) *LPSC VII*, 1391-1412 [10] Jourdan et al. (2011) *Geology*, in press [11] McCoy et al. (1999) *GCA 63*, 1249-1262