NO EVIDENCE OF IMPACT INDUCED VOLATILE LOSS FROM MASKELYNITE OF LONAR CRATER, INDIA. Saumitra Misra[1], Horton Newsom[1], Tania Mukherjee[2], Ananda Dube[3], Debasish Sengupta[2], [1]Institute of Meteoritics and Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, USA (saumitramisra@hotmail.com, newsom@unm.edu); [2]Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur- 721302, India (tania_megh@yahoo.co.in, dsgg@gg.iitkgp.ernet.in); [3]P147/3, Janak Road, Kolkata- 700 029, India.

Introduction: The discovery of maskelynite [1] in the moderately shocked basalt in the ejecta clasts of the ~50,000 year old Lonar crater [2-4] on Deccan Trap was an important criteria for establishing the meteoritic impact origin of this crater. However, little is known about the detailed petrology and geochemistry of this mineral, particularly the loss of volatiles during its formation. It was only found experimentally that the Lonar maskelynite was formed under a shock pressure between > 200 and < 400 kbar [5], and it reverted to a crystalline state only at a temperature of 800^{o}C [6]. In the present paper we focus mostly on the loss of volatile elements from the maskelynite due to impact, and its compositional variation compared to plagioclase of unshocked basalts.

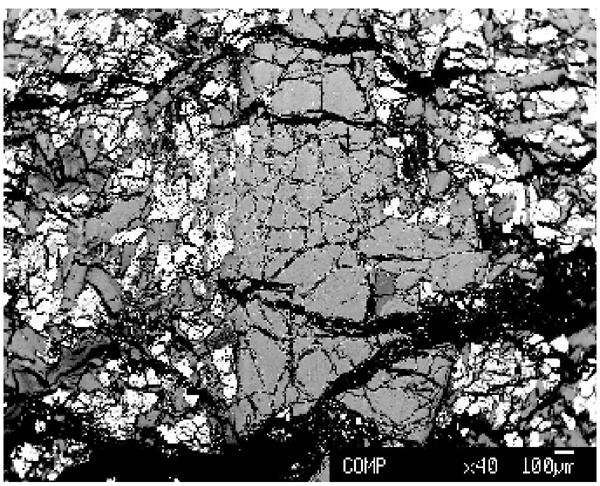

Fig. 1. BSE image of maskelynite showing planer fractures, darker gray portion is maskelynite. Sample L60G from the WSW rim of Lonar Crater.

Analytical techniques: The XRD analyses of samples were carried out at the Central Research Facility, IIT, Kharagpur, India, by an X'PertPRO, PANlytical, Holland, machine (model no. PW3040/60) with Co target and Fe filter under a working voltage of 40 Kv, 30 mA current, and a scanning speed of 0.0533^{o}. A JEOL 8200 electron microprobe with five wavelength-dispersive (WD) spectrometers at the University of New Mexico, Albuquerque, USA, was used for quantitative analysis of major oxides and few trace elements (Zn, Ba, Pb) using a 15 µm broad beam, 15 KeV accelerating voltage and 20 nA sample current, with ZAF correction routines.

Petrology and XRD: Isolated cm-size pieces of maskelynite-bearing shocked basalts within the fine ejecta blanket of Lonar Crater are highly cleaved and fragile. In thin section the maskelynite-bearing shocked basalt shows occasional isolated pockets of brown-colored impact-melts. The maskelynite grains are clean, colorless, having planar fractures (**Fig. 1**) with well preserved porphyritic texture [6]. The additional observation is that this mineral in some cases exhibits flowage structure (**Fig. 2**) indicating their formation during a melt-stage [7].

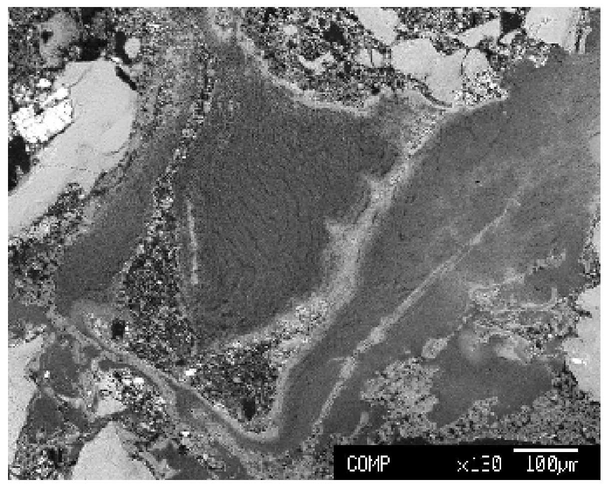

Fig. 2. BSE image of maskelynite showing flowage structure, darker gray portion is maskelynite. Sample L60G.

The XRD analysis of a maskelynite-bearing shocked basalt (powder) sample shows predominance of augite peaks, while remnant of labradorite peak (2θ ~ 27.4101^{o}) is also seen suggesting partial retention of plagioclase structure [8] in this highly shocked basalt. The alteration products include a clay mineral similar to mazzite (sodium-potassium-calcium-magnesium-aluminum-silicon hydrate, XPDF file no. 70-2386) and bromo-muscovite (potassium-aluminum-boron-fluorite-silicate- hydroxide, no. 46-1384).

Geochemistry: The average chemistry of plagioclase from unshocked basalt and maskelynite are given in Table 1. The only differences in average compositions are that maskelynites are marginally enriched in MgO, Na_2O and K_2O ; and depleted in CaO compared to the plagioclase in unshocked basalt. Volatile trace oxides like ZnO and PbO, however, do not show significant differences between these two members.

In the SiO_2 versus Al_2O_3 and CaO bivariant plots the plagioclases from unshocked basalt and partially shocked basalt [9], and maskelynite show overlapping but sharply defined linearly decreasing trends (**Fig. 3a, b**), while the trend is linearly increasing in SiO_2 versus Na_2O plot (**Fig. 3c**). In all these plots the compositions of maskelynite are relatively evolved compared to the plagioclases in unshocked or partially shocked stage.

Discussion: Our present investigation on Lonar maskelynite shows that some remnant of plagioclase structure is retained in shocked basalt during its transformation to maskelynite. It was not only a solid stage transformation of plagioclase by impact, but also partly formed from dense quench glass. The remaining mineral that escaped the shock pressure was mostly clinopyroxene.

Table 1: Average geochemistry of Lonar unshocked plagioclase and maskelynite. SD- standard deviation.

	Unshocked plagioclase		Maskelynite	
Grain no:	-		3	
No. of analysis	46		36	
	Average	SD	Average	SD
SiO_2	50.306	1.805	51.332	1.991
TiO_2	0.066	0.022	0.066	0.022
Al_2O_3	30.954	1.516	30.296	1.266
$Fe_2O_3^T$	0.803	0.298	0.738	0.292
MnO	0.006	0.007	0.008	0.009
MgO	0.159	0.069	0.229	0.099
CaO	13.751	1.511	13.205	1.527
Na_2O	3.587	0.799	3.863	0.755
K_2O	0.178	0.140	0.216	0.121
P_2O_5	0.003	0.003	0.007	0.005
ZnO	0.022	0.013	0.028	0.019
BaO	0.010	0.008	0.018	0.014
PbO	0.011	0.009	0.014	0.010
Total	100.124		100.019	

There is no significant difference in chemistry between plagioclase from unshocked basalt and maskelynite (**Table 1**) suggesting no significant chemical fractionation occurred by shock pressure during impact. Marginal enrichment of Na_2O in maskelynite over plagioclase also ruled out the possibility of characteristics Na loss in impact-melts and spherules [9] due to shock pressure. Systematic linear variation between Si, Al, Ca and Na can easily be explained by cationic replacement in plagioclase lattice structure [10] rather than impact.

The possible activity of aqueous or hydrothermal transport within the fine ejecta around the rim of Lonar Crater was indicated by their depleted nature of MgO, Na_2O and K_2O, and enrichment in Rb and Cs over target basalt [11]. Relative enrichment of Br in the impact-melt and spherules [9] also suggested this idea. Our new results [12] confirm some chemical effects of limited aqueous alteration on proximal and distal ejecta. Present findings on secondary minerals like bromomuscovite and mazzite in the XRD analysis of the maskelynite-bearing shock basalt also confirm the activity of H_2O and halogen within the ejecta blanket. However, more data are needed to understand the chronology and temperature history of this aqueous activity within the impact ejecta at Lonar.

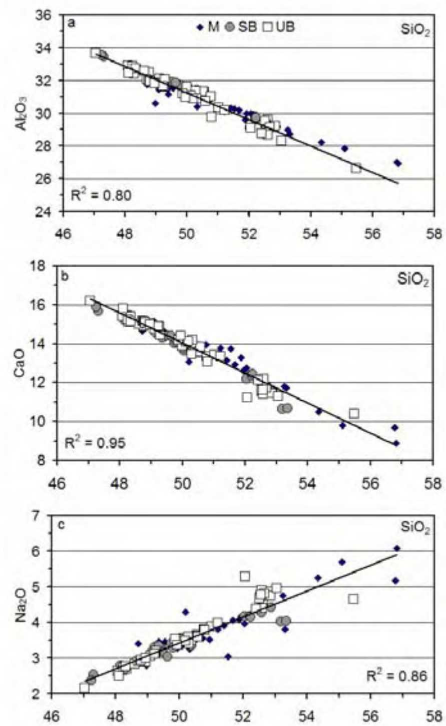

Fig. 3. Plots of plagioclase from unshocked basalt (UB), partially shocked basalt (SB), and maskelynite (M) in major oxide bivariant plots.

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