QUENCHED MORPHOLOGIES IN IMPACT GLASS FROM LONAR CRATER, INDIA: ROLE OF WATER? N.S.Chinchalkar[1] and R.A. Duraiswami[1], [1] Department of Geology, Savitribai Phule Pune University, Ganeshkhind Road, Pune, India - 411007

Introduction: Lonar Crater (76.52°E, 19.98°N, ~563 m amsl.), located in Maharashtra, India, is a simple impact crater with a diameter of 1.8 km and the hypersaline lake formed in it lies at about 137 m below the raised rim of the crater.

A previous study described the impact glasses from Lonar with respect to their geochemistry and microtextures [1]. In this work, we provide more insights into the microtextures of impact glasses from Lonar, upon the crystal morphologies which indicate quenching due to water.

Methods: Samples of impact glass were collected from near the Amber Lake, north of Lonar Crater (Fig. 1). These samples were retrieved from debris flow deposits, possibly reworked ejecta, near the north eastern exterior of the Lonar crater wall. Ex-situ samples of shocked basalts were also collected from the rim of the crater and used for petrographic analyses.

Electron Probe Microanalysis (EPMA) of impact glass was carried out at Indian Institute of Technology, Bombay with a CAMECA SX5. The instrument was equipped with 5 Wavelength Dispersive Spectrometers. Quantitative analysis used a 15 µm beam, 15 KV accelerating voltage and 20 nA sample current and a counting time of 10s. The standards used for calibration were albite (Na), diopside (Mg,Ca), Th-glass (Si), corundum (Al), orthoclase (K), rhodonite (Mn), hematite (Fe), barite (Ba), chromium trioxide (Cr), Rutile (Ti), and metal (V).

Along with determination of the chemical composition of the glass, the various mineral phases in the glass were identified by their major oxides.

Fig. 1: Google Earth image of Lonar Crater. Location of Amber Lake is marked with a square.

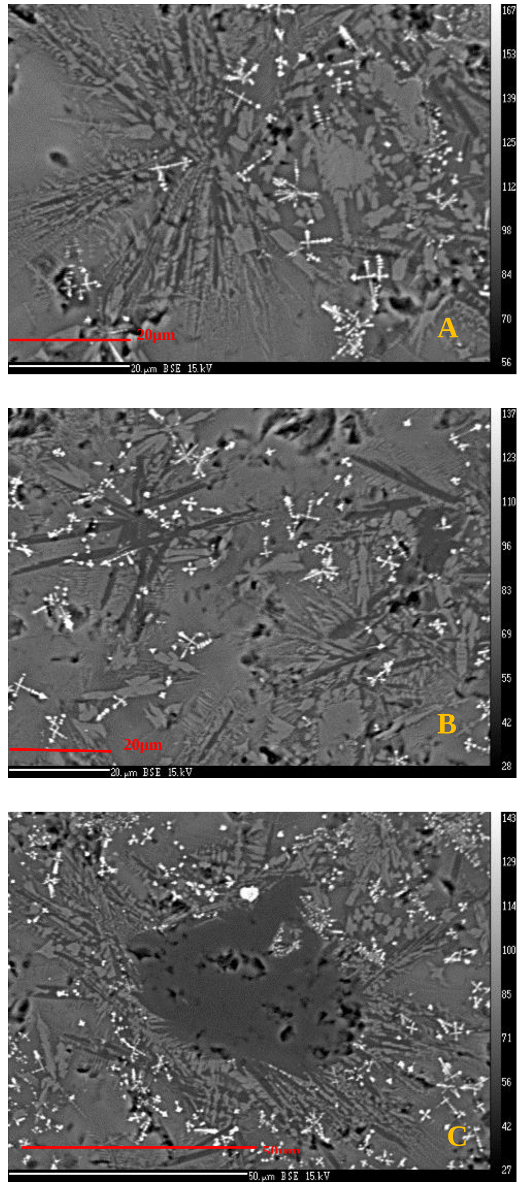

Fig. 2: BSE images of glass from Lonar Crater. A,B: Quenched plagioclase crystals surrounded by glassy groundmass and dendritic Ti-magnetite crystals. C: A patch of glass surrounded by quenched plagioclase laths.

Mineral	Ti- Mag	Opx	Cpx	Glass	Plagioclase
No. of analyses	4	2	12	15	8
SiO2	1.0655	47.386	49.82908	51.9732	49.819
TiO2	26.712	0.7195	1.201083	2.258	1.201
Na2O	0.06625	0.1215	0.31275	2.417533	0.313
MgO	1.05	6.722	12.63608	5.268733	12.634
Al2O3	1.4855	0.7115	2.342083	13.7212	2.342
K2O	0.03525	0.0985	0.090333	0.598267	0.090
CaO	0.30775	5.8975	15.0705	10.211	15.068
FeO	63.4065	36.8935	17.51542	12.83127	17.512
BaO	0.167	0	0.006917	0.033	0.007
V2O3	1.15675	0.025	0.1225	0.103333	0.122
MnO	0.524	0.786	0.3505	0.210867	0.350
Cr2O3	0.0085	0	0.0295	0.0138	0.029
Total	95.98625	99.3605	99.50992	99.64413	99.490

Table 1: Oxide weight percentages of glass obtained by EPMA.

Mineral phases in Lonar impact glass: The impact glass was studied under petrographic microscope, however owing to their very small size, no indivial minerals could be identified. However, Back Scattered Electron (BSE) images (Fig. 2) of the impact glass show presence of grains of clinopyroxenes (Ferroan-Augite), a very small amount of orthopyroxene (Pigeonite), and a dominance of plagioclase plus complete glassy phases. The glassy phases were identified (Table 1) based on comparison with geochemical data presented in earlier publications on impact glasses from Lonar [1, 2, 3]

The glasses are geochemically similar to the target basalts from Lonar [1,3]. BSE images show devitrification textures like quenching where crystallites of plagioclase have started to nucleate [1]. Basalts from the crater which have experienced lower grades of shock pressures compared to the impact glass show presence of brown glass which is compositionally similar to the impact glass (Fig. 3).

Other than feldspars and pyroxenes, the impact glass shows presence of skeletal crystals of Ti-Magnetite (Fig. 2). Formation of such dendritic magnetite crystals may be attributed to the rapid cooling of the molten rock and reabsorption of Fe from the magnetite into the melt.

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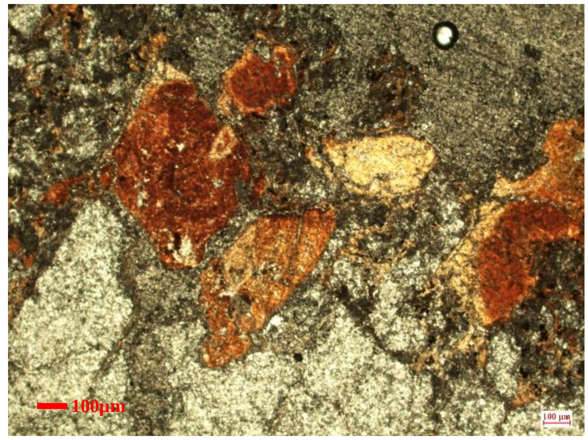

Fig. 3: Photomicrograph showing partial conversion of plagioclase to brown glass in shocked basalt of Lonar Crater.

Discussion: The texture of impact glass is mostly holohyaline, with presence of plagioclase microphenocrysts. These plagioclase laths occur as slender, elongated 5-10 µm needle shaped crystals with swallow tails and fan spherulitic textures which commonly represent undercooling conditions [4,5]. These textures and crystal morphologies are analogous to those reported from natural igneous settings like pillow lavas and experimentally produced textures of underwater-cooled basalts, spinifex textured rocks, etc. that have been attributed to quenching with water [4,6]. We thus conclude that the textures of Lonar impact glass indicate a role of free water in the formation of the morphologies. Whether the origin of this water is phreatic or meteoric is yet to be investigated. Presence of natural aquifers in the Deccan basalts is not uncommon due to the vesicular, lobate and jointed nature of the Deccan Traps [7] and may account for a phreatic origin of the water, while stratified ejecta deposits near Amber Lake argue for the presence of surface water. Further work is ongoing to determine the origin of the water present at the time of formation of the impact glass.

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