PETROGRAPHIC CHARACTERIZATION OF IMPACTITES FROM DHALA CRATER, INDIA.

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Introduction: The Dhala impact crater located in the north-western part of the Bundelkhand Gneissic Complex (BGC) in Shivpuri district, Madhya Prasesh, Central India is overlain by a mesa-like structure of the Vindhyan Supergroup of rocks, with an annular zone of granitoid breccia. The Dhala crater represents an eroded remnant of a Palaeoproterozoic impact structure [1] where the brecciated country rock is exposed at present day erosion level. The present study, based on the surface and sub-surface samples aided by petrographic and high resolution SEM–BSE imaging, identified three types of impact breccia (Type I, II and III). These breccias exhibit intense granulation up to sub-micron level (< 1 µm) [4], and also testify sporadic presence of impact melting particularly from melt breccia.

Results: Three distinct types of impact breccia are identified along the ~1.5 km wide annular zone of Dhala crater based on field observation and petrographic studies. The Type I breccia (also referred as granite breccia), consists of extensively fractured and brecciated granioids (> 90% granitic clasts), xenoliths of granite gneiss, calc-silicate rocks, felsic volcanics, vein quartz and dolerite dyke. These fragments are bounded by a pink/purple colored granitic matrix/groundmass (Figure 1). This variety is the most exetensive among all the breccia types.

Figure 1: Granite breccia (Type I) at SW of Maniar village

The Type II breccia (also referred as melt breccia) is reddish to orange in colour, relatively fine-grained, and contains lithic and mineral clasts / fragments occasionally having fluidal shapes. This type is mostly identified in the drill-cores at various depths and also as isolated pockets within the granite breccia at surface. Extremely fine-grained, angular to sub-angular fragments of brownish to orange colored felsic volcanics having near circular and stretched vesicles occur as lithic fragments / clasts in the melt breccia (Figure 2). Sporadic dark greenish coloured mafic rock clasts are also embedded within the melt breccia. Sharp lithocontact between melt breccia (Type II) and granite breccia (Type I) is observed at Pagra and Maniar villages.

Figure 2: Melt breccia (Type II) with angular mineral-clasts / lithic fragments

Impact melt breccia is comparatively fine-grained. Flow banding with several rip-off clasts of feldspar and quartz, fractured zoned zircons, Planar Fractures (PFs) and Planar Deformation Features (PDFs) bearing quartz and feldspar, toasted feldspar etc. are recorded in the melt breccia and fractured granitic basement, particularly from borehole samples provided by Atomic Minerals Directorate for Exploration and Research (AMDER). Flow banding with angular to sub-angular rip off clasts and melt-rock interaction having several varieties of flowage textures are evident of impact in-

duced melting. These flow structures could only be identified within the Type II breccia, based on which, they have been referred as *'melt breccia or suevite breccia'* [2] (Figure 3). Diagnostic shock features are reported from Type-I and II breccia units [1 and 3].

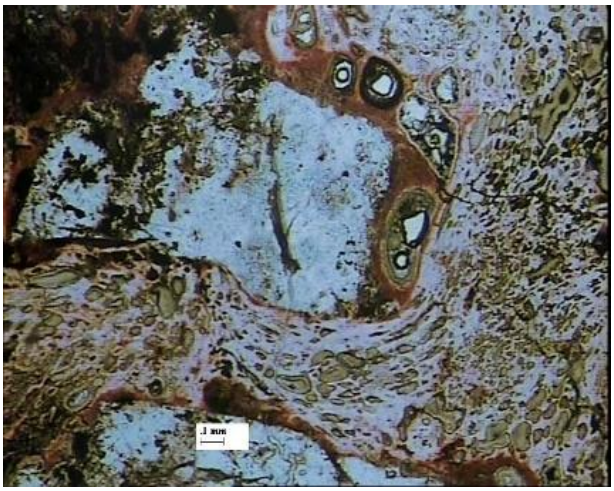

Figure 3: Photomicrograph of flow banding with rip off clasts (quartz and K-feldspar) and green colored mafic glass droplets (chloritic composition) in Type II breccia (in PPL; Magnification – 200X; Scale Bar – 0.1 mm)

Multiple criss-cross veins and/or patches containing extremely poorly sorted numerous clasts, likely to be formed by intense fracturing and comminution due to impact, is generally referred as cataclasite veins or Type III breccia (Figure 4). These diversely orientated cataclasite veins have sharp contact with the brownish/purple/orange colored pulverized groundmass / matrix. These cataclasites apparently show aphanitic mosaic texture in mesoscopic and/or microscopic scale. The high resolution SEM–BSE images exhibit intense brecciation upto sub-micron level and absence of impact melting as reported by [4]. At places the clasts are crudely aligned in Type III breccia (Figure 5).

Figure 4: Cataclasite vein (Type III) in granite breccia at east of Mohar village

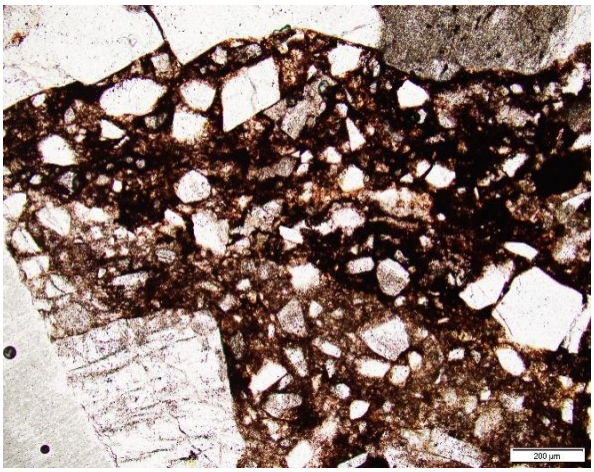

Figure 5: Photomicrograph of cataclasite breccia (Type III) shows crude alignment of clasts

Detailed petrography and shock characterization of Type-III breccia have been reported by [4]. Apart from these breccias, a few Giant Quartz Veins (GQVs) belonging to the BGC at close proximity to the breccia zone are also brecciated as obsereved at Bamera village. These GQVs trending N30°E are thoroughly brecciated which is interpreted to be fault induced related to a later event.

Conclusion: Extensive field and laboratory studies of Dhala crater brought out new evidences in support of in-situ brecciation, cataclasite and melt breccia development of the country rock, without much of aerial transportation [4]. Interestingly, the granitoid clasts / fragments observed within both proximal and distal facies of the annular breccia zone (including Type I, II and III breccia) have close resemblance with the surrounding country rock i.e. parts of BGC. Therefore, combined studies of both surface and sub-surface samples from the Dhala crater suggest shock melting with escalation of shock pressures > 50 GPa [5]. Detail probing of melt-breccia zone, particulalrly from borehole samples at different depths in collaboration with AMDER supports the same.

References:

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