MOST SHERGOTTITES WERE ONCE VESICULAR: EVIDENCE FROM 3D COMPUTED X-RAY TOMOGRAPHY

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Introduction: Shergottites are commonly regarded to be dense rocks without vesicles. However, this view is changing for shergottites containing abundant impact melt pocekts [1-2]. Impact melt pockets are rounded to irregular regions of shock-generated melts that are common in shergottites (e.g., [3-6]). Shock experiments and modeling demonstrated that impact melts form readily under moderate shock conditions in powder or vesicle-bearing rocks, easier than those in relatively denser rocks under the same shock conditions (e.g., [7-10]). Most previous observations were confined to 2D observations, but the unique 3D perspectives gained by using X-ray computed tomography reveal the relationship between residual vesicles, fractures and host rocks [2]. Built upon previous reports of 3D tomography of Tissint, here we present the reconstructed 3D texture of Tissint and additional 3D CT results of other shergottites.

Results: Several interesting features were reported in [2] for Tissint, which are also present in at least two other shergottites. Melt pockets with a diameter >140 µm are randomly distributed and rounded without connecting melt veins inbetween. All impact melt pockets contain irregular shaped voids in the middle of the glass regions. All pockets are associated with clusters of fractures. Moreover, larger pockets are associated with ring fractures in the rock matrix, which follow the contour of the pockets. For the largest pocket, there are two layers of ring fractures. Additionally, minerals inside the ring fractures are stretched with a preferred orientation converging to the melt pockets.

We used a semi-automated segmentation method to emphasize the fractures and vesicles, and generated the 3D internal view between these two features.

Discussion: Similar to previous report in [2], the irregular voids in the interior of every pocket are likely residual pore space from incomplete collapse of pre-impact vesicles. They differ from spherical ones that are typical from volatile outgassing. Moreover, profile analysis of volatiles near these voids was inconsistent with outgassing [6]. Residual vesicles are also reported in other shergottites in 2D observations (e.g., [3,4]). Thus, impact melt pockets of >140 µm diameters in shergottites represent locations of pre-impact vesicles. A further *implication is that pre-impact rocks for the impact-melt-pocket-bearing shergottites were likely crystallized from volatile-rich melts.*

It has been demonstrated that impact melt pockets are enriched in volatiles compared to the surrounding rocks (e.g., [1, 6, 11-12]). The volatile source for enriched H, F, and Cl is most likely related to subsurface fluids (alteration or vaporied subsurface ice or salts carried by subsurface source). Considering shergottites were delivered from >1 m depth, *impact melt pockets in shergottites provide the best, if not only, means to study the surface or subsurface fluids at different times and locations, before we can collect, analyze, or return subsurface samples from Mars*.

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