FEATHER FEATURES IN QUARTZ: STRUCTURAL AND TEXTURAL INSIGHTS FROM FIRST TEM AND EBSD MEASUREMENTS.

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Introduction: Feather features (FFs) are a recently discovered [1], deformational feature in quartz that has been found in 26 confirmed impact craters so far [2]. They are suggested to form under low shock pressures [2] and potentially can be added to the list of shock-induced microstructures in quartz, along with PDFs and planar fractures.

FFs consist of a main planar fracture (PF) that has been sheared during shock compression and from which short, parallel to subparallel lamellae emanate in one direction, typically at an angle of 50-60°. The orientation of these lamellae is always consistent with the sense of shear along the fracture. The crystallographic orientation of the fracture and lamellae show a degree of crystallographic control, with (0001), $\{10\bar{1}1\}$ and $\{11\bar{2}2\}$ as the most common rational low index crystallographic planes.

Generation of FFs: Analysis of multiple sets of FFs in natural samples shows that all FF lamellae within a sample trend in roughly the same direction, while the sheared PFs form conjugate sets at ~90° angles. The principal axis of stress of the shock wave is therefore assumed to lie at a 45° angle to the conjugate sets and parallel to the FF lamellae. Thus FFs can be used as indicators for the orientation of differential stress within the shock wave.

Although the generation of FFs as a shear-induced structure is clear in principle, details of their formation are not yet completely understood. Specifically, the quartz grain's lattice is commonly distorted near the shear fracture, visible as an undulatory extinction pattern under the microscope. In conventional structural geology, the orientation of this lattice distortion forms as the result of "dragging" of material along the shear plane. Surprisingly, FFs show the exact opposite orientation.

Results and implications: EBSD (electron backscatter diffraction) measurements are currently being performed on FFs to analyze lattice deformation at a high resolution. Preliminary EBSD results confirm the lattice deformation determined by microscope analyses. Based on these initial results, we suggest that lattice deformation along the PF is caused by elastic lattice strain accumulated during shearing in the shock wave, which is then rapidly released during unloading, resulting in the opening of the FF lamellae as extensional fractures (mode I) while rotating the lattice between two individual lamellae, causing additional mode II in-plane shear along the lamellae and resulting in a distortion pattern visible in EBSD measurements. Preliminary TEM analyses show that the junctions of the FF lamellae with the PF are filled with vesicular amorphous material.

Further EBSD and TEM work is planned to give more detailed insights into the kinematics of dynamic fracturing and shearing. A deeper understanding of this process can potentially be used to constrain and differentiate fracturing mechanisms in shock waves (and their visible expressions in quartz grains) from fracturing in lower-dynamic, tectonic regimes.

References: [1] French B.M. et al. (2004). *GSA Bulletin*, 116, 200-218. [2] Poelchau M.H. and Kenkmann T. (2011) *Journal of Geophysical Research* 116, B02201.