DEVELOPING NEW SEM METHODS TO IDENTIFY PLANAR DEFORMATION FEATURES IN QUARTZ

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Introduction: Planar deformation features (PDFs) in quartz are essential for the correct identification of impact structures and distal ejecta layers. We are developing new scanning electron microscopy (SEM) methods to identify and characterize PDFs in quartz, in order to be able to distinguish them from other planar microstructures in quartz, such as tectonic deformation lamellae (DL).

Methods and samples: We use a panchromatic cathodoluminescence (CL) detector in an SEM, in combination with red, green and blue color filters, to image shocked quartz grains. Three filtered images are combined into a (non-quantitative) color composite. Orientation contrast (OC) imaging and electron backscattered diffraction (EBSD) techniques are used in order to demonstrate the amorphous nature of unaltered PDFs. Amorphous material does not show a diffraction pattern.

SEM-CL is used to image PDFs in samples from the Ries (Germany), Rochechouart (France), Vredefort (South-Africa) and Popigai (Russia) craters, as well as DL in samples from the Flinders Range (Australia), the Ardennes (Belgium) and Cantabria (Spain). Additionally, the PDFs are studied with OC-EBSD.

Results and discussion: In all samples, the PDFs emit mainly red light in the color CL images, while the host quartz grain can have a range of colors, from red to blue. [1] demonstrated that a strong red band occurs in the CL spectrum of silica glass. This indicates that the red-luminescing PDFs are probably amorphous. TEM observations are required to confirm this. The SEM-CL images have a high resolution; lamellae of a few hundred nm wide are clearly visible. Characteristics of PDFs and DL in CL images are very different. While PDFs are extremely narrow (max. ~750 nm in our images) and straight structures, DL are much wider (max. ~4-5μm in our images), variable in thickness and are often slightly curved. DL sometimes emits light of different colors; a range from red to blue is observed.

In OC images PDFs show up as light, very thin straight lines in darker grey host quartz. First results show that indeed diffraction patterns are weaker within PDFs than in the surrounding quartz, but the pattern is not totally absent, either because the PDFs are not completely amorphous or because also the surrounding quartz is sampled by the electron beam. OC-EBSD results furthermore show that in all studied samples Dauphiné twins associated which are bound by or parallel to PDFs. Dauphiné twin associated with PDFs have been reported before from the Charlevoix [2] and Vredefort [3] craters, and were attributed to a transformation from β- to α-quartz during cooling [2] and to stresses during impact [3].

Conclusions: Color SEM-CL images show that PDFs generally emit red light and are easily distinguished from DL. First results indicate that OC-EBSD techniques might be useful to demonstrate the amorphous nature of unaltered PDFs. The presence of Dauphiné twins associated with planar microstructures in quartz might be used as an extra indicator for their shock origin.

References: [1] Fitting, H.J. et al. 2001. *Journal of Non-Crystalline Solids* 279: 51-59. [2] Trepmann, C. A. and Spray, J. G. 2005. *Geological Society of America Special Paper* 384: 315-328. [3] Wenk et al. 2005. *Geology* 33(4): 273-276.