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Looking at Dauphiné twins in vein quartz as a potential paleostress indicator

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Paleostress studies commonly call upon (1) a fault slip data inversion technique, (2) a calcite twin stress inversion technique, (3) recrystallized grain size piezometry for quartz, or (4) direct measurements of residual lattice strain. Recent advances in orientation imaging microscopy (OIM) using electron backscatter diffraction (EBSD) on a scanning electron microscope (SEM) have revealed that Dauphiné twinning is very common in quartz in naturally deformed quartz-bearing rocks in a wide range of tectonometamorphic conditions. It has long been known that mechanical Dauphiné twinning in quartz can be stress-induced.

Based on the results of an extensive EBSD-OIM analysis on vein quartz, taken from well-studied early to late-orogenic veins in the High-Ardenne slate belt (Germany, Belgium), we explore the potential use of mechanical Dauphiné twins as a paleostress indicator, possibly completing our toolbox for reconstructing paleostresses in the Earth's crust.

The vein quartz studied precipitated in low-grade tectonometamorphic conditions (∼200-400°C), typical for the brittle-plastic transition zone at the base of the seismogenic crust (∼7-15km). Quartz has only been weakly affected by low to moderate temperature (200 to 400°C) crystal-plastic deformation. The samples show grains with a high concentration of Dauphiné twin boundaries and others free of twin boundaries, thus being untwinned or completely twinned. This pattern depends on the crystallographic orientation. Twin boundaries are arrested by grain or subgrain boundaries, suggesting that Dauphiné twinning occurred on a pre-existing fabric that resulted from crystal-plastic deformation. An analysis of the orientation distribution of the rhombs in the twinned variant domains of individual quartz (sub-)grains reveals a particular preferred orientation of the poles to rhombs.

We will discuss the possible significance of these observations with respect to paleostresses that may have caused the mechanical Dauphiné twinning.