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Critical Re-Evaluation of Calcite Twins as a Low-Temperature Deformation Geothermometer

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Low-temperature deformation (below 300˚C) in calcite is characterized by cataclasis, pressure solution processes and twinning. Twin width, twin density and the number of twin systems activated are used as indicators of temperature and differential stress. It is suggested that twin width and twin morphology correlate directly with temperatures of deformation in naturally deformed coarse-grained calcite. Thin twins (< 1 μm) dominate below 170˚ and thick twins ($> 5\mu$m) dominate above 200˚C. Hence, twin morphology has been used as a quick and easy geothermometer.

Here, we use several field and experimental examples to compare deformation temperatures derived from calcite twins with independent temperature estimations. Widths of twins were measured separately using an optical microscope partly equipped with a universal stage. In addition twin densities (number of twins/mm) have been estimated for the experimentally deformed samples.

Our data from field studies show that twin morphology and twin width do not correspond to deformation temperatures at least for temperatures below 250˚C. The deformation temperatures that are derived from twin width and twin morphology do not agree with temperatures estimated by other methods (e.g. vitrinite reflection, conodont color alteration index).

The data from our deformation experiments indicate that the width of calcite twin lamellae changes as a function of deformation temperatures, but this change is not systematic and does not allow using calcite twins as a low-temperature deformation geothermometer.

In addition to temperature estimates, the twin density technique is used to estimate differential stress magnitudes ($\Delta\sigma$). The derived differential stress varies between 55

and 330 MPa. With exception of two samples the calculated differential stresses are in excellent agreement with the experimental values.