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Strain rate dependent deformation behaviour of calcite at lower greenschist facies conditions

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Crystal plastic deformational behaviour of calcite has been the focus of many experimental studies. Different strain rates, pressure and temperature conditions have been addressed to investigate a wide range of deformation regimes. However, a direct comparison with natural highly strained rocks remains difficult because of extreme differences between experimental and natural strain rates.

A secondary shear zone (flanking structure) developed in almost pure calcite marble on Syros (Cyclades, Greece). Due to rotation of a crack a heterogeneous strain field in the surrounding area occurred resulting in different strain domains and the formation of the flanking structure. Assuming that deformation was active continuously during flanking structure development, the different strain domains correspond to different strain-rate domains. The outcrop thus represents the final state of a natural experiment and gives us a great opportunity to get natural constraints on strain rate dependent deformation behaviour of calcite.

Due to the extreme variation in deformation strain rate, different microstructures and textures can be observed resulting from the activation of different deformation mechanisms. In all strain rate domains crystallographic preferred orientations are present, indicating that calcite preferentially deforms within the dislocation creep field. However, in fine grained areas (3.3 µm) evidence for grain boundary sliding exists. In order to get more information on additional strain accommodating mechanisms, high resolution analyses via transmission electron microscopy have been performed, showing a high dislocations density in sliding grains. We therefore, conclude that grain boundary sliding was accommodated by the activity of dislocations.

The consistency of experimentally determined equations is tested with parameters derived from the investigated samples, which deformed under natural conditions, closing the gap between experimental and natural geological strain rates.