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Quantifying heterogeneous microstructures: core and mantle subgrains in deformed calcite

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In rocks deforming at high temperature by crystal plastic mechanisms, a substructure of subgrain walls and dislocations develops in the crystals. Various elements of the substructure, in particular subgrain size and dislocation density, are potentially useful as indicators of deformation mechanisms and conditions in the Earth. For example, it has been found that the size of subgrains changes with flow stress, hence, could be used as an indicator of the stress in the geological past ('palaeostress') if a calibrated subgrain size-stress relationship is available for the relevant rock type. Unfortunately, it is not well established what the best way is to quantify a subgrain size that is representative for the heterogeneous microstructure that develops in deformed calcite. In this presentation, we show how to adapt electron backscattered diffraction (EBSD) methods for accurately quantifying heterogeneous microstructures in calcite: recrystallised grains, deformed grains and within the latter, core and mantle subgrains. The method for separating the different microstructural features is based on the average misorientation angle within the grains and subgrains. For deformed grains containing subgrains, this internal average misorientation is higher than in recrystallised, substructure free grains. In general, mantle subgrains are small and because they have no substructure inside them, they have a low internal average misorientation. In contrast, large core subgrains have a higher internal average misorientation because they often still contain a lower angle substructure.