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In situ heating and deformation experiments in the SEM

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The development of substructure is an important process in rocks deforming at elevated temperature by crystal-plastic processes. Substructure is a useful indicator of deformation mechanisms and palaeostress in the lithosphere. Moreover, it provides an important control on the mechanical properties of materials. A comprehensive study of the nature and mechanical significance of substructures is key, therefore, in increasing the accuracy and reliability of palaeostress estimates and to properly describe the rheological properties of rock aggregates deforming by dislocation processes. Such an understanding will prove central in the advancement and refinement of manifold models of multi-scale dynamic processes through the materials and Earth sciences, from the atomic-scale to orogenesis and mantle convection.

In situ high-temperature electron backscatter diffraction (EBSD) and SEM imaging experiments on metals and selected rock-forming minerals have proved successful in the observation and quantification of recrystallisation and phase transformations up to ~1000C (e.g. Seward et al., 2002; Seward et al., 2004; Bestmann et al., 2005), and the incorporation of the resulting microstructural data into numerical models (e.g. Piazolo et al., 2004).

We aim to document the kinematics of intracrystalline substructure development and the way such substructures interact with intergranular boundaries during high temperature deformation experiments. The primary project objective is to develop experimental protocols into high-temperature (<1400C) deformation experiments, in situ in a scanning electron microscope (e.g. Seward et al., 2002). These will provide information on substructure development and the interaction of substructure with boundaries that are relatively easy to relate to 2D models, and those representative of real rock microstructures, respectively.