

# Geochemical Modification of Plastically-Deformed Zircon

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Electron backscatter diffraction (EBSD) analysis of Indian Ocean zircon deformed at amphibolite facies reveals variations in intragrain crystallographic orientations of up to 20°. Quantitative orientation maps show this variation to reflect progressive localised bending of the zircon and the formation of discrete low-angle orientation boundaries accommodating between 0.5-3° misorientations. Analysis of crystallographic pole figures and minimum misorientation angle / axis pairs shows that these variations are associated with rotations around low index crystallographic axes. The distribution of orientations and misorientation axes are consistent with crystal plastic deformation of zircon associated with the formation and migration of [100] dislocations into low-angle tilt boundaries by  $\langle 001 \rangle \{100\}$  glide.

Panchromatic cathodoluminescence (CL) studies of the deformed zircon indicates homogenisation of primary growth zoning and a decrease in emittance in areas of high-dislocation density. Compositional maps derived from wavelength CL data show that this variation corresponds to relative changes in rare earth element (REE) geochemistry (specifically a change in Er/Tb) that is spatially identical to plastic strain mapped by EBSD. The change in REE is quantified by ion microprobe (SHRIMP) analyses that show both a systematic increase in REE abundance in deformed zones and a relative enrichment in lighter / heavier REE elements. These data confirm the modification of zircon REE chemistry within the areas of crystal plasticity and indicate that the enhanced diffusion of REEs into the zircon is spatially linked to the presence of dislocations. These dislocations behave as high-diffusivity pathways, increasing bulk diffusion rates and effective diffusion distances in the zircon by  $10^5$  compared to theoretical migration distances calculated from empirically derived volume diffusion data.

The presence of deformation-related crystal-plastic microstructures in zircon, and their role in modifying elemental diffusion, questions the commonly made assumption of chemical robustness and has fundamental implications for diffusion and dissolution of zircon in high-grade rocks and therefore the interpretation of zircon trace-element and isotopic data.