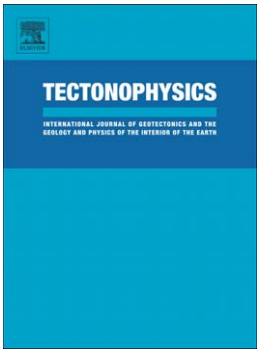

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Microstructure of calcite deformed by high-pressure torsion: an X-ray line profile study

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Abstract

Calcite aggregates were deformed to high strain using high-pressure torsion and applying confining pressures of 1-6 GPa and temperatures between room temperature and 450°C. The run products were characterized by X-ray diffraction, and key microstructural parameters were extracted employing X-ray line profile analysis. The dominant slip system was determined as $r\{10\bar{1}4\}\langle\bar{2}021\rangle$ with edge dislocation character. The resulting dislocation density and the size of the coherently scattering domains (CSD) exhibit a systematic dependence on the *P-T* conditions of deformation. While high pressure generally impedes recovery through reducing point defect mobility, the picture is complicated by pressure-induced phase transformations in the $CaCO_3$ system. Transition from the calcite stability field to those of the high-pressure polymorphs $CaCO_3$-II, $CaCO_3$-III and $CaCO_3$-IIIb leads to a change of the microstructural evolution with deformation. At 450°C and pressures within the calcite stability field, dislocation densities and CSD sizes saturate at shear strains exceeding 10 in agreement with earlier studies at lower pressures. In the stability field of $CaCO_3$-II, the dislocation density exhibits a more complex behavior. Furthermore, at a given strain and strain rate, the dislocation density increases and the CSD size decreases with increasing pressure within the stability fields of either calcite or of the high-pressure polymorphs. There is, however, a jump from high dislocation densities and small CSDs in the upper pressure region of the calcite stability field to lower dislocation densities and larger CSDs in the low-pressure region of the $CaCO_3$-II stability field. This jump is more pronounced at higher temperatures and less so at room temperature. The pressure influence on the deformation-induced evolution of dislocation