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Evidence for r<a> slip in calcite

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Torsion deformation experiments performed on Carrara marble a few years ago (Pieri et al., 2001; Tectonophysics 330, 119-140) have shown the development, at high strain, of a lattice preferred orientation with a sharp single orientation component with the calcite r{10-14} plane parallel to the shear plane and the direction a<-12-10> parallel to the shear direction. This suggested that the r<a> system is an important slip system in calcite, confirmed by results of plasticity models. However, the r<a> system thus far has not been demonstrated to be operative in calcite, while slip on the r-plane in the <-2021> direction is well established. We performed direct shear experiments on single crystals of calcite and now found unequivocal evidence for r<a>. Square samples of size 8x8x0.5 mm have been deformed in a direct shear piston configuration mounted in an axial loading set-up in a constant volume, internally heated argon gas medium deformation apparatus. Samples have been deformed to a shear strain of γ = 1.5, at a temperature of 1000 K, a confining pressure of 300 MPa and a shear strain rate of 1.7x10^{-4} s^{-1}. The calcite samples were oriented such that either the r <-2021> or the r<a> system was activated, given that the latter actually exists. Stress-strain curves show a yield point at about γ = 0.2, followed by a quasi-steady state part up to γ = 1.5. We have used Electron Backscatter Diffraction (EBSD) to analyze the deformed calcite single crystals. Results clearly show evidence for activity of the r<a> system. At the conditions investigated, the r<a> system is about 10% stronger than the classical r <-2021> system. Detailed misorientation analysis also demonstrated the local development of small subgrains and recrystallized grains. We are currently

analyzing rotation axes associated with the development of these subgrains.