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Texture dependent grain size in experimentally deformed quartzite

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Quartzite samples experimentally sheared at conditions where recrystallization occurs predominantly by grain boundary migration show a continuous evolution in the c-axis crystallographic preferred orientation (CPO) with increasing shear strain (up to gamma=8) and degree of recrystallization (up to 100%). The c-axis pole figure evolves from a broad peripheral maximum indicative of basal <a> slip, to an inclined single girdle with two maxima indicative of rhomb <a> slip, and finally an elongate single maximum at the girdle center indicative of prism <a> slip. We used optical methods to track the strengths of the CPOs in a number of different orientation domains with increasing shear strain. The domains correspond to c-axis orientations suitable for different slip systems (basal <a>, rhomb<a>, prism<a>) or "hard orientations" such as the direction of the applied shear stress. From orientation gradient images, we determined the grain boundary density in each of the domains. Inverting the grain boundary density, we found that the size of prism <a> recrystallized grains is 1.5 times that of the average and 2 times that of the rhomb grains, indicating that the domain of prism <a> slip deforms at lower flow stresses than the bulk of the sample at our experimental conditions. Based on the recrystallized grain size piezometer, this difference in grain size between prism and rhomb domains corresponds to a difference in shear stress of 23 MPa (at a bulk flow stress of ˜100 MPa). These findings are supported by auto correlation function (ACF) analysis of the various orientation domains and how they evolve with strain. Shear strain is partitioned among the c-axis orientation domains. The derived viscosity contrast between domains indicates that porphyroclasts with c-axes in the basal domain are initially hard but progressively soften; recrystallized grains in the rhomb domain are relatively weak, and those with c-axes in the prism domain are the weakest.