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Constraints on strain rate and fabric partitioning in ductilely deformed black quartzites (Badajoz-Córdoba Shear Zone, Iberian Massif)

Pablo Puelles (1), Benito Ábalos (1), and Sergio Fernández-Armas (2)

(1) Universidad del País Vasco, Facultad de Ciencia y Tecnología, Geodinámica, Bilbao, Spain (pablo.puelles@ehu.es), (2) Universidad del País Vasco, Servicios Generales de Investigación-SGIKER, Bilbao, Spain

The Badajoz-Córdoba Shear Zone is a is 30-40 km wide and 400 km long, NW-SE trending structure located at the boundary between the Ossa-Morena and Central-Iberian Zones of the Iberian Massif. Two elongated domains can be differentiated inside: the Obejo-Valsequillo domain to the NE and the Ductile Shear Belt (DSB) to the SW. The former exhibits Precambrian to Cambrian volcano-sedimentary rocks unconformably overlaying a Neoproterozoic basement formed by the "Serie Negra". The latter, 5-15 km wide, is composed mainly of metamorphic tectonites including the “Serie Negra” and other units located structurally under it. The petrofabric of "Serie Negra" black quartzites from the DSB is analyzed in this study with the Electron Back-Scattered Diffraction technique (EBSD).

Black quartzites represent originally siliceous, chemical-biochemical shallow-water marine deposits, currently composed almost exclusively of quartz and graphite. Macroscopically they exhibit an outstanding planolinear tectonic fabric. Petrographically, coarse- and fine-grained dynamically recrystallized quartz bands alternate. The former contain quartz grains with irregular shapes, mica inclusions and "pinning" grain boundaries. Oriented mica grains and graphite particles constrain irregular quartz grain shapes. Quartz ribbons with chessboard microstructures also occur, indicating recrystallization under elevated temperatures coeval with extreme stretching. Fine-grained recrystallized quartz bands are dominated by quartz grains with straight boundaries, triple junctions, a scarcer evidence of bulging, and a higher concentration of dispersed, minute graphite grains.

Quartz lattice-preferred orientation (LPO) patterns permit to identify two well-developed maxima for [c] axes: one close to the Y structural direction and the other one around Z, and <a>-axes girdles normal to Y and Z. Although both [c] axis maxima appear in the coarse- and fine-grained bands, subsets can be isolated with grain cluster orientations around Y and Z. Quartz [c]-axis orientations close to Y predominate in coarser-grained bands, whereas [c]-axes scatter around Z in fine-grained zones. A relationship between microstructure and crystal orientation can thus be unraveled. In both fabric types the asymmetry of the LPOs with respect to the external XYZ reference unravel non-coaxial deformation components.

Microstructural and LPO evidences indicate that two intracrystalline quartz deformation modes have operated in the "Serie Negra" black quartzites in parallel domains interleaved at the mm- to cm scale. Unless one of them took place under higher-temperature conditions ({m}<a> slip in the high-T amphibolite-facies) and is a relic feature, both modes should have operated simultaneously. Thus, high-temperature boundary migration and the dispersed inclusion pattern of small mica and graphite grains constrained the pinning grain boundary microstructures, the {m}<a> intracrystalline slip, and the larger size of some quartz crystals. Simultaneously, a larger concentration of disseminated graphite led to formation of finer-grained quartz aggregates (due to grain growth) deformed by the (0001)<a> intracrystalline slip systems, that dominate lower-T quartz plasticity (under greenschist- to amphibolite-facies conditions). Arguably, this intracrystalline slip system partitioning was initially constrained by primary variations in inclusion concentration. Likely, these induced a domainal variation in the rate of plastic strain accommodation that led to the current banded microstructural and fabric organization.