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Characterizing a middle to upper crustal shear zone: microstructures, quartz c-axis fabrics, deformation temperatures and flow vorticity analysis of the northern Ailao Shan-Red River shear zone

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Abstract

Structural and microstructural characteristics, deformation temperatures and flow vorticities of the northern Ailao Shan(ALS) high-grade metamorphic belt provide significant information regarding the nature and tectonic evolution of the Ailao Shan-Red River (ASRR) shear zone. Mineral deformation mechanisms, quartz lattice-preferred orientation (LPO) patterns and the opening angles of the quartz c-axis fabric of samples from the Gasa section indicate that the northern ALS high-grade metamorphic belt has experienced progressive shear deformation. Deformation temperatures of magmatites, mylonitic gneisses, schists and phyllonites from the NE to SW across the strike of the shear zone gradually decrease from $>650^{\circ}\text{C}$ at the northeastern unit through the intermediate to $\sim 300^{\circ}\text{C}$ at the southwestern unit during the early stage, corresponding to their original structural levels. The late stage low-temperature ($300\text{-}400^{\circ}\text{C}$) shearing is superimposed on rocks throughout the belt with the formation of discrete, small-scale shear zones, especially on the thin-banded mylonitic rocks along both margins. The kinematic vorticity values estimated by a rotated rigid porphyroclast method and oblique grain-shaped/quartz c-axis-fabric method imply that the general shear-dominated flow (0.49-0.77) progressively changed to a simple shear-dominated flow (0.77-1) toward the late stage of ductile deformation. The two stages of shearing are consistent with early shortening-dominated and late extrusion-controlled regional tectonic processes. The transition between them occurred ca. 27Ma in the ALS high-grade metamorphic belt along the ASRR shear zone. The large amount of strike-slip displacement along the ASRR shear zone is predominantly attributed to accelerated flow along the shear zone during the late extrusion-controlled tectonic process.

Keywords: Ailao Shan-Red River shear zone; Northern Ailao Shan high-grade metamorphic belt; Microstructural and fabric analysis; Deformation temperatures; Flow vorticity; Progressive shear deformation

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