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Delineating microstructural features of deformation and recrystallization of Ca-rich amphibole from naturally deformed amphibolites

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Amphibole is a hydrous mineral form under metamorphic conditions of the lower crust and in subduction zones. Despite its abundance and ubiquitous texture, the deformation mechanisms of amphiboles are not well understood. We characterize the microstructure of three amphibolites with a high modal fraction of hornblende or actinolite (≥70%) that were deformed under different conditions of pressures and temperatures. We investigated three natural amphibole samples from different localities in India: amphibolite from the Chitradurga shear zone (CSZ) with P-T conditions of ~5 kb and ~600 °C, hornblendite from the Mayodiya Ophiolite Complex (MOC) from NE Himalaya, with P-T conditions of 7.8-8.2 kb, and 770-820 °C, and hornblendite from the Koraput Alkaline Complex (KAC) with P-T conditions of 7.6-8.4 kb, and 860-883 °C. To depict the deformation and recrystallization mechanism/s we used electron backscatter diffraction (EBSD) to analyze the grains' shape, orientation, and the small, intragrain misorientations. The CSZ exhibits elongated actinolite grains with sharp boundaries, tabular shape, and areas of localized deformation illustrated by high-amplitude 'V-shaped' kinking of the actinolite grains. The MOC hornblendite exhibits wedge-like elongated grains with crosscutting relations and twinning in the hornblende grains. The KAC hornblendite exhibits very large grains (several mm) with smaller grains at their periphery and highly lobate grain boundaries. MOC and KAC hornblendites show large porphyroblast grains with high intragrain misorientations surrounded by smaller matrix grains and low intragrain misorientations, consistent with a recrystallization fabric. In addition, in the MOC sample, the orientation of grains away from the porphyroblasts shows the continuous spread of their orientation compared with the porphyroblast. Relying on the microstructural observations, we interpret that the CSZ sample was deformed under brittle kinking and the MOC and KAC samples (with elevated P-T conditions) were deformed and recrystallized under temperature-dependent mechanism (e.g., dislocation creep, diffusional processes). Interestingly, although the apparent difference in deformation mechanism, all samples show the same [001] alignment of their intragrain misorientation axis, which does not fit with the common (100)[001] slip system for amphiboles. The different deformation mechanisms will be discussed in light of the microstructural observations and the ability to use the intragrain misorientation axis as a proxy for assessing the deformation mechanism and/or slip system.