Deformation mechanisms of UHP eclogites during exhumation varies with the presence or absence of supercritical fluid or melt, Taohang, Sulu belt, China

Zhe Chen[1], Lu Wang[1], Michael Brown[2], Tim E. Johnson[3]

[1] State Key Laboratory of Geological Processes and Mineral Resources, and Center for Global Tectonics, China University of Geosciences Wuhan, 430074, China;

[2] Department of Geology, University of Maryland, College Park, MD, 20742-4211, USA;

[3] School of Earth and Planetary Sciences, Curtin University, GPO Box U1987, Perth, WA, Australia

Characterizing the deformation mechanisms of natural UHP eclogites is essential information to understand exhumation dynamics in collisional belts, particularly with respect to the presence or absence of supercritical fluid or melt. Here, we document the microstructures, crystallographic preferred orientations (CPOs) and inherited structural water contents of minerals in UHP eclogites to explore links between the rheological behaviour of different eclogite types and the presence or absence of supercritical fluid or melt. Three types of foliated eclogite from layers with different mineralogy and composition were analyzed from the same early meter-scale rootless tight-isoclinal fold nose that formed under UHP conditions (Wang *et al.*, 2018): 1) garnet-rich bimodal eclogite, 2) kyanite-bearing quartz eclogite, and 3) phengite- and zoisite-bearing (hydrous) quartz eclogite. Only the last type preserves evidence of melting, including in-situ intergranular leucosome pockets. The three eclogite types record different omphacite CPOs: L-, SL-, and S-types, respectively. Garnet shows no prominent CPO in any of the samples. FTIR and EBSD results show that the bimineralic eclogite without hydrous minerals preserves the lowest inherited structural water content in omphacite and garnet. In this type, the abundance of intracrystalline misorientation and subgrain boundaries indicates dislocation creep was the dominant deformation mechanism with dynamic recrystallization by subgrain rotation. Supercritical fluid was present in the kyanite-bearing quartz eclogite during the early stage of exhumation (Wang *et al.*, 2020). In this type, omphacite and garnet preserve the highest amount of inherited structural water. Strong shape preferred orientation, straight grain boundaries with well-developed multi-junction structures, and the absence of misorientation or subgrain boundaries show that this eclogite deformed dominantly by grain boundary sliding regulated by diffusion creep. Supercritical fluid was present in the hydrous quartz eclogite during early exhumation, whereas omphacite+phengite-breakdown melting occurred during the late stage of exhumation (Feng *et al.*, 2020). Omphacite and garnet have elongated grain shapes and associated compositional zoning, which with the absence of intracrystalline misorientation indicates dissolution-precipitation creep was the dominant deformation mechanism. We conclude that the dominant deformation mechanism of eclogites at Taohang changed from dislocation creep to diffusion creep with the presence of supercritical fluid or melt during exhumation. Partial melting of eclogite is significant in reducing the rheological strength of eclogite, potentially enhancing exhumation.

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