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Relic Oceanic Crust at Sub-Arc Depth: An Example from UHP Eclogites Enclosed in Serpentinities from the Southwestern Tianshan, China

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1 Abstract

Ultra-high pressure (UHP) eclogites that derive from subducted oceanic crust are rarely found at the Earth's surface because they need to be enclosed in a buoyant host rock such as serpentinites that facilitate exhumation (Hermann et al., 2000; Guillot et al., 2001). Under normal subduction geotherms, serpentinites break down just before UHP conditions are reached and therefore most of the exhumed eclogites representing subducted oceanic crust formed under fore-arc conditions. We investigated eclogite blocks enclosed into serpentinites that occur in the southwestern Tianshan oceanic subduction, China. A previous study proved that the serpentinites derive from altered oceanic crust and experienced UHP metamorphism at low temperatures of 510-530°C (Shen et al., 2015).

Three relatively fresh eclogite samples were studied in detail. Sample 129-7 shows the retrograde mineral assemblage of amphibole + biotite + albite + chlorite + minor titanite and peak metamorphic relics of omphacite + garnet ± chlorite. Sample C107-23 is mainly composed of amphibole + albite + chlorite + zoisite + muscovite + minor titanite as a retrograde assemblage and garnet + phengite as the peak metamorphic relics with omphacite only found as inclusions in garnet. Similar to sample C107-23, sample C11066 preserves large-grained euhedral to subhedral garnet relics with omphacite inclusions, and epidote, diopside, amphibole, muscovite, chlorite, albite and biotite are in the matrix belong to the retrograde assemblage. These three retrograde eclogite samples were modelled using thermodynamic calculations in the MnNCKFMSHO (MnO-Na₂O-CaO-K₂O-FeO-MgO-Al₂O₃-

SiO₂-H₂O-Fe₂O₃) system. Based on the peak assemblage of omphacite+garnet and the crossing of the grossular and pyrope isopleths in garnet, peak P-T conditions of ~460-470 °C, 28-29 kbar (129-7), 450-500 °C, 28-35 kbar (C107-23), ~475-505 °C, 26-29 kbar (C11066) were calculated. The retrograde assemblages indicate near isothermal decompression resulting in a clockwise P-T evolution of these eclogites. The peak metamorphic pressures at 500°C are well within UHP conditions (coesite stability field) and are within error the same as peak conditions of the host serpentinites (Shen et al., 2015). This provides evidence that eclogites and serpentinites shared the same evolution. We infer that the subducted low-density serpentinites were assembled with the high-density eclogites during subduction and helped the latter to exhume back to the surface. The studied eclogites thus represent rare examples of relics of oceanic crust that was subducted to sub-arc depth.

References

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