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Clinopyroxenite from the Sulu ultrahigh-pressure terrane, eastern China: Origin and evolution of garnet exsolution in clinopyroxene

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ABSTRACT

The Rizhao garnet clinopyroxenite occurs as small mantle slices faulted into subducted continental crust in the Sulu ultrahigh-pressure (UHP) terrane, China. Two representative garnet clinopyroxenites with exsolution microstructures were studied: (1) a massive ilmenite-rich specimen, composed of coarse-grained clinopyroxene containing abundant exsolution rods of grossular-rich garnet (>20 vol%) + ilmenite (~3–4 vol%) in a fine-grained matrix of clinopyroxene + garnet + ilmenite; and (2) megacrystic garnet-bearing sample, characterized by garnet containing inclusions of clinopyroxene and ilmenite; the clinopyroxene inclusions show exsolution rods and blebs with variable amounts of garnet (1–15 vol%) and minor ilmenite. Both exsolved and matrix garnets have similar grossular-rich compositions. The aggregate composition of clinopyroxene + garnet + ilmenite intergrowth is similar to the whole-rock composition. We propose that the parental phase of exsolved garnet + ilmenite lamellae and clinopyroxene host was either a homogeneous clinopyroxene (hypothesis A) or a majoritic garnet (hypothesis B) that experienced three discrete evolution stages. If the parental phase was clinopyroxene (ABO_3), with an Si deficiency in the B site, the Rizhao garnet clinopyroxenite could have an initial assemblage clinopyroxene ± Grt ± Ilm formed at near-solidus conditions (≤1400 °C, at 5 GPa) in the upper mantle. The second stage is defined by garnet exsolution from the primary clinopyroxene involving decreasing temperature and/or increasing pressure, related to continental subduction. Coexisting clinopyroxene host and garnet exsolution (Grt_{exs}) recrystallized at temperatures of ~900 °C at an assumed minimum *P* of 5 GPa. The third stage is represented by recrystallization of exsolution phases to form the fine-grained matrix of Cpx + Grt + Ilm at 700 °C and ≥ 3 GPa during the early exhumation of the UHP terrane. The speculative hypothesis B implies that the proposed majoritic garnet was from the mantle transition zone (<450 km depth); this suggestion remains to be tested.