# Garnet-pyroxene exsolution microstructures in orogenic peridotite predate ultra-high pressure metamorphism in Su-Lu, China

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Over the last decade, garnet-pyroxene mineral exsolution microstructures have increasingly been recognized in sub-continental lithospheric mantle (SCLM) slices (orogenic peridotites) that were tectonically emplaced during orogeny into the continental crust of several ultra-high pressure (UHP) metamorphic belts. The origin of the unexsolved precursor mineral has generally been subjected to a low temperature subduction-zone environment, although similar mineral microstructures are known from SCLM xenoliths that formed in a high temperature mantle environment and lack any plate tectonic overprint. Clear distinction between superimposed processes in orogenic peridotites has major implications for geodynamic reconstructions of UHP metamorphic belts.

Here we report on garnet lamellae that occur in cm-scale ortho- and clinopyroxene porphyroclasts enclosed in orogenic garnet-peridotite from Xugou, Su-Lu UHP metamorphic belt, China. The garnet lamellae are 30-100 microns in width, up to several mm in length and wide-spaced. Thin sections perpendicular to the [001] axis of pyroxene suggest that garnet precipitated parallel to the (100) and (010) planes of pyroxene, consistent with an origin by exsolution from aluminous precursor pyroxene. Additional, narrow-spaced lamellae of Cr-spinel, a few microns in width and several hundred microns in length sub-parallel to the garnet lamellae, show another generation of exsolution in porphyroclastic orthopyroxene. Both exsolved aluminium phases in orthopyroxene are associated with lamellae of clinopyroxene similar in size. It follows that the successive exsolution from the aluminous orthopyroxene precursor involved both Al and Ca, that is only possible during cooling[1].

Porphyroclastic orthopyroxene has flat compositional profiles with 0.20 wt% $Al_2O_3$ content that indicates an equilibration of the exsolved microstructure at 5.6 GPa and 760 degree C. The peridotite matrix assemblage composed of garnet + orthopyroxene + clinopyroxene + olivine +/- phlogopite records a strain-induced recrystallization and lacks precipitates in mineral cores. Matrix orthopyroxene cores have 0.12 wt% $Al_2O_3$ content implying higher metamorphic conditions of 6.3 GPa and 840 degree C than estimated from the minor deformed porphyroclasts. These pressure-temperature estimates from the same mineral phases preserved in two structurally different positions overlap with the range in metamorphic conditions reported for the peak UHP metamorphism in the region (5-7 GPa and 780-870 degree C)[2].

Consequently, the exsolution microstructure preserved in porphyroclastic minerals at Xugou formed prior to but preserves a mineral-chemical equilibration similar to the local UHP metamorphism. Comparable microstructural and petrological observations in mantle fragments, recently reported from the western Scandinavian Caledonides, show that destruction (recrystallization) of the mineral exsolution microstructure is consistent with prograde UHP metamorphism during continental plate subduction.[3–4] The significance of mineral exsolution microstructures to UHP metamorphism will be discussed in the presentation. The similarity found in the mantle fragments from both orogens strongly suggests that mineral microstructures in orogenic peridotites preserve more information on the evolution of the SCLM than previously recognized.

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