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Lawsonite pseudomorphs and aqueous fluids in UHP talc-garnet-chloritoid schists of Makbal Complex, northern Tien-Shan

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The Makbal UHP metamorphic complex is situated in the western part of Kyrgyz Range, northern Tien-Shan Mts., and it composed mainly of quartzites, garnet-mica schist, marbles and carbonate-rich rocks. The talc-garnet-chloritoid schists (Tlc-Grt-Cld) occur as layers within quartzites and include lenses of eclogites and garnet amphibolites. Coesite has been found in garnets from both the Tlc-Grt-Cld schist layers ($P > 25$ kbar; $T < 600$ oC) and surrounding quartzites (Tagiri et al., 2010), suggesting that the Makbal complex suffered UHP conditions. In Tlc-Grt-Cld schist, garnet porphyroblasts (up to 1.5 cm in diameter) are set in the matrix consisting mainly of talc (XMg = 0.88-0.92) and Mg-rich chloritoid (XMg = 0.39-0.43) with minor glaucophane, quartz, chlorite (XMg = 0.77-0.80), paragonite, phengite (Si = 3.4-3.5), rutile, apatite and tourmaline. Garnet porphyroblast with a homogeneous composition (Prp20-22, Alm63-65, Grs12-15, Sps1-2) and the matrix phases are interpreted to be formed at UHP conditions and the retrograde reaction is minor in the studied sample (KA-2).

Multiphase solid inclusions (MSI) mainly composed of clinozoisite + quartz + kyanite + paragonite + chloritoid + margarite + chlorite are newly observed in garnet porphyroblast. These MSI, up to 0.1 mm, show idiomorphic-prismatic shapes. Some cracks, still visible under the microscope, appear around or in an area proximal to MSI. These cracks filled by chlorite, clinozoisite, quartz and chloritoid, and they are not connected to the fractures crosscutting garnet.

The estimated/reconstructed bulk composition of MSI indicates that they originated from former lawsonite, which can be stable under peak UHP stage. We suggest that lawsonite was stable along with garnet, chloritoid, talc and glaucophane at prograde and peak-UHP stages and it was decomposed to clinozoisite + quartz + kyanite + paragonite at lower pressures during the exhumation. The micro-cracks radiating from MSI may imply the possible pathway of fluids released due to the breakdown of lawsonite during decompression.

The fluid inclusions are distributed in quartz developed in pressure shadow around porphyroblastic garnet. They occur as negative-crystal shaped in clustering or as isolated inclusions. The Raman spectroscopy shows the presence of CO2, H2O, N2, and CH4 gas species in aqueous fluid inclusions. The compositions of fluid inclusions in quartz in 'pressure shadows' near garnet could be reasonably close to the fluid composition when the quartz was formed at near to peak metamorphic conditions, especially if the inclusions can be shown to occur as isolated inclusions or in clusters (Hollister, 1981).

References:

Tagiri et al., Jour. Min. Petr. Sci. 105, 233 (2010). Hollister, in Fluid inclusions: application to petrology, Short course handbook, Hollister & Crawford, Eds. (Miner. Assoc. Canada, 1981), pp. 1-12.

Keywords: lawsonite, aqueous fluids, UHP metamorphism, Makbal, Tien-Shan, Kyrgyzstan