The role of fluid for diamond-free UHP carbonate and calc-silicate rocks from the Kokchetav Massif

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H2O-rich fluid played an important role for the formation of diamond-free rocks under UHP conditions. Local heterogeneity of fluid compositions during UHP metamorphism has been well demonstrated in cm-scaled sample of diamond-free banded marble. Diamond-free garnet-clinopyroxene rocks that look like a skarn also suggested very low XCO2 under UHP conditions.

The diamond-free banded marble (no. Y665) consists of three zones; zone-A: Ti-clinohumite-bearing dolomitic marble, zone-B: dolomite marble, zone-C: dolomite marble that lacks Ti-clinohumite and forsterite. All three zones lack diamond. Zone-A is characterized by the presence of Ti-clinohumite and by Ti-clinohumite-aragonite tie-line at the peak metamorphic conditions. Diopside lacks any lamellae. Large-grained Ti-clinohumite shows clear compositional zoning of TiO2 between the core (1.5-1.7 wt.%) and the rim (2.0-3.3 wt.%). Zone-B indicated the stability of dolomite-diopside pair. No lamella was observed in diopside. Zone-C contains diopside with phlogopite and garnet lamellae. These lamellae were confirmed with a laser Raman spectroscope and an electron microprobe. A retrograde product, high MgCO3 calcite with large-grained exsolved dolomite lamellae indicating precursor aragonite + dolomite assemblage, occurs in zone-C. This means dolomite-diopside pair was stable under UHP conditions in zone-C. All three zones have different bulk chemical compositions each other; however, the tie-line relations are unable to be explained only by their bulk compositions. In zone-C and B, diopside-dolomite pair was stable, whereas an incompatible assemblage aragonite-Ti-clinohumite was stable in zone-A. Aragonite-clinohumite is stable at very low XCO2, and diopside-dolomite has wide stability range in XCO2 that is higher than that of aragonite-clinohumite. The difference in the distribution of Ti-bearing phases in each zone was detected by chemical mappings. Many of Ti-clinohumite grains occur in zone-A (low XCO2 side); however, a few grains of Ti-bearing phases in zone-Band C (relatively high XCO2 side). Such paragenetic relations and the distribution of Ti-bearing phases in banded specimen (no. Y665) strongly suggest the heterogeneous fluid compositions and the fluid origin of TiO2 during UHP metamorphism. The banded structure of this Kokchetav marble might be created by such kind of fluid effect.

Garnet-clinopyroxene rocks (no. XX16) consists mainly of garnet, clinopyroxene, quartz, amphibole, K-feldspar, and symplectite after clinopyroxene with minor amounts of titanite, calcite. No diamond occurs in this calc-silicate rock. Coesite exsolution needles and plates were found in titanite in this sample. Coesite was identified with a laser Raman spectroscope. The mode of occurrence of the coesite in titanite is similar to that reported in the calcite marble from Kumdy-Kol; however, this garnet-pyroxene rock is clearly different from the calcite marble in modal composition and the chemical compositions of clinopyroxene; this indicates that protoliths for those rocks were different each other. Clinopyroxene contains K-feldspar and phengite lamellae that were identified by the laser Raman spectroscope and the electron microprobe.

Summarizing all these data described above, diamond-free marble and calc-silicate rocks had been subjected to UHP metamorphism with strong effect of H2O-rich fluid. The H2O-rich fluid could be initiated by the dehydrations in surrounding gneisses and eclogites in the Kumdy-Kol area.