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Construction of a P-T path based on metasomatic mineral assemblages from the Western Tianshan HP-UHP metamorphic belt

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The Chinese Tianshan orogen extends between the Tarim plate to the south and the Yili- Kazakhstan block to the north. It is an oceanic HP-UHP metamorphic belt containing blueschists, eclogites and phengite-rich schists. We investigated the P-T conditions for metasomatic zones which formed around a carbonate-rich metaquartzite inclusion embedded in mafic rocks. The inclusion is a lens 12 cm long and 4 cm wide. From the core of the inclusion outward, the zonation is: 1) deerite-bearing metaquartzite, 2) 'omphacitite' (0.5 cm thick), 3) eclogite (3∼4 cm thick), 4) 'zoisitite' (1.5 cm thick) , 5) zoisite blueschist host rock. The PT conditions for the rock types were estimated using intersections of the garnet isopleths in psuedosections calculated by THERMOCALC 3.33 with updated internally consistent thermodynamic datasets and solid-solution models.

The metaquartzite is dominated by Fe-rich minerals, and contains deerite, magnetite, hematite, garnet, sodic amphibole, aegirine, talc and carbonate (dolomite and calcite). The phase equilibrium is modeled in the NCFMASHO+CO2 system, in which the garnet core composition plots at around 21.5 kbar, 480 °C, where the predicted stable assemblage is gl + g + chl + hem (hem found as inclusions in garnet), and about 16.5 kbar, 545 °C for the rim in the stability field for aeg + gl + g + mt +chl (in equilibrium in the quartz matrix). The core composition (Fe/(Mg+Fe) = 0.36) of dolomite indicates 530-570°C and pressures higher than 22kbar.

Eclogites are composed mostly of garnet, clinopyroxene, glaucophane, zoisite, phengite, and quartz. Clinopyroxene is zoned from aegirine-augite in the core to omphacite in the rim. Isopleths of garnet and phengite compositions reflect peak conditions of 550°C, 25kbar in the lawsonite zone, followed by approximately isothermal decompression.

The zoisite zone is a gradational boundary between eclogite and blueschist. The core and rim of garnet indicate similar conditions of ∼22 kbar, ∼545 °C, whereas the apparent assemblage (ep + g + mu/pa ± gl) lies in area of lower pressure. Similarly, in the blueschist host rock, garnets and phengites record higher pressure (23 kbar, 555 °C) than the apparent assemblage .

The PT estimates for metaquartzite and metabasites outline a PT path that starts at ∼22 kbar and 480 °C, then reaches a metamorphic peak of ∼23 kbar and 555 °C followed by near isothermal decompression. The progressive path lies along a 6.5 °C/km geotherm, suggesting cold oceanic subduction. For metaquartzite, the path starts in the hematite-bearing zone and ends at stable zone for magnetite, which is found in equilibrium with quartz in matrix. The pressure peak recorded in eclogite is consistent with Si-content in phengite from 'zoisitite'(3.65) and blueschist (3.45).

We conclude that metasomatic mineral assemblages preserve valuable information about PT paths during mass transfer in subduction zones. The assemblages in different domains record P-T information for different stages of the orogenic evolution.