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Coexisting carbonate-bearing eclogite and omphacite-bearing blueschist in SW Tianshan, China: petrology and phase equilibria

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Carbonate-bearing eclogite and omphacite-carbonate-bearing blueschist coexist in the same lithologic sequence in the Tianshan high/ultrahigh pressure-low temperature (HP/UHP-LT) metamorphic belt, Northwestern China. The carbonate-bearing eclogite consists of garnet + omphacite + ankerite ± magnesite + phengite ± paragonite + epidote/zoisite + glaucophane + rutile/titanite + pyrite. The coexisting omphacite-bearing blueschist consisting of glaucophane + garnet + omphacite + ankerite ± magnesite + phengite ± paragonite + epidote/zoisite + barroisite + rutile/titanite + pyrite is intimately interlayered with the eclogite. High carbonate contents in oceanic metabasalts suggest that the precursor basaltic crust has undergone significant hydrothermal alteration prior to subduction. Lawsonite pseudomorphs of epidote/zoisite + paragonite assemblages in garnet are commonly observed in the studied eclogite and blueschist. Textural evidence such as glaucophane and omphacite inclusions (apparently in textural equilibrium) in garnet, omphacite inclusions in matrix glaucophane porphyroblasts, glaucophane inclusions in omphacite and the apparent textural equilibrium of matrix glaucophane and omphacite demonstrate that glaucophane was a stable peak metamorphic phase in the blueschist. Moreover, the identical glaucophane compositional zoning in matrix glaucophane and glaucophane inclusions in both omphacite and garnet, support the contemporaneous coexistence of glaucophane and omphacite. Phase equilibrium modelling (using Perple_X based on effective bulk-rock composition) in the NCaKFMASCHO (Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-CO_2-H_2O-Fe_2O_3) system indicates that both carbonated eclogite and omphacite-bearing blueschist equilibrated at the same metamorphic peak conditions of 540 - 565 ^oC and 21.8 - 23.1 kbar. Calculated $X(CO_2)^*$ isopleths reveal the presence of a mainly aqueous fluid phase (0.014 and 0.012 in the studied eclogite and blueschist, respectively) during peak metamorphic conditions. The coexistence of eclogite and omphacite-bearing blueschist at the same peak metamorphic conditions implies that the stability of the high-pressure mineral assemblages largely depends on the respective bulk-rock composition, e.g., especially the CaO content. Ca-rich bulk-rock compositions favour eclogitic mineral assemblages while Ca-poor bulk-rock compositions produce blueschist mineral assemblages at similar high-pressure metamorphic conditions. The present study suggests that three different types of blueschist were formed during subduction of the South Tianshan oceanic crust: the first type exhibits prograde pre-peak-metamorphic blueschist, the second type peak-metamorphic blueschist coexisting with eclogite and the third type retrograde blueschist formed by rehydration of eclogite during exhumation in the subduction channel.

$^*X(CO_2)$ =CO_2 /(H_2O+CO_2), in mol