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Blueschists, eclogites, and decompression assemblages of the Zermatt-Saas ophiolite: High-pressure metamorphism of subducted Tethys lithosphere

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ABSTRACT

The Zermatt-Saas ophiolite of the Swiss Alps represents a complete sequence of Mesozoic Tethys oceanic lithosphere. The ophiolite was subducted during early phases of the Alpine orogeny and the mafic rocks were transformed to eclogites and blueschists. Metabasalts locally preserve pillow structures in which glaucophanite forms rims on eclogitic pillow cores.

Omphacite-garnet-glaucophane-epidote-ferroan dolomite-Mg-chloritoid-talc-paragonite-chlorite–rutile form characteristic coeval blueschist- and eclogite-facies assemblages. Omphacite + garnet + glaucophane + epidote + rutile represents an equilibrium assemblage that formed during deformation and in the period when the rocks reached the greatest depth of subduction. In rocks containing this assemblage, an additional significant mineral pair is Mg-chloritoid + talc. Coarse chloritoid (X_{Mg} ~ 0.45) and talc formed in dispersed clusters after the last penetrative deformation. The assemblage may require > 2.7 GPa pressure to form. It developed at maximum pressure conditions corresponding to the return-point of the ophiolite in the subduction zone. Coarse paragonite and chlorite replaced parts of the earlier formed assemblages and removed free H_2O from the rocks.

Exhumation of the HP to UHP ophiolite rocks was accompanied by development of symplectite rims and other replacement products along grain boundaries of the eclogite minerals by decompression reactions in a fluid-deficient regime. Particularly noteworthy is the formation of margarite, paragonite, chlorite, albite, barroisite, and preiswerkite. The latter mineral, a very rare Na-biotite, formed as a result of the decomposition of chloritoid + paragonite and is associated with magnetite and hercynite. Omphacite breakdown produced diopside-albite-barroisite symplectites.

Calculated equilibrium assemblage phase diagrams for metabasite compositions indicate *P-T* conditions of ~2.5–3.0 GPa and ~550–600 °C. The conditions of the subduction-related metamorphism denote *P* and *T* at the return-point, which coincide with the upper *P-T* limit of antigorite. Antigorite-serpentinites constitute the largest volume of rocks within the ophiolite. We suggest that the *P-T* conditions recorded by the exhumed mafic rocks are coupled to those of antigorite breakdown in the serpentinite that released large amounts of dehydration water in the subducted serpentinite slab facilitating exhumation of the Zermatt-Saas eclogites and blueschists.