European Mineralogical Conference
Vol. 1, EMC2012-273, 2012
European Mineralogical Conference 2012

Magnesite-bearing eclogite from the Tauern Window/Eastern Alps

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The Eclogite Zone of the Tauern Window in the Eastern Alps is a monometamorphic package of strongly to isoclinally folded and foliated metabasites and siliciclastic to carbonaceous metasediments derived from the continental slope of the subducting Penninic Ocean. The magnesite eclogite described here is a very rare type in the compositional and textural spectrum of eclogites: The peak metamorphic assemblage is made up of coexisting garnet, omphacite and abundant glaucophane, as well as subordinate kyanite, magnesite, muscovite and quartz. The peak P-T conditions derived from this assemblage by THERMOCALC average-PT calculations are: 661±41°C and 26.7±1.6 kbar. Retrograde minerals in the matrix include paragonite, talc, dolomite, calcite, hornblende and quartz. Only omphacite and garnet are significantly zoned: omphacite tends to be idiomorphic and has cores rich in aegirine; garnet is also idiomorphic and has a Fe-rich core and becomes richer in Mg towards the rim while Ca only slightly decreases. Garnet porphyroblasts are up to several millimeters in diameter and document some of the prograde change in mineral assemblage in their inclusion population: the cores are characterized by Fe-rich chlorite, albite-rich plagioclase, quartz, glaucophane, paragonite, biotite/wonesite, calcite and ilmenite. The outer core is characterized by often large polymineralic inclusions, mostly xenomorphic, but sometimes rhobohedral in shape, perhaps pseudomorphic after lawsonite. These polymineralic inclusions typically contain (clino)zoisite, paragonite, muscovite and a Fe-Al-rich amphibole (Fe-pargasite). Rutile is present in the outer core and glaucophane in this domain can be rimed by a mainly barroisitic Na-Ca-amphibole which, like pargasite, can also form separate inclusions. Omphacite of variable composition and glaucophane are dominant in the outermost core, while the garnet rims are mostly inclusion-free.
Retrograde phenomena include partial transformation of kyanite to paragonite, rims of dolomite + talc around magnesite and the local growth of small patches of hornblende, sometimes together with paragonite and quartz, from the glaucophane-omphacite matrix. Retrogression is very local and was induced by minor hydration. A more detailed reaction path can be narrowed down by a fixed composition diagram (“pseudosection”) for which also the amount of CO_2 is held constant to derive stability fields for magnesite, dolomite and calcite/aragonite. Preliminary calculations show that the main stage of crystallization is characterized by the reaction glaucophane + zoisite = omphacite + garnet + kyanite + quartz + H_2O and ended with the exhaustion of zoisite (only traces of allanite left in the matrix). The subsequent whole rock reaction garnet + glaucophane + quartz = omphacite + kyanite + H_2O was modally unimportant but may be responsible for the very low modal abundance of quartz in the sample. Garnet originally grew as the Fe-buffer phase, replacing chlorite, and coexisted with lawsonite and zoisite (the Al- and Ca-buffers respectively) until lawsonite was terminately replaced by kyanite. The role of carbonates is mainly passive, controlling the activity of CO_2 in the fluid, which is generally low at high-pressure metamorphic conditions.