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Multi-events metamorphism of the eclogites in the Lake Zone, southwest Mongolia

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Early Cambrian eclogites have been described from the Chandman district in the Lake Zone, southwest Mongolia (Hanzl and Aichler, 2006; Takasu et al., 2008; Stipska et al., 2010). The Alag Khadny metamorphic complex consisting of metamorphic rocks and ultramafic bodies is exposed for about 10 km across and 4 km wide, and it occurs between the ophiolite complex and migmatized metamorphic rocks in the Lake Zone. Several lenticular-shaped bodies of eclogites and amphibolites (max. 2 km x 0.8 km) occur in the matrix of orthogneisses and minor pelitic gneisses.

Eclogites consist mainly of garnet, omphacite ($Jd < 46\%$), and amphibole with subordinate amounts of epidote, phengite, paragonite, plagioclase, biotite, K-feldspar, rutile, titanite, quartz, calcite, hematite, ilmenite and zircon. The eclogites experienced three metamorphic events i.e. the precursor metamorphic event (M1) of HT-amphibolite facies; HP metamorphism (M2) of the eclogite facies; and HP-metamorphism (M3) of the epidote-amphibolite facies.

Garnets occur as porphyroblast and they show a prograde zoning. The core of the garnets contain polyphase and single grain inclusions of high TiO₂ (up to 1.32%) taramite, taramite+quartz, Fe-pargasite, tschermakite, plagioclase (An<19)+biotite+epidote. Those inclusions indicate relatively high-temperature metamorphism of amphibolites facies conditions (M1).

The prograde stage of the first HP metamorphic event (M2) is characterized by polyphase and single grain inclusions in the garnets such as barroisite+taramite+epidote+quartz, barroisite+Mg/Fe-hornblende+quartz, plagioclase (An=3-5)+epidote, chlorite, calcite, and rutile. The peak eclogite facies conditions of 560-680 C and 22-25 kbar (Ravna, 2000; Ravna and Terry, 2004) estimated by the compositions of garnet+omphacite ($Jd < 46$)+phengite ($Si = 6.58-7.11$) assemblage. The retrograde stage of eclogite facies is characterized by symplectite of sodic plagioclase (An=1-11)+amphibole and/or Na-poor clinopyroxene ($Jd = 2-25$). These mineral assemblages give 450-560 C and 4-11 kbar (Holland and Blundy, 1994; Holland, 1983).

The second HP metamorphism of the epidote amphibolites facies (M3) is characterized by prograde zoned amphiboles with winchite, actinolite, tremolite core and barroisite rim. They contain inclusions of garnet, omphacite and symplectite of clinopyroxene+sodic plagioclase suggesting that the amphiboles crystallized after the M2 metamorphism. The cores of the amphiboles indicate 300-400 C and 3-8 kbar, whereas the rims indicate >400-600 C and 3-12 kbar (Otsuki and Banno, 1990). Taramite/tschermakite outermost rim is occasionally developed.

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