

Metamorphic history of garnet amphibolite from the Neldy Formation, Makbal district in the Kyrgyz Northern Tien-Shan

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The Kyrgyz Tien-Shan Mountains extend from east to west, separating the Kazakhstan plate to the north and the Tarim plate to the south. They are divided into three tectonic units; the Northern Tien-Shan, the Central (or Middle) Tien-Shan and the Southern Tien-Shan. In the Northern Tien-Shan there are two HP and UHP metamorphic complexes, Makbal HP and UHP in the western part, and Aktyuz HP in the eastern part of the complexes. The Makbal complex in the Kyrgyz Northern Tien-Shan is located in the western segment of the CAOB.

The metamorphic rocks exposed in the Makbal district are divided into the Akdzhon and the Scharkyrak Groups based on their metamorphic conditions. The Akdzhon Group contains rocks of the HP and UHP metamorphic conditions, whereas the Scharkyrak Group underwent greenschists facies metamorphism. The Akdzhon Group is divided into two contrasting metamorphic formations, the structurally lower Makbal Formation and the upper Neldy Formation.

The Neldy Formation is mainly composed of garnet-phengite schists and chlorite-carbonate rocks, along with minor metaquartzites and marbles. Amphibolites and garnet amphibolites occur in the garnet-phengite schists as lenses or blocks up to 50 m across. Eclogites preserved in the cores of the garnet amphibolite bodies. Garnet amphibolite consists mainly of amphibole (magnesian hornblende, ferropargasite, ferrotschermakite, tschermakite, barroisite, actinolite), garnet and chlorite, with minor amounts of quartz, epidote and albite. Accessory minerals are paragonite, titanite and calcite. A schistosity is defined by preferred orientation of amphibole.

Garnets in the garnet amphibolite are rich in almandine (X_{Alm} 0.35-0.64), with variable amounts of spessartine (X_{Sps} 0.00-0.20), grossular (X_{Grs} 0.27-0.61) and pyrope (X_{Prp} 0.01-0.07) compositions. Garnet displays a compositional zoning, in which decrease X_{Sps} (0.20-0.04), increases X_{Alm} (0.35-0.60), X_{Grs} (0.31-0.62) and slightly increase X_{Prp} (0.01-0.03) from the core to the rim and contain inclusion of paragonite, titanite, chlorite, epidote and amphibole (actinolite, magnesian hornblende). The garnets are partly replaced by chlorite and aggregates of amphibole (ferrotschermakite, barroisite), chlorite and quartz along the cracks. Amphiboles in the matrix are zoned with magnesian hornblende and barroisite cores to ferrotschermakite and tschermakite rims and contain inclusions of titanite and quartz.

Based on the texture and mineral composition, we consider that the prograde stage probably stable in the epidote-amphibolite facies condition due to the existing of barroisitic amphibole and epidote along with garnet, paragonite, albite and chlorite. The tschermakitic rim of matrix amphibole suggests that the peak stage probably stable in the amphibolite facies conditions. The expected metamorphic condition of the garnet amphibolite from the Neldy Formation corresponding with peak $P-T$ conditions of 610-620 °C and 14-16 kbar for the garnet amphibolite from the Makbal complex (Rojas-Agramonte *et al.*, 2013).

References:

Rojas-Agramonte Y., Herwartz D., Garcia-Gasco A. *et al.*, (2013) *Contrib Mineral Petrol*, 166, 525-543.

Keywords: Garnet amphibolite, metamorphic history, amphibolite facies, Makbal complex, Neldy Formation, Kyrgyz Tien-Shan