

Mineralogy and formation of the Nkob talc deposit (Central Anti-Atlas, Morocco)

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The Nkob talc deposit is located in the Pan-African Anti-Atlas Belt, south of the Siroua inlier, 25 km NW of Taznakht city. It is hosted in the Precambrian metasedimentary formations of the Proterozoic Taghdout group.

The deposit is delimited to the west by the Amassine monzogranite (614 ± 10 Ma) and to the east by the rhyolitic lava of the Ouarzazate Group. It is limited by metapelites in the North and South, which are marked by large crystals of cordierite and andalusite resulting from the contact metamorphism generated by the granite.

The formations are generally EW oriented with a dip to the north. They are affected by a foliation of major direction ESE-WNW sloping towards the North. Within the deposit, there is an alternation of beds, decimetric to metric of dolostones recrystallized into marble and beds of talc (white, metric, friable), associated with small chloritite beds. The whole being straightened with a subvertical dip to the north.

Three types of marbles have been identified within the deposit. A blackish marble very rich in dolomite with minor quantities of calcite, talc and chlorite. The second is greenish and very rich in serpentine associated with calcite and minor amounts of talc and chlorite. As well as a reddish marble due to concentration of oxides. Veins containing calcite, serpentine, phlogopite, talc, chlorite intersect all the carbonate formations of the deposit. In talcites, talc is associated with calcite, dolomite being totally absent. Chlorite and phlogopite are very rare (even absent). Chloritites are totally blackish or composed of an alternation of dark and clear green layers. This alternation is mainly due to the presence or absence of phlogopite (dark layers) and chlorite (green layers) phases.

Talc crystals grow in carbonates. They have an elongated prismatic shape, sigmoidal and sometimes star-shaped in association with calcite and dolomite residues. Serpentine occurs as nucleases or irregular masses within carbonates and rarely contains preserved olivine residues (forsterite). Another type of serpentine is also distinguished by its fibrous shape and light green colour (chrysotile). This second variety is only found in the western limit of the deposit in direct contact with the granite. Chlorite comes in the form of elongated prisms, associated with phlogopite, and small tremolite crystals.

The mineralogical study of the rocks in the deposit identified an early mineral assemblage consisting of "dolomite + calcite + olivine + phlogopite", and a secondary mineral assemblage consisting of "calcite + talc + serpentine + chlorite \pm sulphides \pm oxides".

The magnesium required to form talc would have been released by destabilizing pre-existing carbonates (dolomites) under the effect of silica-rich hydrothermal fluids from Amassine granite. Serpentine crystallized as a substitute after olivine (formed by decarbonation reactions during contact metamorphism) and was replaced by serpentine by the effect of circulating hydrothermal fluids. Chlorite is mainly formed by the replacement of phlogopite. Iron oxides and sulphides (pyrite, chalcopyrite...) are added late to the previously formed assemblage.

The Nkob deposit has been affected by at least two metamorphic conditions. HT minerals such as cordierites and andalusites in metapelites, as well as the dolomite-olivine-phlogopite assemblage in marbles, indicate that the contact metamorphism has reached the amphibolite facies associated with the emplacement of Amassine granite. While the association of talc, serpentine, chlorite, tremolite indicate a retrograde metamorphism of greenschist facies.

This study suggests that the source rocks of the Nkob deposit were magnesium carbonate rocks (dolostones) that would have reacted with a fluid of magmatic origin rich in silica extracted from the Amassine granite. This reaction is responsible for the appearance of a primary paragenesis with dolomite + calcite + olivine + phlogopite. The minerals in this paragenesis were transformed into talc + serpentine + chlorite during the cooling and percolation of fluids from the granite.

Keywords: Anti-Atlas, Taghdout Group, Mineralogy, talc-carbonate, serpentine, Metamorphism, Hydrothermal circulation.