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P–T pseudosections of Nova Mahala deposit using the software package PERPLE_X

P-T диаграми за находище Нова Махала на базата на софтуерния пакет PERPLE_X

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The object of this work is to demonstrate the potential and limitations of the software package PERPLE_X for thermodynamic modeling of the P-T conditions of crystallization and thermobarometry on the example of the granite pegmatites from the area of Nova Mahala village, Pazardzhik.

The pegmatites of the area are known above all for their epidote and albite crystals with jewelery quality. They are of the type Albite-oligoclase-microcline rare-earth pegmatites according to the original classification of Ivan Ivanov (Ivanov, 1991). According to the structural division of Ivanov (2017) they are placed among the rocks of the Posestrimska formation of the Central Rhodope Metamorphic Group, formed primarily of gneisses.

PERPLE_X is a free available in the network and constantly developing software package for thermodynamic modeling of mineral-formation processes, which allows on the basis of the chemical analysis, a classical or XRF bulk composition on the rocks of a given region, taking into account the minerals included, easy and effective to make conclusions for the crystallization conditions. For the purposes of this investigation, the examined data for the bulk composition is from the village of Dorkovo, published in the monograph "The granite pegmatites in Bulgaria" (Ivanov, 1991). In the future, it is planned to receive more accurate survey of the rocks and minerals from the region, with own XRF analysis, which will give greater reliability and statistical representativeness of the obtained results.

P-T pseudosection calculations were carried out with PERPLE_X 8.4.2 following the internally consistent thermodynamic dataset and equation of state for H_2O of Holland and Powell (1998). P-T pseudosections were calculated within the P-T range 0.1–1.5 GPa, 200–700 °C. Iron was assumed to be Fe^{2+} because Fe^{3+} content in the main minerals (garnet, biotite, white mica) is negligible and Fe^{3+}-bearing oxides occur in trace amounts. CaO was reduced according to P_2O_5 content in the rocks, on the likelihood that phosphorus binds exclusively to calcium in ideally-composed apatite (Cruciani et al., 2014).

The phases considered in the calculation were plagioclase (Pl), sanidine (San), epidote (Ep), biotite (Bt), phengite (Pheng), garnet (Grt), amphibole (Amph) and melt (L). Solid solution models are those of Holland and Powell (1998) for white mica, garnet, biotite and plagioclase. Calculations were performed using the H_2O content derived from the LOI value and the fluid phase was considered as pure H_2O. Different H_2O contents have also been considered with the aim to obtain information on the phase relations at various H_2O contents. Bulk rock compositions used in P-T pseudosection calculations are shown in Table 1.

Table 1. Bulk compositions of pegmatites from Dorcovo used in P-T pseudosection calculations. Chemical analysis of whole rock data in wt% are recalculated into mol% after apatite correction and FeO^{tot} conversion

	wt%	mol%
SiO_2	71.52	78.31
TiO_2	0.05	0.041
Al_2O_3	15.15	14.663
Fe_2O_3	0.45	–
FeO	0.09	0.1339
MnO	–	–
MgO	–	–
CaO	2.95	1.7194
Na_2O	4.26	2.2609
K_2O	4.56	1.5925
P_2O_5	0.04	–
H_2O-	0.16	0.2924
H_2O+	0.54	0.9862
Sum	99.77	100

Substantially the results obtained confirm the findings of the unpublished studies of one of the authors on the fluid inclusions in epidote minerals from the Nova Mahala locality. Using two-sided polished epitope plaques have been discovered that homogenization temperatures of gas-liquid inclusions have been established in a wide range – from 350 to 260 °C, which speaks of a long process of crystallization of the paragenesis of minerals from the studied pegmatites. Similarly are the conclusions from the thermodynamic study of Velinov (1969), which in a brief statement conclude that the process it's going on from medium to low temperature crystallization at a depth of up to 1000 m.

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