NEW DATA ABOUT PETROGRAPHY AND MINERALOGY OF GARNET-BEARING MICA SCHISTS IN THE FRAME OF SAKAR PLUTON, SE BULGARIA

N. Tzankova, S. Pristavova

(Submitted by Corresponding Member I. Velinov on January 17, 2007)

Abstract

The garnet bearing two-mica schists from the metamorphic frame of Sakar Pluton are investigated. As a result of this study the mineral parageneses are determined and chemical composition and peculiarities of the rock-forming minerals are defined. The minerals from the studied rocks in the areas of the villages Orlov Dol, Hlyabovo and Planinovo are separated in three metamorphic parageneses (pre-, syn- and postkinematic) from the region of Dervishka mogila – in syn- and postkinematic and south of the village Oreshnik – synkinematic with two generations. Investigated main rock minerals are garnet with predominant almandine composition; white mica – phengite with paragonite component and paragonite; biotite; staurolite; feldpaps and chlorite.

Key words: metapelites, garnet, staurolite, pre-, syn-, postkinematic parageneses, Sakar

Introduction. Metapelites are preferable subject for petrological studies according to their abundance of mineralogical parageneses – indicators for P-T conditions of the metamorphic processes. Being a significant element of the composition of high grade metamorphic complexes, they are successfully used for deciphering and reconstruction of their metamorphic evolution. New data about petrography, mineralogy and metamorphic evolution of garnet-bearing schists from the frame of Sakar Pluton will be presented in two consecutive papers.

Geological setting. In tectonic respect, the studied region is refereed to the Sakar unit, which belongs to the Strandzha zone of the Balkan Segment of the Alpine-Himalaya Orogenic belt [1]. This region is included in the Sredna Gora morphostructure zone [2]. The examined schists crop out mainly in the eastern, southern and northern part of the metamorphic frame of Sakar Pluton. They had been collected from five localities: Orlov Dol, Hlyabovo, Dervishka mogila, Oreshnik and Planinovo (Fig. 1.). Stratigraphically they belong to Zhalti chal [3] and Ustrem [4, 5] Formations. Rocks from the first one are considered to be metamorphosed in the range of amphibolite facies with alternation of progressive and regressive stages during the Precambrian and Phanerozoic [6-9], and those from the eastern part – in epidote-amphibolite facies.
[10], and the rocks from the Ustrem Fm. – epidote-amphibolite facies [11] or amphibolite facies [9]. Other authors consider these rocks as an element of a uniform metamorphic complex with single manifestation of regional metamorphism [12, 13].

Petrography. The studied rocks are determined as garnet-bearing two-mica schists to gneiss-schists. The following mineral parageneses have been defined for the
rocks from the area of Orlov Dol: Grt+Qtz+Ore (prekinematic) (Plate Ia); Grt+Bt+white mica+Qtz+Fs+Ky+Chl+Ore minerals (synkinematic) (Plate Ib, c); Bt+white mica+Qtz+Chl (postkinematic). Abbreviations are according to KRETZ [14]. Besides listed minerals, some accessory minerals take part in the rocks composition: apatite, tourmaline, rutile, zircon, titanite and late hydrothermal minerals – sericite, calcite, epidote and chlorite. For rocks from the region of Hlyabovo along the valley of Yavuzdere (enriched in garnet two-mica schists) the following parageneses have been defined: Qtz+Ms+Ore (prekinematic); Grt+Bt+white mica+Qtz+Pl+Ore minerals (synkinematic)+Ky+St\(^{1}\); Bt+white mica+Qtz (postkinematic), as those from prekinematic one present only as inclusions in the garnet which mark an earlier foliation. The rocks from Dervishka mogila are represented of garnet-containing two-mica schists which are very similar to the others from the studied region. They are composed of intensively deformed biotite-muscovite strips alternating with quartz ones; garnet; feldspars – plagioclase and potassium feldspar in sporadic grains; chlorite; ore mineral; and accessory: tourmaline, apatite, zircon and zoisite. Two mineral parageneses are characteristic of these rocks: Grt+Bt+white mica+Qtz+Chl+Pl+KF+Ore (synkinematic) and Bt+white mica+Chl+Qtz+Pl (postkinematic). Micas present in both parageneses, but those from the first one show sub parallel orientation defining the main foliation in the schists. The last one in these rocks is strongly folded with formation of the crenulation cleavage (Plate Id) in which at least two stages of development could be separated [15]. The first one represents the third stage – development of metamorphic differentiation in the folded areas (M-domains), and the second one reflects the fourth stage – growth of new mica from the second paragenesis (Plate I, e, f). The rocks from the region of Oreshnik are represented by garnet-staurolite two-mica schists containing paragenetic minerals differentiated by early and late kinematic growth: 1) Grt+Bt+Chl+Qtz; 2) St+Grt+Bt+white mica+Qtz+Pl+Ore minerals (Plate II, 1, 3). South-west from the village of Planino, garnet-staurolite two-mica schists with parageneses: Grt+Qtz+Bt+Ky+Ore mineral (prekinematic); St+Grt+Bt+white mica+Qtz+Pl+Ore minerals (synkinematic) (Plate II, 2); Bt+white mica+Chl+Qtz (postkinematic) have been examined. Accessories in the rocks from the region of Oreshnik and Planino are represented by small tourmaline crystals, apatite, zircon, and ore mineral.

Main rock-forming minerals in the mica schists. Garnet. Garnet from all studied outcrops of the metapelites from the frame of Sakar Pluton is enriched in almandine (Alm 70.23–78.96 mol %) with varying amounts of Pyr, Grs and Sp. In the prekinematic paragenesis garnet is morphologically represented by porphyroblasts with clear features of intensive deformation up to defragmentation and it is found in schists from Orlov dol and Planinovo (Plate I, a). Their chemical composition shows slightly raised magnesium content comparing to the garnets from synkinematic paragenesis in the same schists. These garnets are characteristic of complex type chemical zonality (Fig. 2a). The complex type zonality is often observed in garnets grown under polymetamorphic conditions [16].

The garnets from the second paragenesis (synkinematic) show clear syntectonic growth which porphyroblasts contain S-type trails of inclusions or helicitic fabric (Plate I, b). They are widespread in the studied rocks. This garnet shows optical anisotropy close to quartz inclusions into it which represents a relict deformation in its crystals resulting from «stress» [17] and corresponds to its syntectonic fast growth (Plate I, c). The investigation of the spatial variations in the percent composition of the end members shows normal chemical zonality, which is characteristic of conditions of continuous rise of temperature – prograde metamorphism. In the samples from OD-5,

\(^1\)The minerals Ky and St are observed only in the heavy mineral concentrates as single grains.
HY-8 and DM-14 the zoning trend is kinked to the reverse direction in the peripheral areas of garnets (Fig. 2b), which indicate retrograde processes occurred during their formation. Garnet surfaces are often corroded.

**White mica.** White mica is the most abundant mineral in comparison to the other rock-forming minerals in the studied rocks. It is represented in three morphological varieties belonging respectively to three parageneses. According to its composition, the white mica is phengite with paragonite component (Pg 12.05–42.09 mol %) and paragonite. Phengite from the area around the villages of Orlov Dol and Hlyabovo is characteristic of the highest iron and magnesium content. Among the representatives of the synkinematic paragenesis their quantity is higher (Fe 0.210–0.218; Mg 0.086–0.092) than in those of postkinematic (Fe 0.099–0.149; Mg 0.061–0.081). Despite phengite, white mica with dominant paragonite composition is established in schists from the Yavuzdere valley and the area of the village of Hlyabovo: Pg 83.56–88.7 mol %, Phng 8.88–15.16 mol % and Mrg 1.00–2.37 mol %.

Plate I. a) Disintegrated prekinematic garnet with formation of “shadow pressure” among biotite, muscovite and quartz (OD), II N, base – 1.04 mm; b) S-like rotated quartz inclusions in the synkinematic garnet porphyroblasts (OD), +N, base – 2.08 mm; c) anisotropic areas (?) in garnet around quartz inclusions (OD), +N, base – 0.53 mm; d) formation of crenulation cleavage in the enriched of white micas schists (OD), +N, base – 0.53 mm; e) crenulation cleavage 3th degree with development of metamorphic differentiation in the folded areas (M-domens), II N, base – 1.04 mm; f) crenulation cleavage – 4th degree with growing of new micas, +N, base – 1.04 mm (DM)
**Biotite.** Biotite presents in all examined schists in varying ratios regarding to the white mica. Representatives are observed in the three detached parageneses. Biotite from the rocks around villages of Oreshnik and Planinovo are with the highest content of magnesium \( (X_{Mg} 0.56-0.58) \). These schists are characteristic of high MgO content and staurolite presence. Biotite from the schists without staurolite (Orlov dol, Hlyabovo and Dervishka mogila) is with \( X_{Mg} 0.38-0.50 \). Members of different parageneses differ slightly by their contents of magnesium.

**Staurolite.** Staurolite is studied in the schists from around the villages of Oreshnik (crystals up to 70 mm) and Planinovo (crystals up to 30 mm) as an element of the synkinematic paragenesis. Staurolite from both regions is with domination of the iron endmember. The chemical composition of staurolite from both examined mineralizations differs basically by the nordmarkite endmember which is recognized only in the minerals from the region around the village of Planinovo \((0.20-0.48 \text{ mol } \%\)). The large porphyroblasts from the schists from the village of Oreshnik show slightly expressed zonality, whereas in the staurolite from the village of Planinovo no chemical zonality has been established. A crown of garnet with included staurolite relics has been observed around a staurolite crystal from the region of the village of Oreshnik (Plate II, 1). Probably this is a reaction structure formed during the pressure lowering at the final metamorphic stage or as a result of changes in fluid regime at high temperatures.

**Feldspars.** In the studied schists feldspars are sporadically represented and only in the region of Dervishka Mogila they are more abundant. Potassium feldspar was recognized in schists NE from the villages of Orlov dol and Dervishka Mogila. Plagioclases present everywhere as single grains from synkinematic acid plagioclase – acid to basic oligoclase with \( \text{An}_{13.08-25.25\%} \). The presence of medium plagioclase – andesine with \( \text{An}_{34.00\%} \) was established solely in the region of the village of Planinovo.

**Chlorite.** Minerals from the chlorite group present in the three parageneses. They are defined as medial members of the isomorphic row chamosite-clinochlore according to their chemical composition. Chlorite with the highest contents of magnesium is recognized in the schists from the area south from the villages of Oreshnik \((X_{Mg} 0.60)\) and Planinovo \((X_{Mg} 0.61)\), where it associates with staurolite. Chlorite from the region of the villages of Orlov dol – OD-2, OD-4, OD-6, as cores from the zonal chlorites from OD-5 are defined as ripidolite. The peripheral part of the zonal chlorite from OD-5 is compositionally close to brusvgite. Chlorite from the schists south from the village of Planinovo is chemically corresponding to pychochlorite.

**Conclusions.**

1. Three mineralogical parageneses in the investigated schists (pre-, syn-, and post-kinematic) are recognized. Prekinematic garnet with similar chemical zonality in association with kyanite and biotite was recognized in the northern and southern parts of the studied region. This supposes the polymetamorphic character of the schists from the region of the villages of Orlov dol and Planinovo. Synkinematic paragenesis strongly dominates in the region of Hlyabovo, Oreshnik and Dervishka Mogila;

2. Garnets from the examined rocks are characterised by complex (prekinematic) and normal (synkinematic) chemical zonality;

Plate II. 1 - Fragment of staurolite crystal (OR), IIN, base 11 mm: 1a - corona of garnet around staurolite, IIN, base 1.04 mm; 1b - inclusion of staurolite in the garnet corona, IIN, base 0.53 mm; 1c - formation of biotite and chlorite aggregate at the expense of the staurolite, IIN, base 1.04 mm; 2)S-like rotated inclusions in staurolite, IIN, base 1.04 mm (PL); 3) big flakes of biotite and chlorite among fine grained muscovite-quartz mass, IIN, base 1.04 mm (OR)
3. Phyllosilicates in the rocks are biotite and white mica – phengite with paragonite component and paragonite;

4. Staurolite as a main rock-forming mineral in these rocks is established in the region of the villages of Planinovo and Oreshnik. The iron endmember dominants in its chemical composition. Crystals from the region of the village of Oreshnik differs from those from the village of Planinovo with slightly expressed chemical zonality.

REFERENCES


Department of Mineralogy and Petrography
St. Ivan Rilski University of Mining and Geology
1700 Sofia, Bulgaria

e-mail: niktzankova@abv.bg
stpirst@mgu.bg

N. Tzankova, S. Pristavova