Доклади на Българската академия на науките
Comptes rendus de l'Académie bulgare des Sciences
Tome 60, No 2, 2007

GEOLOGIE
Minéralogie

VARIABILITY OF RHOMBODODECAHEDRAL GARNET CRYSTALS FROM METAMORPHIC ROCKS IN THE FRAME OF SAKAR PLUTON, SE BULGARIA

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

Abstract

Deviations from the ideal rhombododecahedron are observed in the metamorphic rocks from the frame of Sakar pluton. They are presented in elongation of the crystals along one of the axes G_4 or G_3, around which the elongated in the same direction quadrangular rhombohedral or hexahedral faces are developed. The point group of the visual symmetry of the crystals is interpreted in terms of the Curie symmetry-dissymmetry principle. The influence of the orientated pressure, active perpendicular to the one of the axes of the symmetry is supposed for the main factor, which has provoked the anisotropical conditions of the garnet crystal growth.

Key words: garnet, morphology, real rhombododecahedron, Sakar

Introduction. Three morphological types of garnet with predominant almandine composition [1] from the metamorphic frame of Sakar pluton are studied: rhombododecahedral {110} – habit type f, rhombododecahedral {110} crystals with small {211} faces – habit type e and crystals with equivalent development of {110} and {211} faces – habit type c. The predominant crystal habit type of the garnets is type f. The garnets with habit type e are found occasionally in schists which outcrop in the area of the village of Orlov Dol (in the section between villages Orlov Dol and Madretz, in the valley of Konduzdere river and in the point where the Konduzdere river joins the river Sokolitza), Oreshnik, Planinovo and Hlyabovo (occurrence "Stenata"). The habit type c of the garnet crystals is observed only in metamorphic rocks which are outcropping northeast of the village of Orlov Dol, in the valley of Yavuzdere river and southwest of the village of Dervishka Mogila [2].

Some of the garnet crystals in the studied rocks are elongated or flattened. The aim of this study is to provide data about the type of deviations from the ideal isometric shape of rhombododecahedral crystals and the reasons which caused these deviations.

Up to now studies have been carried out on garnets from the region of Topolovgrad [3–6] and from the vicinity of the village of Dervishka Mogila [7, 8].

Geological notes. The examined schists outcrop eastwest, southwest and northwest from the Sakar granite pluton, which is a part of the Strandzha-Sakar zone in

the Srednogorie morphotectonic unit [9, 10]. Stratigraphically the studied metamorphic rocks belong to Zhalti Chal [11] and Ustrem [12, 13] Formations. It has been suggested that they have undergone metamorphism into the amphibolite [8,13–15] or epidote-amphibolite [16, 17] facies.

Sampling. The places of sampling are in the region of the villages: Orlov Dol – garnet-bearing two-mica schists from the area between the villages of Orlov Dol and Madrets; at the north-western end of the villages of Orlov Dol; in the valley of the Konduzdere river and western from the village of Orlov Dol; Hlyabovo – garnet-bearing two-mica schists along the Yavuzdere valley and garnet-bearing chlorite schists from the occurrence "Stenata"; Oreshnik – garnet and staurolite bearing two-mica schists; Planinovo – garnet and staurolite bearing schists and amphibolites and Dervishka Mogila – garnet-bearing two-mica schists in the area of the Dervishka Mogila peak.

Methods. The habit types of the studied garnets are defined according to the suggested habit types for garnets in Bulgaria by I. KOSTOV [6]. Some of the garnet crystals were studied with the help of contact goniometer Karl Zeiss Jena at the St. Ivan Rilski University of Mining and Geology, Sofia. The point group of visual symmetry of the crystals is interpreted in terms of the Curie symmetry-dissymmetry principle.

Results and discussion. The crystals with habit type *c* are characterized by insignificant deviation from the ideal isometric form. The morphological shape of some of the investigated crystals with rhombododecahedral habit type *f* is close to the ideal one (Fig. 1*a*), i.e. their habit type is presented by twelve equivalently developed rhombohedral faces. Deviations from the ideal rhombododecahedron are observed in the metamorphic rocks in the area of the villages Orlov Dol, Oreshnik, Planinovo and Dervishka Mogila and they can be called rhombododecahedroids (non-ideal rhombododecahedral crystals). Deviations from the ideal isometric shape are expressed in elongation of the crystals along one of the axes with tetragonal symmetry (G_4) or trigonal symmetry (G_3), around which the elongated in the same direction quadrangular rhombohedral or hexahedral faces are developed (Fig. 1; Fig. 2). Some of the established crystallographic forms in the studied garnets were found as illustrations in the Goldschmidt atlas [18]. The ideal rhombododecahedron which is presented in Fig. 1*a* is identical with those in Fig. 1 in Table 55 of the Goldschmidt atlas; the elongated along the G_3 axis rhombododecahedron with rhombic-like faces around the same axis – Fig. 1*c* is identical with those in Fig. 92 in Table 61 of the Goldschmidt atlas; the elongated along axis G_4 rhombododecahedron with nonequivalent (alike two by two) hexahedral faces around the same axis – Fig. 2*a* corresponds to those in Fig. 42 in Table 57 of the Goldschmidt atlas. Figures of garnet rhombododecahedrons like this in Fig. 1*b* (elongated along one of the axes G_4 with development of the rhombic-like faces around the same axis) and Fig. 2*b* (elongated along one of the axes G_4 rhombododecahedron with equivalent development of the hexagonal faces around the same axis) are not found in the Goldschmidt atlas.

The described crystallographic forms of the garnet crystals elongated along one of the axes of the symmetry with nonequivalent development of the faces around it have developed as a result of crystal growth in terms of dissymmetrical surroundings and do not correspond to the $m3m$ point group of the external symmetry, i.e. hexaoctahedral class of the isometric system, which is characterized by the symmetry formula $3G_44G_36G_29PZ$. The decreasing of the visual morphological symmetry of the

Fig. 1. Types of garnet rhombododecahedrons which are observed in the metamorphic rocks in the area of the villages Orlov Dol, Oreshnik, Planinovo and Dervishka Mogila: *a* – ideal, *b* – elongated along one of the axes G_4 with development of the rhombic-like faces around the same axis; *c* – elongated along the G_3 axis rhombododecahedron with rhombic-like faces around the same axis

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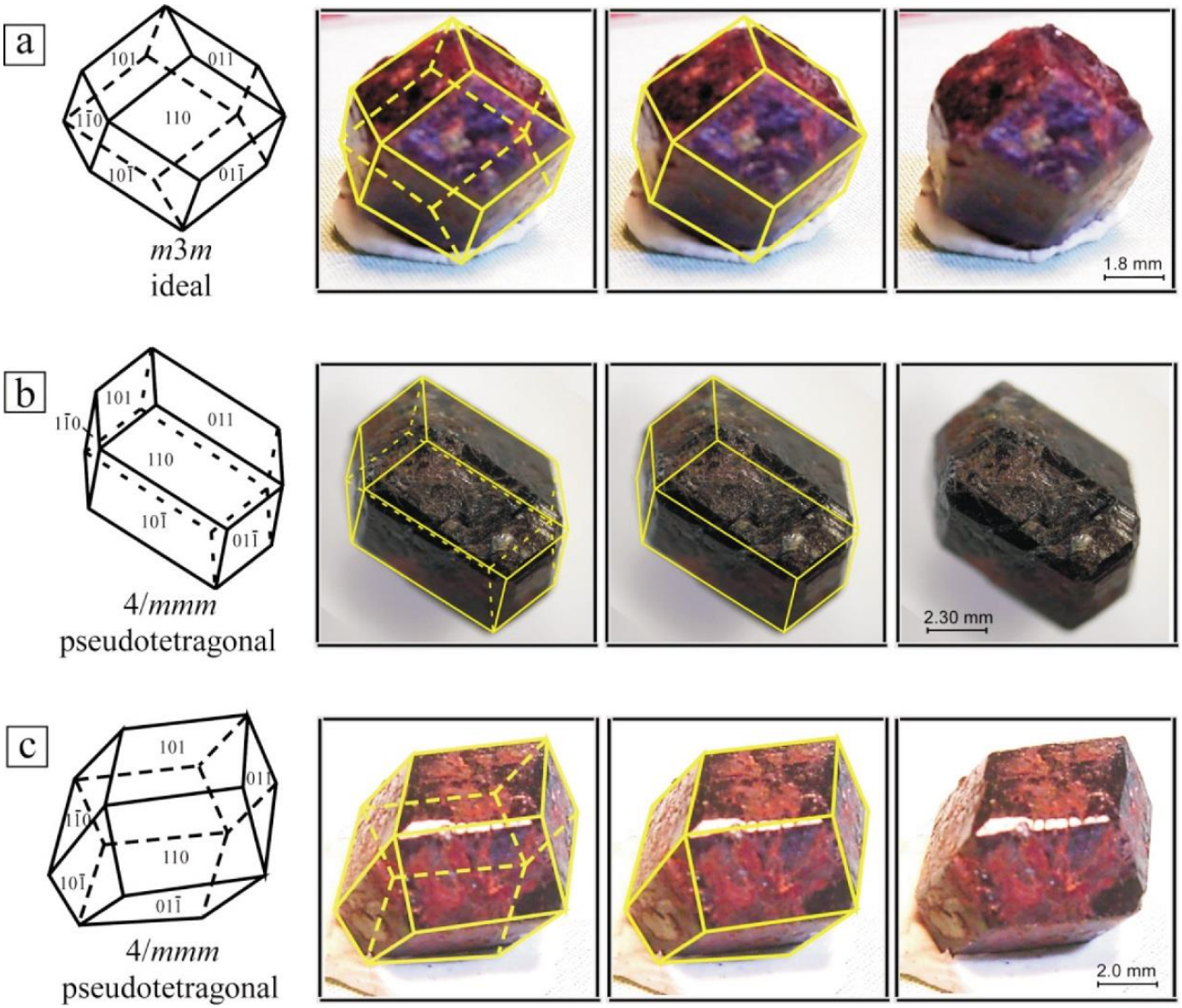
a
101
01$\bar{1}$
1$\bar{1}$0
110
10$\bar{1}$
01$\bar{1}$
m3m
ideal
1.8 mm
b
101
011
1$\bar{1}$0
110
10$\bar{1}$
01$\bar{1}$
4/mmm
pseudotetragonal
2.30 mm
c
101
01$\bar{1}$
1$\bar{1}$0
110
10$\bar{1}$
01$\bar{1}$
4/mmm
pseudotetragonal
2.0 mm

Fig. 1

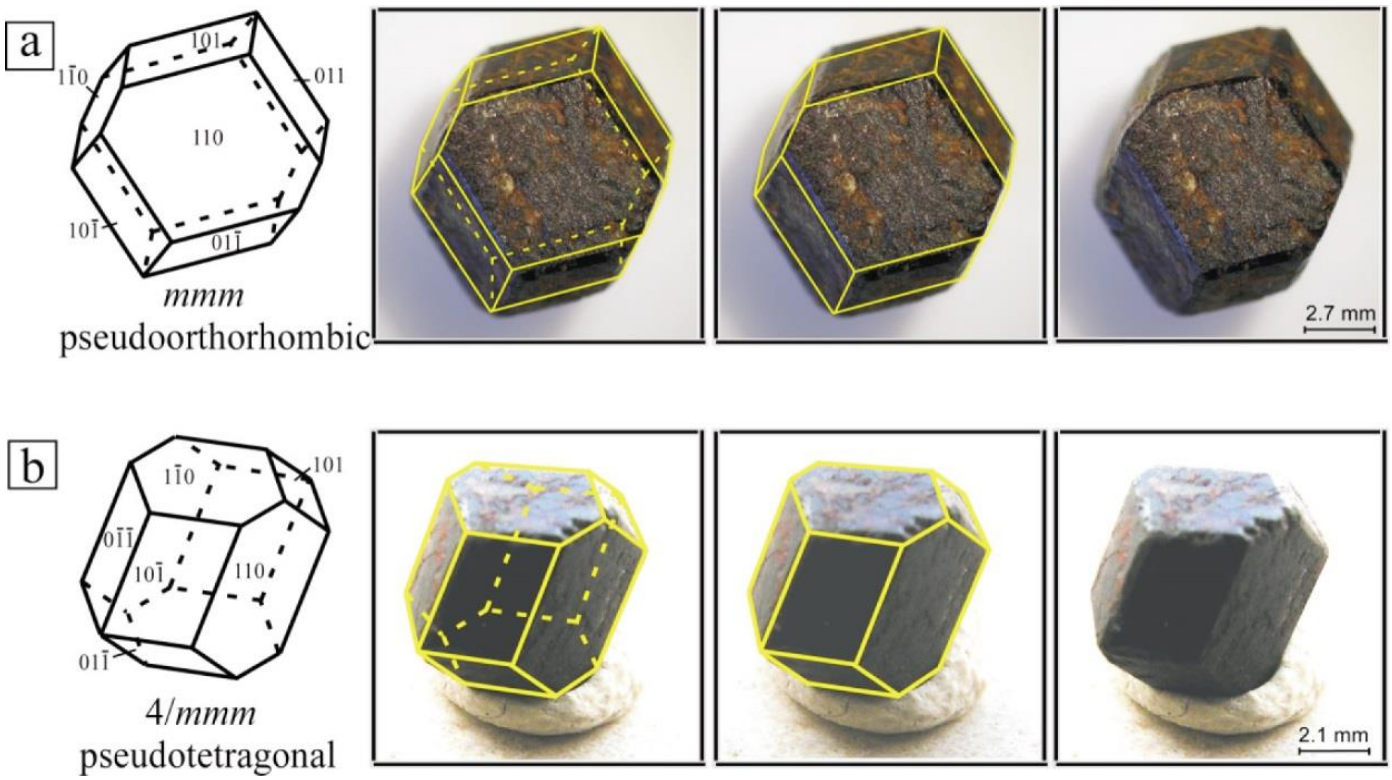
a
101
1$\bar{1}$0
011
110
10$\bar{1}$
01$\bar{1}$
mmm
pseudoorthorhombic
2.7 mm
b
1$\bar{1}$0
101
0$\bar{1}$$\bar{1}$
10$\bar{1}$
110
01$\bar{1}$
4/mmm
pseudotetragonal
2.1 mm

Fig. 2

crystals in comparison with their structural symmetry has been observed in this case. The crystallographic forms presented in Fig. 1*b*, 1*c* and Fig. 2*b* are pseudotetragonal – with point symmetry $4/mmm$. The crystallographic form presented in Fig. 2*a* is pseudoorthorhombic – with point symmetry mmm.

As a result of interpretation of the garnet crystallographic forms in terms of the symmetry-dissymmetry principle, infinite symmetry has been applied to a number of studied rhombododecahedral crystals [19]. The symmetry of the ideal rhombododecahedron $m3m$ fits only in the Curie infinite group of the symmetry $\infty\infty m$, which corresponds to the static sphere. The point group of the symmetry $4/mmm$ is a subgroup of the Curie infinite group of the symmetry ∞/mm, i.e. static cylinder. The point group of the symmetry mmm fits to the Curie infinite group of the symmetry $\grave{\infty}/mm$, i.e. static bicone, as a development of the Curie infinite groups [20].

The garnets during their crystal growth react sensibly to the changes in conditions of crystallization and as a result certain changes in their morphology occur. The crystals which symmetry fits only to the Curie infinite group of the symmetry $\infty\infty m$, i.e. ideal rhombododecahedrons $m3m$ are characteristic by crystal growth under isotropic surroundings – influence of lithostatic pressure and all-round diffusion of the chemical elements (Fig. 1*a*).

For garnets with point group of symmetry $4/mmm$, which is a subgroup of the Curie infinite group of the symmetry ∞/mm, i.e. static cylinder the crystal growth was under conditions of orientated pressure (perpendicular to G_4) is suggested. According to the Rikke principle it is possible the crystals to be partially dissolved under the influence of the orientated pressure and to continue their growth to direction of the lowest pressure. It is quite possible the orientated perpendicular to the one of the axes G_4 pressure to cause the elongation of the garnets into direction of this axis and to lead to the development of the pseudotetragonal habit of the crystals (Fig. 1*b*; 1*c* and 2*b*).

The point group of the symmetry mmm which fits in the Curie infinite group $\grave{\infty}/mm$ can be called the symmetry of the stream. The crystals with such kind of symmetry are possible to be formed not only in terms of orientated pressure, but as a result of intersection of the supplied solutions too. The garnets with pseudoorthorhombic symmetry mmm (Fig. 2*a*) are observed only in the area of the village of Dervishka Mogila. They are characterized by elongation along one of the axes G_4 and possess nonequivalent development of the hexagonal faces around the same axis. According to the fact that the host rocks are strongly folded, presumably the garnet crystals with pseudoorthorhombic symmetry are formed in terms of oriented pressure, which has been active perpendicular to one of the axes G_4 and parallel with one of the axes G_2 (perpendicular to two of the bigger in size hexagonal faces).

Conclusion. The deviations of the ideal garnet rhombododecahedron in the schists from the area of the villages Orlov Dol, Oreshnik, Planinovo and Dervishka Mogila are described and they can be definied as rhombododecahedroids. They are characterized by a reduction of the visual morphological symmetry of the crystals in comparison with their structural symmetry as a result of the change in the symmetry of mineral forming surrounding. The influence of the orientated pressure, active perpendicular to the one of the axes of the symmetry is supposed as the main factor which influenced the anisotropical conditions of the garnet crystals growth.

Fig. 2. Types of garnet rhombododecahedrons which are observed in the metamorphic rocks in the area of the villages Orlov Dol, Oreshnik, Planinovo and Dervishka Mogila: *a* – elongated along axis G_4 rhombododecahedron with nonequivalent (alike two by two) hexahedral faces around the same axis; *b* – elongated along one of the axes G4 rhombododecahedron with equivalent development of the hexagonal faces around the same axis ⟵

Acknowledgements. I am grateful to Dr. R. I. Kostov for the fruitful discussions and to N. Gospodinov for the help during sampling.

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