Stress analysis and structural settings in the area of the skarn deposits Krumovo, Southeastern Bulgaria

Анализ на напреженията и структурна характеристика в района на скарновото находище Крумово, Югоизточна България

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Introduction

In the northern foothills of the Manastery Heights the Manastery Upper Cretaceous intrusion formed the Krumovo magnetite deposit. It is located at 26 km SSE of the town of Yambol. The development of the deposit for extraction of magnetite ore began in 1906 and continued till 1986. Although it was significant source of magnetite for many years the published works on the deposit are not many. The skarn mineralization of the deposit was described by Panaiotov and Ivanova-Panaiotova (1956) and the petrology of the Manastery intrusion by Kamensov (1968). The overall tectonic setting in the northern periphery of the Manastery Heights, revealed by the drilling, was elucidated by Panaiotov (1966) but works on the detailed structural features on the deposit are still missing.

Geological settings

The Manastery basic intrusion has pronounced magmatic differentiation. The central and southern parts of the intrusive are occupied by gabbro and in its northern periphery by diorite porphyrites. The latter occur in the form of irregular, up to several hundred meters, dyke-like bodies intersecting each other (Panaiotov, Ivanova- Panaiotova, 1956) and the petrology of the Manastery intrusion by Kamensov (1968). The overall tectonic setting in the northern periphery of the Manastery Heights, revealed by the drilling, was elucidated by Panaiotov (1966) but works on the detailed structural features on the deposit are still missing.

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The metamorphic mantle of the intrusion contains Paleozoic gneiss-granites, diabases, diabase tuffs and green schists and Triassic marbles (Vasilev, Savov, 1962). Parts of the mantle are preserved only in the northern periphery of the pluton. Its preservation is due to the presence of a graben structure – Miladinovo-Dryanovo graben (Panaiotov, 1966). Dimitrov (2000, 2015) has shown that the oldest metamorphic rocks in the graben, belonging to the Sokol Formation (Catalov, 1985), have been metamorphosed twice. The regional metamorphism being of possible Late Jurassic age (Chatalov, 1990). The contact effect of the magma on the metamorphic mantle was expressed in the formation of hornfelses and magnesium and calcium skarns, which contain magnetite ore with hematite (specularite).

The normal fault that outlines the graben from south (Panaiotov, 1966; Dimitrov, 2005) has served for northern boundary of the gabbroic magmatic complex. All industrial deposits are located in areas penetrated by postmagmatic fluids. These are most likely fracture zones, located obliquely to the main structures of the graben (Panaiotov, 1966). The graben is striking to 300–310°, and its eastern part is shifted by about 4 km to the northeast, compared to the western part. The displacement occurred, towards 30–35° NE, according to Savov (1960). This later fault displaces all Manastery pluton and its mantle.

Structural setting of the deposit

The magnetite ore bodies are closely related to the dykes introduced during the last stages of pluton development. The dyke formations in Krumovo occur in two clearly delineated areas, in which the ore bodies are also located. These areas form the North and South domains (Fig. 1a) of the deposit. Between the domains there is an elongated in E-W zone, occupied mainly by diorite, where no dykes are present.
Marble bodies are also missing in this zone. The zone most likely marks a fault line, which was sealed by magma (Panaiotov et al., 1954f). These fault zones resulted in an observed uplift of the contact of the pluton. As a result of the uplift, and possible rotation, the ore bodies in the southern domain are dipping to south, while in the northern domain they are dipping to north (Bonev, Guzgunova, 1956f).

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Resent structural findings

In the area of the deposit, measurements of faults, joints and dykes were obtained. Slip directions were measured for 27 faults in the northern and 25 in the southern domain using the Aki-Richards convention, described in the manual of the FaultKin software (Marrett, Allmendinger, 1990) for rakes of strike on planes. The slip data are processed with a software FaultKin, which applies paleostress tensor calculations (Allmendinger et al., 1989) and plots the principal stress directions. The purpose of the study is to compare the inferred stress and dyke directions in the two domains of the deposit. Processed fault slip data for the direction of principal stresses (Fig. 1b) indicate for σ1 in the northern domain plunging in to E (trend 095°, plunge 13°) and in southern domain (Fig. 1c) plunging in to SSE (trend 160°, plunge 17°).

It is noteworthy that the dyke orientations in the two domains are different. In the northern domain their intersection dips to SW (Fig. 1d) and in the southern domain it dips to SE (Fig. 1e). It is of significance that stress orientation and dyke orientation differ in both domains. For such relatively small area it cannot be explained easily. One likely explanation is that the fault zone, separating the domains, imposed rotation on the fault blocks, which affected ore bodies and dykes as it was already suggested by Bonev and Guzgunova (1956f).

Joints were also analyzed. The results show three system of joints. First system with strike 280–315° and dip 50–80° in NE direction, rarely with dip 50–70° in SW direction. Second system with strike 350–030 and dip 40–75 in W direction. Third system with strike 035–060 and dip direction in NW and SE. The joints from system I and III are with rough surfaces and joints from system II are with smooth surfaces. This allows them to be classified as shear and extension joints.

The exposed data imply that block rotation took place after the formation of the dykes and the ore bodies. This rotation happened along the fault zone, shown on the map. The age of this fault zone, or the time of its reactivations, are not clear. One possibility is that Illyrian fault tectonics affected the deposit area (Tsankov, 1983). Since lineament studies in the region (Nachev, 2013) have shown that the neotectonic fault directions, in the Neo-gene sediments, are similar to the fault directions in the crystalline rocks, it is likely that these movements are still active nowadays.

References


