Mineral composition and provenance of prehistoric stone axe head from the surroundings of Nevestino village, Kyustendil District, SW Bulgaria

Минерален състав и произход на праисторическа каменна брадвичка от околностите на с. Невестино, Кюстендилско, ЮЗ България

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Introduction

A prehistoric stone axe head was investigated and the results in brief are presented here. It is an exhibit of the Historical Museum in the town of Kyustendil having inventory number 090 OF I-27 and filed in the museum archives on March 10, 1981. The stone axe head was found in 1980 in the Pobien Kamak locality (around the Pobien Kamak peak) near-by Nevestino village (~13 km ESE of the town of Kyustendil) by Stefan Chohadjiev (Veliko Tarnovo University). It was illustrated with a photograph and drawing in Chohadjiev (2007). It was supposed that the stone axe appeared an imitation of metal casting and was made in the Bronze Age (S. Chohadjiev, pers. comm.). Axe composition was studied by prof. Svetoslav Belev (former High Institute of Mining and Geology) who decided that the stone axe was made of natural rock without features of secondary melting and casting. His report (two pages) and the prepared thin section were not saved. The aim of present study is to determine the mineral composition of rock of axe, its nomenclature name, and to infer the provenance of the artifact.

Material and methods

The museum exhibit was used to cut two plates for polished and thin sections. They were investigated in transmitted and reflected light, and in scanning electron microscope. Mineral composition was determined by energy dispersive X-ray microprobe analysis using ZEISS SEM EVO 25 LS-EDAX Tident spectrometer at acceleration voltage of 20 kV and electron beam current of 500 pA. The standardless quantification results were performed through automatic background subtraction, matrix correction, and normalization to 100% for all of the elements in the peak identification list. The whole study was made in the Institute of Mineralogy and Crystallography, Sofia.

Results

The stone axe head has dimensions of 5.7×4.7×3.5 cm. It is made of massive dark grey-greenish rock (Fig. 1). The rock is medium- to fine-grained, holocrystalline, of variegated texture – subophitic or hypidiomorphic. It comprises plagioclase (~40%), clinopyroxene (~20%), biotite (~20%), ilmenite, magnetite and rarer titanomagnetite (~20% together). Accessory minerals are titanite and apatite. Plagioclase forms short tabular to lath-shaped crystals up to 1 mm long. It displays polysynthetic twinning, which is almost obliterated due to alteration by albite, carbonate, epidote-clinozoisite, and acicular amphiboles (tremolite and actinolite). Its composition varies from An_{78} to An_{34}. Most of the basic plagioclase was inhomogenously albitized. Potassium feldspar occurs rarely and it is completely adularized, containing traces of Na, Ca, Ba, and Fe. Commonly, clinopyroxene ($Wo_{42.13–49.71}En_{31.16–38.27}Fs_{16.79–19.6}$; $Ac_{0–1.69}$) forms short prismatic crystals but elongated prismatic crystals up to 0.5 mm long also occur. It forms also subhedral to anhedral grains. Clinopyroxene is altered by tremolite and actinolite, and in places is completely or partly replaced by chlorite. It contains TiO_2 (up to 4.28 wt%) and traces of Na_2O and MnO (both <1 wt%). Biotite is brown and appears as short flakes, as the longest flakes reach up to 0.3 mm. It is replaced in part by chlorite. Disorderly oriented ilmenite, titanomagnetite, magnetite, titanite and apatite are enclosed in plagioclase and pyroxene. Ilmenite forms euhedral prismatic crystals up to 3 mm long. It is lamellar due to hematite exsolutions. Titanomagnetite and magnetite form euhedral to anhedral isometric grains to 0.2 mm across and aggregates. Ilmenite contains traces of Mn and Ca, and magnetite – Ti and Mg. The content of TiO_2 in the titanomagnetite is 16.56 wt% (in one analysis), contenting also traces of Mg. Titanite is anhedral, sized to 0.1 mm across and

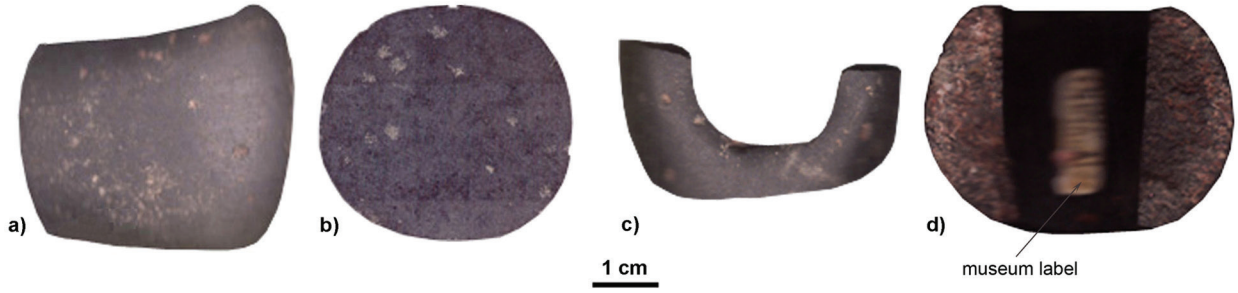

Fig. 1. View of the stone axe head: *a*, by side; *b*, to a polished cross section; *c*, by side of the socket for a wood handle, a cut; *d*, to the socket for a wood handle

appears as granular aggregates. Apatite is euhedral, prismatic to acicular. It is fluorapatite (F from 2.24 to 3.53 wt%) with traces of S, Fe, Mg and Ti.

Discussion

The studied rock is composed mainly of plagioclase and clinopyroxene, and contains in addition biotite and opaque oxides. The rock is altered by albite, epidote, clinozoisite, tremolite, actinolite, chlorite, and carbonate, i.e. greenschist alteration. The most basic plagioclase is bytownite, which is inhomogenously albitized. The main rock composition, the presence of plagioclase of An>50 and the amount of mafic minerals ~60% determine the rock as gabbro (Le Maitre, 2002). Biotite could be present in gabbros in an amount of 1–2% (Haldar, Tishljar, 2014). In our case biotite presents in ~10%. Probably part of it is secondary. By definition, gabbro is medium to coarse-grained rock but in our case the rock is medium- to fine-grained (Fig. 1). That is why, following the recommendations of the Subcommission on the systematics of igneous rocks (Le Maitre, 2002), this rock have to be named microgabbro. In the Kyustendil District similar rocks belong to the Struma Diorite Formation (SDF). The latter comprises gabbros, microgabbros, gabbrodiorites, diorites, and granites. They form small intrusive bodies and numerous dykes. These rocks were irregularly altered by a migmatization and in a greenshist facies of regional metamorphism. The SDF crops out on the Lisets Planina, Osogovo Planina, Verila Planina, and Vlahina Planina (Dimitrova, 1967; Haydoutov et al., 1994; Milovanov et al., 2008). The outcrops on the Vlahina Planina are nearest, ~2–3 km away from the Pobien Kamak locality. Haydoutov et al. (1994) believed that diorites of SDF from the Vlahina Planina appeared dioritized gabbros as dioritization resulted from the superimposed metamorphic alteration. Pyroxene of the studied sample shows composition very similar to that of pyroxene of dioritized gabbros of SDF from the Vlahina Planina, and the studied plagioclase is albitized like the plagioclase of dioritized gabbros of SDF (Haydoutov et al., 1994). Ilmenite, magnetite and titanomagnetite are characteristic and abundant minerals of the studied stone axe like the gabbros of SDF (Kanourkov, 1988; Haydoutov et al., 1994).

Conclusions

1. The stone axe from the surroundings of Nevestino village (Pobien Kamak locality), Kyustendil District, was made of microgabbro rock similar to gabbro rocks of the Struma Diorite Formation, both in mineral composition and mineral chemistry, when one compares data presented herein and previous published ones. **2.** It is proposed that the studied prehistoric stone axe was made of local rock of SDF from the Vlahina Planina since the nearest outcrops of SDF are in a distance of ~2–3 km from the Pobien Kamak locality.

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