СПИСАНИЕ НА БЪЛГАРСКОТО ГЕОЛОГИЧЕСКО ДРУЖЕСТВО, год. 79, кн. 3, 2018, с. 165–166
REVIEW OF THE BULGARIAN GEOLOGICAL SOCIETY, vol. 79, part 3, 2018, p. 165–166
National Conference with international participation “GEOSCIENCES 2018”

Mineral composition of Neolithic nephrite-bearing edge tools from the Kyustendil District, SW Bulgaria. Preliminary data

Минерален състав на неолитни нефритсъдржащи сечива от района на Кюстендил, ЮЗ България. Предварителни данни

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Keywords: Neolithic, stone edge tool, nephrite, Struma River valley.

Introduction

This short communication presents results of mineralogical study on two stone edge tools from the surroundings of Kocherinovo town and Mursalevo village (the Struma River valley), SW Bulgaria. The stone tools are museum exhibits of the Regional Historical Museum (RHM) in the town of Kyustendil and were found in 2014, in cultural layers of Neolithic settlements. The stone tool from the surroundings of Kocherinovo town has field inv. no. 3 and dimensions of 2.6×2.4×0.65 cm while that one from the surroundings of Mursalevo village has field inv. no. 331 and dimensions of 2.4×1.9×0.8 cm (Fig. 1) (Vandova, 2017).

Material and methods

The museum exhibits were investigated in a non-destructive way following requirements of museum officers at the RHM-Kyustendil. A powder sample was taken from each of them by scratching with a steel blade and investigated under stereomicroscope and scanning electron microscope. Step-scan X-ray powder diffraction data were collected over a range of 3–70° 2θ with CuKα radiation on D2 Phaser-Bruker AXS Bragg-Brentano diffractometer (30 kV, 10 mA, step of 0.05° 2θ and a counting time of 1 s/step). Mineral composition was determined by energy dispersive X-ray microprobe analysis – EMPA (automatic background subtraction and matrix correction)

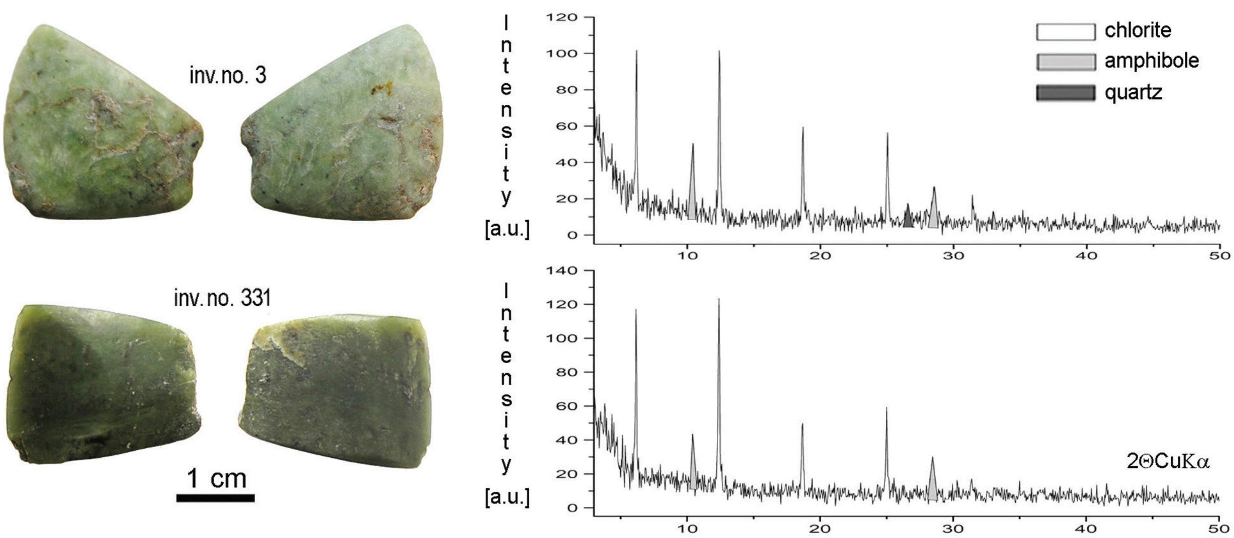

Fig. 1. The studied stone tools seen from the two larger sides (left) and the respective X-ray powder diffraction patterns (right)

using ZEISS SEM EVO 25 LS-EDAX Tident spectrometer (20 kV, 1000 pA, beam diameter of 1 μm and detection limits <0.01 wt%).

Results and discussion

Visual inspection of the two stone tools revealed that they have been grinded with shaping of side edges, sharpening of the blade, and then finely polished. They have sharp cutting edges which display short broken portions indicating usage before being buried underground. The stone edge tool of inv. no. 3 is made of pale yellow-green inhomogeneous crypto-crystalline rock comprising darker grassy-green spots as well as scarce dots of black opaque mineral of square outlines. At places the rock displays an alteration of a few mm wide bands colored in yellow-green and grassy-green. The rock is cracked as the cracks are filled with iron hydroxides. The stone tool of inv. no. 331 is made of dark green crypto-crystalline massive homogeneous rock (Fig. 1). Both tools strongly resemble nephrite and consist of chlorite and amphibole. That one of inv. no. 3 contains in addition small amount of quartz (X-ray data, Fig. 1). In SEM-images chlorite appears as micron-sized flakes to 20–30 μm across; amphibole is fibrous with fibers to ~30 μm long, very large length-to-width ratios (>50), and needle-like terminations. The fibers are arranged in bundles. Amphibole of the stone tool of inv. no. 3 is tremolite: $Mg/(Mg+Fe^{2+})=0.96$ and $Si=7.92$ in formula (av. of 2 EMPA), whereas amphibole of the stone tool of inv. no. 331 is actinolite with higher amount of FeO_t, $Mg/(Mg+Fe^{2+})=0.89$ and $Si=7.33$ a.p.f.u. (av. of 2 EMPA) (Leake et al., 1997). Chlorite is Mg-type, with FeO_t of 6–10 wt%, traces of Cr_2O_3, CaO, MnO, K_2O and Na_2O, and corresponds to clinochlore (4 EMPA) (Wiewiora, Weiss, 1990). The two stone tools have similar mineral composition – chlorite and amphibole appear main minerals. This composition determines the raw rocks as chlorite-actinolite and chlorite-tremolite ones. The different colors of tools arise from the composition of amphibole: actinolite brings dark green color to the tool no. 331 while tremolite – pale yellow-green spotty appearance to the tool no. 3; chlorite in both is green one. Since nephrite is compact variety of tremolite or actinolite (Kostov, 1993), then the studied tools appear nephrite-bearing ones and can be considered as a part of the enigmatic Neolithic Balcan nephrite culture introduced by Kostov (2005). It is well constrained that nephrite has a metasomatic origin and forms either at the contact of serpentinites and more silicic rocks like gneisses, schists and granites or by silicic fluids replaced dolomite (review in Harlow, Sorensen, 2005). Serpentinites in SW Bulgaria form numerous small bodies (Zagorčev et al., 2015 and references therein) and cases of reaction zones of chlorite (±talc)-actinolite composition at the contact serpentinite/gneisses or calcareous or mica schists or marbles formed during regional metamorphism have been described from Bulgaria (Kozhuharova, 1977). Earlier, nephrite (actinolite-tremolite) in SW Bulgaria was found in a talc-tremolitic body within migmatized biotite gneisses (Zidarov et al., 2010) but this body is too small to be the only source of the numerous and diverse nephrite artifacts found within the Balkan Peninsula (Kostov, 2005). Because of the small size of serpentinites and their reaction zones it can be assumed that the nephrite deposits there have been exhausted since Neolith. This solves the issue of the absence of nephrite deposits in Bulgaria in modern times.

Conclusions

1. The studied Neolithic stone edge tools from the Kyustendil District have been made of chlorite-tremolite and chlorite-actinolite rocks. **2.** It is assumed that raw material of the tools appear local rocks formed by a contact-infiltration metasomatism at the contact of seprentinites with Si- and Al-rich metamorphic rocks which both outcrop in SW Bulgaria. **3.** The studied stone tools are nephrite-bearing and present products of the “Neolithic Balcan nephrite culture”.

Acknowledgements: Authors thank officers of the RHM, Kyustendil for given museum exhibits, Y. Tzvetanova (IMC, Sofia) for X-ray analyses, and I. Zagorchev (GI, Sofia) for fruitful discussion.

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