GEOLOGICA CARPATHICA, 47, 6, BRATISLAVA, DECEMBER 1996
367–370

NEOLITHIC ECLOGITE HAMMER FROM THE NITRIANSKY HRÁDOK (WESTERN SLOVAKIA)

DUŠAN HOVORKA[1] and ĽUDMILA ILLÁŠOVÁ[2]

[1]Department of Mineralogy and Petrology, Faculty of Sciences, Comenius University, Mlynská dolina, 842 15 Bratislava, Slovak Republic
[2]Archeological Institute, Slovak Academy of Sciences, Akademická 2, 949 21 Nitra, Slovak Republic

(Manuscript received June 20, 1996; accepted in revised form October 9, 1996)

Abstract: A fragment of Neolithic hammer made from eclogite has been found among artifacts from the archaeological site of Nitriansky Hrádok. Although there are several possible occurrences of primary source (eastern rim of the Bohemian Massif, the Eastern Alps) of the raw material under discussion we prefer the river Danube gravels deposited eastward of the Alps as the probable source of raw material of the hammer studied.

Key words: Neolithic, Nitriansky Hrádok, polished stone, eclogite, hammer.

Introduction

Polished stone industry accounts for an important part of the stone artefacts produced in the Neolithic to the Early Bronze Age. It is represented by cells, axes, axe-hammers, maceheads and wedges. The aim of their study is determination of their raw material using petrographic analyses (thin sections study, electron microprobe, X-ray diffraction, chemical analyses and others). Among goals of performed studies belongs also identification of the locality of the source determined for the raw-material-rock in the territory of Slovakia or outside its territory and so to ascertain their provenance.

There were several papers dealing with this problem based on investigation results up to the present time, but no detailed petrographic analyses were carried out (raw material of polished artefacts determination was mostly based on naked eyes observations, only partly on thin section studies).

A systematic investigation of the Neolithic polished industry has recently begun (Illášová 1989; Illášová & Cheben 1992; Hovorka & Illášová 1995; Tackenberg 1996; Illášová & Hovorka in print; Miko in print). Some groups of appropriate raw materials recurrent during the whole Neolithic period up to the Early Bronze Age are outlined in a great amount of petrologically analysed polished stone artefacts up to now. A stone hammer found on the site of Nitriansky Hrádok (position Zámeček) is the only one made from eclogite.

The paper is devoted to eclogite — raw material of a stone hammer suggesting a certain source of the raw material. The hammer was found in a Neolithic position of the Lengyel culture (No. 145 52, object No. 4). The site is a polycultural one. From the total number of 82 analysed polished artefacts 20 belong to Neolithic Lengyel culture, 12 to the Eneolithic Baden culture and 50 to Early-Bronze-Age Maďarovce culture.

The site is situated on the southern foothill of the western segment of the Carpathian arc. Several mountains ranges (the Tribeč Mts., being the closest one) are located to the north. A northern promontory of the Hungarian Plain is situated to the south, river Danube is 35 km away (Fig. 1). Site Zámeček is on the loess cliff surrounded by flood plains of the Cítenka and Žitava brooks (Pavúk 1981).

The high-grade metamorphic rock originated under transitional granulite/eclogite facies p-T conditions used for polished artefact is a unique type of raw material in the territory of the Slovak Republic. We present a detailed petrological analysis of the material used and discuss its probable source.

Description of the polished stone fragment

Eclogites are metamorphic rocks mostly of simple mineral composition. Apart from the dominant constituent, Mg-rich (but in some cases also Fe-rich) garnet and Na-rich pyroxene (omphacite), they also contain accessory amounts of rutile, sometime also kyanite, paragonite and other minerals. Eclogites are fine- to coarse-grained rocks of characteristic red-green color. They crop out in numerous geological units, practically always forming small (metre to decametre dimensions) bodies located within high-grade metamorphic sequences or ultramafic bodies.

Eclogites are believed to originate under high pressures and moderate to high temperatures. Such geological conditions are characteristic of the upper mantle, but only rarely for continental crust domain. The most favorable geological conditions for eclogite genesis are those of subduction zones, where plates of oceanic lithosphere are subducted under thicker continental crust. In the following text we will dealt with the problem of the raw material of the given hammer in detail.

The hammer (No. NHr 145 52, Fig. 2) was originally a river cobble. It is of very fresh appearance without any observable products of weathering. The fragment is fine- to medium grained (2–3 mm) and two main components are detectable by the naked eye: purple-red isometric garnets and dark-green to greenish-black columns of amphiboles. The distribution of these minerals in detail is uneven: amphiboles as well as garnets are concentrated in 1–1.5 cm thick bands, which are especially observable in thin section. Such banded fabrics (with a

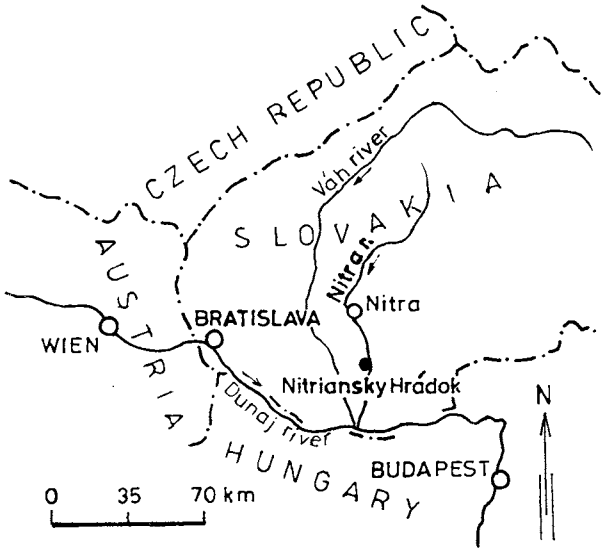

Fig. 1. Location of Nitriansky Hrádok.

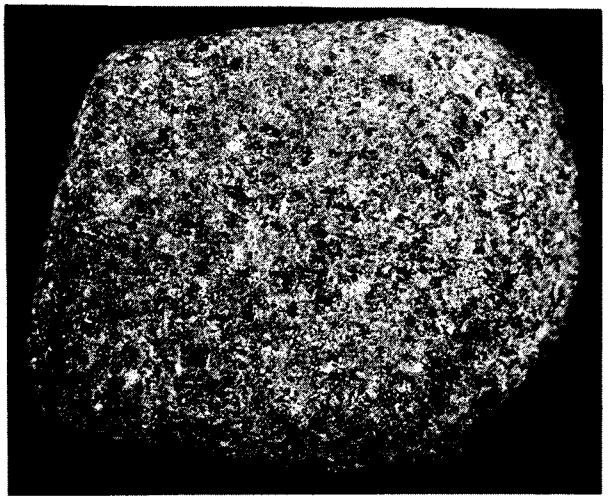

Fig. 2. Fragment of bored eclogitic hammer described in this paper. 0.8× of natural size.

Fig. 3. Kelyphite structure of described eclogite. Thin section, enlarg. 30×, X polars.

gradual transition of individual bands) are characteristic for the rock under consideration. Apart from the banding caused by predominance of one of the main minerals (garnet : amphibole) the bands differ in the size of the phases present. Bands with prevailing idioblastic garnets are coarse-grained in comparison to those composed of amphiboles.

In thin sections of the studied artifact the following mineral assemblage have been found:

garnet + amphibole + clinopyroxene + ilmenite + plagioclase + spinel + quartz.

Idioblasts of garnets are the quantitatively dominant phase. The pyrop end-member is in range 34 to 38 mol. per cent (microprobe determination). The garnets contain enclosures of Cpx and are pronouncedly tectonically crushed with well developed systems of cracks of various orientation. Around individual Grt crystals kelyphite rims (Fig. 3) are developed. They are formed by intensively brownpleochroic hornblend together with acid plagioclase and ± quartz.

The second main mineral phase is brown monoclinic hornblende (amphibole). Its relatively high Na_2O content (3.50 to 3.80 per cent) possible suggests its generation under high pressure. Its pleochroic colours vary between yellowish-brown (in alpha direction) to chocolate-brown (in gama direction). Hornblende/amphibole crystals are very fresh. Sporadically present yellowish-brown monoclinic pyroxenes are characteristic. Grass-green spinel is a typical accessory phase. It belongs to the typical Al-rich type (Al_2O_3 = 62.50 to 63.50 wt. per cent). Spinel forms lobate (0.X mm) grains spatially connected with ilmenite crystals. Rutiles of submicroscopic dimensions are present in the form of inclusions in garnets. Fine-grained quartz is a component of the kelyphitic rims. Opaques dominantly belongs to ilmenite.

As one of the important characteristics of rocks of all kinds is their chemical composition (which during metamorphic processes mostly behaves conservatively) we present the chemical composition of the axe fragment (fragment No. NHr 145 52): SiO_2 = 42.56 %, Al_2O_3 = 17.59 %, $Fe_2O_{3tot.}$ = 13.19 %, TiO_2 = 2.19 %, FeO = 10.16 %, MnO = 0.227 %, MgO = 9.48 %, CaO = 13.76 %, Na_2O = 1.25 %, K_2O = 0.10 %, P_2O_5 = 0.01 %, H_2O^- = 0.08 %, loss of ign. = 0.14 %, CO_2 = 0.29 %, (the following trace elements in ppm): Y = 14, Zr = 8, Nb = 2, V = 322, Ba = 81, Sr = 103, Cr = 318, Ta = 1, Hf = 1, La = 3, Ce = 5, Nd = 4, Sm = 2, Eu = 0.7, Gd = 2.1, Yb = 1.0, Lu = 0.59.

The single analyzed fragment gives no oportunity to discuss the impact of the chemical composition of the given fragment on the genesis and occurrences of given rock-type of raw material. After this stage of work we plan to use all the gathered data in a synthesis of the problems.

Taking into consideration:

i) the chemical composition of analyzed hammer,

ii) banding of the rock with bands formed prevailingly by garnets on one hand and by brown amphibole on the other,

iii) the presence of Al-rich green spinel (instead of rutile),

iv) the presence of relatively fresh clinopyroxene crystals with no signs of reactions,

v) the composition of garnet,

vi) the presence of kelyphite rims round the granet crystals, as well as

vii) the prevalence of amphibole over clinopyroxene we consider that the rock under discussion underwent the following geological history.

After its formation the original (banded, cumulate) gabbro was implaced into the p-T conditions of granulite-eclogite facies of transitional type. The original magmatic mineral association under the above mentioned p-T conditions recrystallized into a simple mineral association: clinopyroxene + garnet. Uplift of the geological body into shallower p-T conditions within the Earth's crust yielded the formation of brown hornblende at the expense of clinopyroxene (hydration process) and the recrystallization of garnets.

Taking into account the above mentioned features of the rock under discussion we designate the raw material of studied axe as the "eclogitic/granulitic melagabbro" which underwent retrogressive recrystallization in high-grade amphibolite to granulite facies p-T conditions.

Possible primary occurrences of raw material

Small lenses of formerly eclogitic rocks have recently been described (Hovorka et al. 1994) within individual mountain ranges of the Western Carpathians (the Tribeč Mts., the Malá Fatra Mts., the Tatry Mts., the Slovenské rudohorie Mts. and others). The complicated geological history of the pre-Carboniferous complexes in which the above mentioned lenses of originally eclogitic rocks are located, strongly influenced the original mineral associations of rock under discussion. No equivalent rocks to the studied hammer are known on the present surface within the territory of the Slovak Republic and adjacent parts of countries in which geological units of the Western Carpathians are situated.

The geological unit to the west — the Bohemian Massif — is well known for its eclogite occurrences. They are spread over huge areas being an integral part of the following geological units (Medaris et al. 1995): the Teplá terrane, Monotonous and Varied terranes, Gfohl terrane (all mentioned being units of a lower order of the Moldanubian zone). In addition eclogites crop out in the Saxothuringian zone (Klápová 1990), a part of the European variscides.

On the north-eastern rim of the Bohemian Massif there are wellknown eclogite occurrences in Silesia (southern Poland). Together with nephrites they have been repeatedly considered to be the source rock-bodies for polished stone industries especially in adjacent part of Poland (Prinke & Skoczylas 1980) and Moravia (eastern part of the Czech Republic — Štelcl & Malina 1972).

In the above mentioned geological units of the Bohemian Massif several genetic types of eclogite have been described (see Medaris et al. 1995). The division is based especially on the geological position, petrological pathway of eclogites within individual geological units based on their fabric and mineral composition.

The last geological megaunit with in situ eclogite bodies occurrences are the Eastern Alps. Within the Eastern Alps several geological units contain eclogite bodies. Among them especially those of the Sieggraben Unit should be mentioned.

Territories to the south of the archaeological site of Nitriansky Hrádok are mostly covered by Neogene sedimentary as well as volcanic/volcaniclastic strata. Apart from this, eclogite on the territory of Hungary has been described only from borehole.

The river Danube reaching the northeastern rim of the Pannonian Basin deposits thick layers or lenses of coarse- to fine-grained detritic material of the Eastern Alps as well as the Bohemian Massif provenience. The pebbles (cobbles) within the

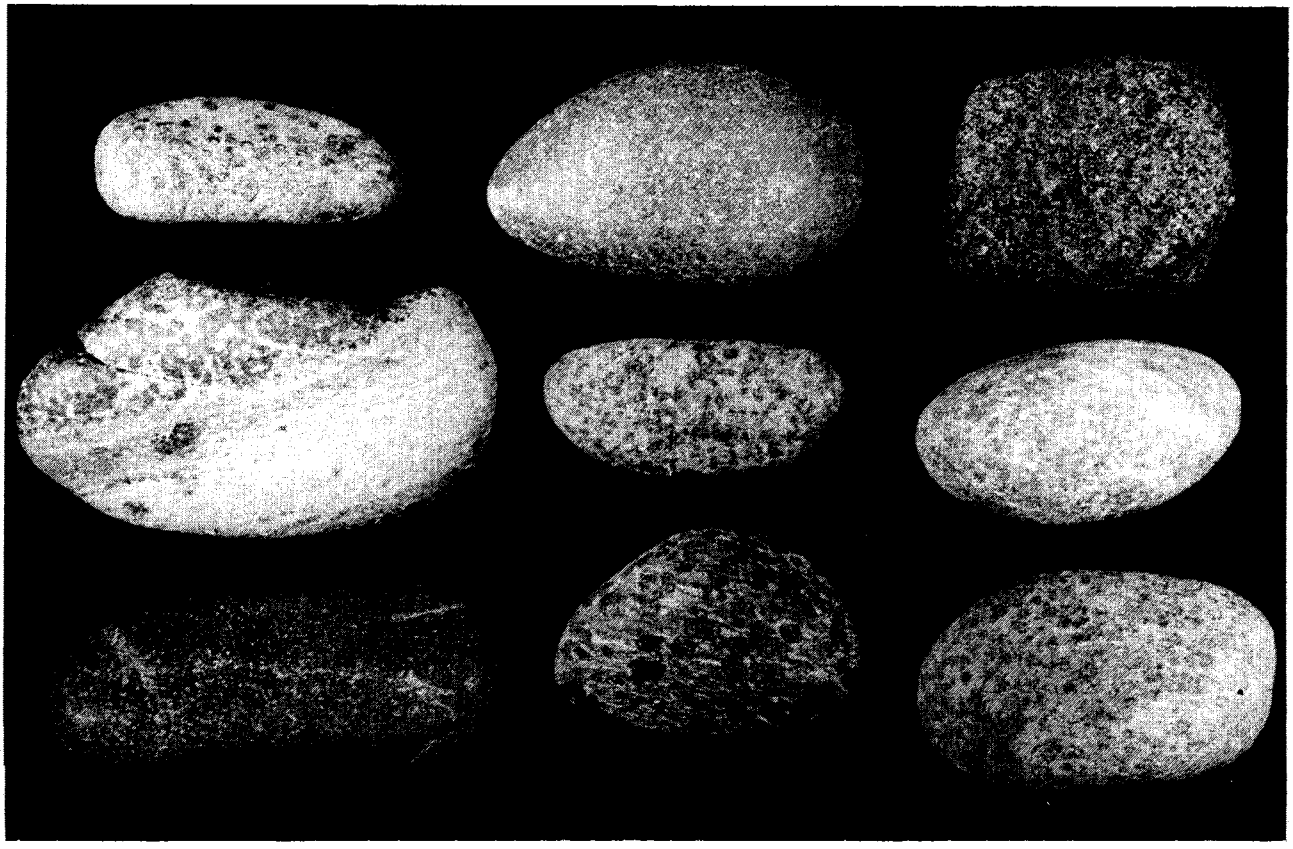

Fig. 4. River Danube cobbles — garnet amphibolites and eclogite are among them. Locality: Bratislava. Diminished to 60 % of the natural size.

river valley are very varied in composition — but it is characteristic that eclogites are found among them (Fig. 4).

Discussion and interpretation

The fragment of eclogitic hammer of the Neolithic Age is a very rare type within the whole western Slovakia province. Neolithic eclogitic tools have not been reported yet from this region. Numerous eclogitic artifacts (tools) have been described from Moravia (Štelcl & Malina 1972) and in the western Europe by D´ Amico et al. (1995). The provenience of raw material is explained in various ways.

Among gravels of the river Danube sediments eclogites are remarkably present. They reach sizes of 7-8 cm in elongation: they are well smoothed and mostly fresh (owing to mechanical abrasion during transport).

The distance between the place of eclogitic hammer find and the nearest possible place of raw material occurrence is 35 km.

It should be pointed out that between the Danube and the Nitriansky Hrádok site there is lowland on both sides of the river Nitra which represents a natural communication path for Neolithic tribes. Based on this fact we prefer the explanation that a river Danube cobble transported from the southern slopes of the Bohemian Massif was used as raw material for the described hammer.

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