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Main Western Carpathians rock lithologies used as the raw materials of the Stone Age

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Abstract. Among raw material types used by the Stone Age human communities all three genetic rock types were identified: igneous, sedimentary as well as various metamorphic rock types. Their quantitative proportion changes from site to site. The great majority of the inorganic raw materials used during the whole Stone Age are of the local provenience. Significantly less frequent implements have been documented, raw materials of which is of distant or even very distant proveniences. Several hundreds kms migration of raw materials, or more probably, of the ready made implements, is documented since the Late Paleolithic.
For the prevailing part of the inorganic raw material types geographical location as well as geological position is well known. But there are described raw material types whose in situ equivalents (geological bodies) are not known on the territory of the country or even on neighbouring territories.
In the Neolithic/Eneolithic, except of hard and competent raw material types, genetically different raw material - plastic clays - represent material of common use, for ceramic vessels manufacturing. Together with clays of various genetical types natural colors (namely products of ores weathering) have been used. On the very end of the Stone Age very seldom use of gold and copper is documented.

Key words: Stone Age, Western Carpathians, main rock lithologies used

Introduction

During the last decades, namely after the World War the IInd, numerous evidences dealing with human activities, from practically whole territory of the Slovak Republic, were presented. Wide river valleys (Váh, Hron, Ipeľ, Hornád and the others) filled up by loess offer suitable environment for human tribes settlements already during the Late Paleolithic. During the last period of the continental glaciation, namely caves offered temporal hidding places against cruel climatic conditions. Such places, in combination with warm mineral water springs (Piešťany, Bojnice, Gánovce and the others) offered basic type of daily food - big animals' meat. So such places have been chosen by new and new human generations as the temporal living places. Surprisingly among inhabitat areas belong also intramontagne basins, whose elevation above sea level is relatively high, for instance the Poprad basin, in the frame of which Gánovce-man cranium of the 105000 years ranking (Vlček 1995), was described.

The end of the Early Neolithic, and namely Middle Neolithic represents time period, when human tribes settled („neolithic revolution"). Hunters-gatherers gradually changed to people, whose main part of the daily food represented the products of their agricultural and pasturage activities. This process in the central Europe starts during 7th millenium before present.

New style of living and increasing number of members of individual human tribes, which reflects more suitable climatic conditions after the last continental glaciation, yielded in consumption of more and simultaneously more variable raw material types. Preparation of new fields, after the burning of forests, necessitates elaboration of great amount of stone implements, namely axes and hammer-axes for wooden houses construction and for the other purposes.

During the Paleolithic inorganic raw material types were represented, taking into account the place of their picking, namely river pebbles, in less amount also in situ geological bodies. From the point of view of their quality, they belong mostly among submicroscopically grained quartz (or its modifications) composed rocks originated by various ways. The majority of them are products of diagenetic or epigenetic processes (various cherts) in not yet consolited sediments. Characteristic are also hydroquartzites (limnoquartzites) occurring namely in the Žiarska kotlina basin. Obsidian, e. g. acid volcanic glass of the Neogene in age is another typical Paleolithic raw material type often used for manufacturing of cutting instruments. Their known occurrences in the Zemplin county (eastern Slovakia and northern Hungary) served as supplyers for the whole central and partly also western Europe. Widespread distribution, together with the western Slovakia finds of instruments made from hydroquarzites document implements/raw material exchange activities already in the Late Paleolithic. Generally, all implements made via chipping of the given raw material types are known under denomination **chipped industry**.

During the Neolithic and namely Eneolithic high demand of working tools, but also weapons and implements having ornamental/decorative aim enforced intro-

duction of new raw material types and simultaneously introduction of new technologies of their elaboration. Smoothing and polishing of hard, mostly fine-grained rocks of all three genetic categories start to be leading process of stone elaboration. The whole colorfull set of implements made by this techniques is called **polished industry**. During the first centuries of the polished technologies use, axes and hammer-axes were fixed in wooden or antlers sticks. Later on (after several centuries) boring of the stone implements was introduced. On the Neolithic/Eneolithic stone implements two types of boring we have documented: full hole boring and core boring.

Geology of the Western Carpathians is extremely complicated. All three genetic types of rock sequences are known to occur on the present-day surface. Mountainous morphology of the most part of the country enabled the supply of variable rock debris into river valleys where from praehistoric man picked up and consequently elaborated suitable raw material types. Though local raw material types (one day walking distance) are mostly used, in individual cases long distance transport of ready made implements is supposed to act. Among the set of Neolithic/Eneolithic implements documented, there are several raw material types of unknown proveniences.

In the following there are presented rock sequences which were sources of, in the Stone Age frequently used, raw material types. The presentation of the raw material types used is based on the stratigraphic principle (e. g. Paleolithic vs. Neolithic/Eneolithic). Characterization of geological units (rock sequences) which offer given raw material types is of first ranking.

Geological units supplying raw materials used

RAW MATERIALS OF QUATERNARY

During the very end of Pleistocene, and namely during the Holocene geological processes operated in the central Europe yielded in formation of several raw material types. In the following there are presented the most important of them.

Raw materials for ceramic production

During the Neolithic (e. g. after the last continental glaciation of Europe) permantly new and new raw material types were introduced to the human communities daily life. Among them one of the most important are raw materials for ceramic production, as well. Mentioned technology was introduced gradually, so time period when ceramic vessels start to be abundand and widespread, is called **ceramic Neolithic.**

Loess

It covers huge areas of the rivers Váh and Hron valleys, Trnava plain and eastern Slovakia lowland, namely during the Neolithic was used as:

a) places very favourable for stable lodgings location (loess was used for plaster production),
b) as the raw material for ceramic production (Figs. 1-3).
c) the very fertile substratum for agricultural activities in the Middle and Late Neolithic.

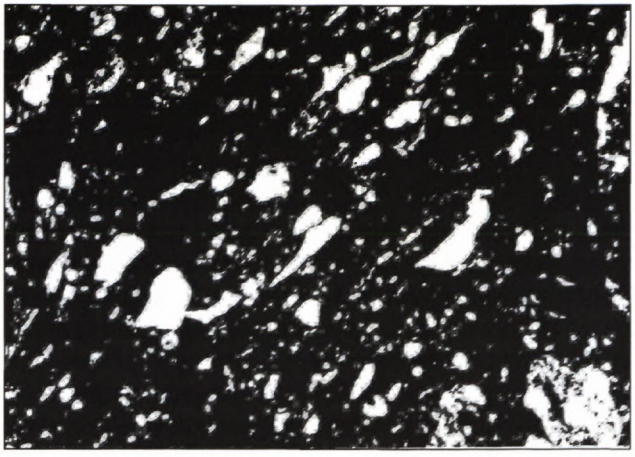

Fig. 1. The lengyel culture ceramic fragment. Preffered orientation of quartz clasts parallel to the outer rim. X polars, magn. 45x.

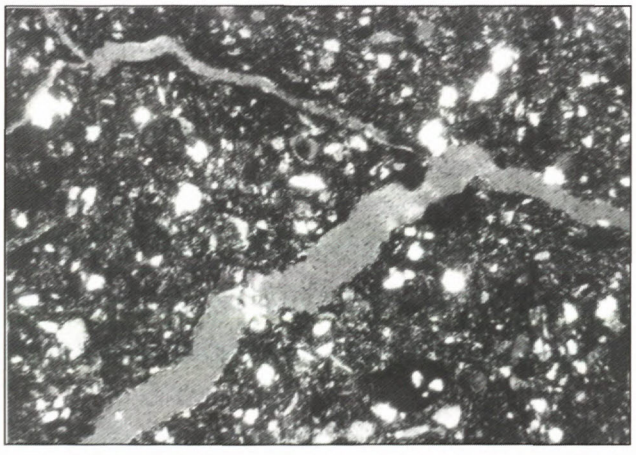

Fig. 2. The lengyel culture ceramic fragment. Hair-like veinlets in ceramic paste filled up by $SiO_2.nH_2O$ maters. X polars, magn. 45x.

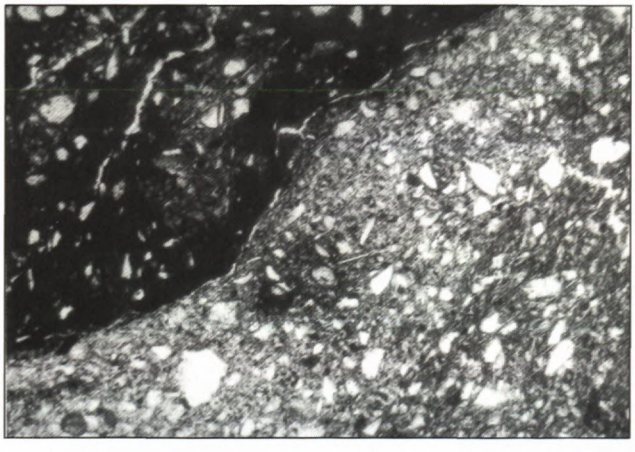

Fig. 3. Older fragment of the ceramic vessel (dark) in the lengyel culture ceramic paste. X polars, magn. 75x.

Clays

Clays of the higher quality are represented by the Neogene and Quartery strata known from several units: from the Danube and the eastern Slovakia lowlands, from the Late Tertiary intramontagne basins located among volcanic chains and the others. As laboratory identification of ceramic raw materials was not yet carried out in great amount, we haven´t arguments for clays of mentioned proveniences utilization.

Another clayey sediments are present as the rivers and brooks bottom deposits. They pass gradually to sandy deposits, so carefull selection of used parts of strata is needed. Utilization of this type of the given raw material type is traceable by clasts of minerals present in the paste of ready made ceramic, which indicate provenience of the crystalline massifs (prevailing quartz grains) vs. Late Tertiary volcanic areas (dominant are clasts of dark minerals).

Natural colors

Already in the Paleolithic man used natural colors for paintings on the caves walls, later on there are evidences of the use of natural colors for dead human bodies painting. The widespread use of natural colors is documented on ceramic fragments (Bárta 1965, Šiška 1980). Colors were used mostly before vessels burning, which technology made coloring more stable.

Natural colors are of different origin. Among widely used belong products of subrecent weathering of siderite bodies. They form so called „gossans" composed of iron oxides and hydroxides. Downward they gradually pass into the fresh parts of Fe-carbonates. Gossans offers yellow and yellowish-brown tints of color. They are easibly dissoluble in water. Pieces of dry parts of gossans were documented from several Neolithic graves in the country.

Another genetic type of natural yellow up to brown color represent irregular clods of haematite occurring within Tertiary conglomerates of the so called Piešťany Formation. Clays of this formation are in some positions intensively colored (pinkish, yellowish and milky-white colors).

Majority of carbonate precipitates from mineralized spring waters are of yellowish to yellowish-brown colors. They are easily crushible to pulver - their use as natural colors is probable.

Various tints of grey up to black colors were obtianed by process of charcoal crushing.

LATE TERTIARY VOLCANIC PROVINCE

Products of the Late Tertiary volcanic activity are variable: they represent subvolcanic and volcanic bodies of various chemical as well as mineral composition, their volcaniclastics and products of hydrothermal silicification and hydrotherms precipitation.

Obsidian

Rapid cooling of effusive lavas yielded in volcanic glass origin. To all types of lavas correspond equivalent volcanic glasses. From practical use the most important are acid volcanic glasses being equivalents of rapidly cooling rhyolithic lavas. One type of acid volcanic glass is obsidian. It has massive compact pattern and low amount (below 2 per cents) of water. In the following we will not take into consideration volcanic glass being integral part of groundmass of more-or-less each effusive rock. We will concentrate on acid volcanic glass forming pronouncedly dominant part of the rock. Spatially obsidian represents marginal parts of lava bodies, or, in less amount the whole volcanic body is represented by volcanic glass.

Density of obsidian varies in the range 2,30-2,40 $g.cm^3$. Characteristic is its low porosity (below 1 per cent). Index of refraction is equal to 1,485. Obsidian from the discussed areas is of darkgrey up to black color. It is clear, transparent, locally low amount of silicate minerals crystallites are observable.

One of the classical areas of the obsidian occurrences in the country (except of those in the Tokaj Mts. in NE Hungary) is the area of village Viničky, in less amount also in the vicinity of the Veľká and Malá Bara villages in the Zemplin Hills (eastern Slovakia). In the area under discussion, mostly in vineyards, blocks of various size of obsidian are known to occur. The area is characteristic by various products and semiproducts of „workshops" producing chipped industry, mostly arrow points, which can be found in high quantity on fields up to now.

In the Paleolithic on sites located in eastern Slovakia obsidian was the leading raw material type. From its occurrences in the Zemplin Hills it was distributed on long distances: eastern Slovakia obsidian implements were found on territory of the Czech Republic, southwestern Poland and in eastern part of Germany, as well. The sites with numerous obsidian industry located on eastern Slovakia are namely Kašov, Cejkov and Hrčeľ.

Obsidian made industry from eastern Slovakia archaeological sites was studied by Bánesz (1961) and Kaminská (1985). Obsidian from central Europe together with its chemical composition was presented in comprehensive paper by Bíro et al. (1986).Valuable analytical data, namely trace elements determination, is presented in paper by Killikoglou et al. (1997). Obsidian was used also in the Neolithic. Neolithic finds of the obsidian industry from the territory of Slovakia were summed up by Šiška (1999).

Hydroquartzite (limnoquartzite)

Late Tertiary rhyolitic volcanism, namely on rim of the Žiarska kotlina basin, is accompanied by intensive hydrothermal activity. Hydrotherms were saturated by the SiO_2, which in intermontagne fresh water lakes precipitated mostly in the form of chalcedony.

Hydroquartzites have various colors (milky white, grey up to redishbrown) and compact as well as porous pattern. They occur as isolated lense-like bodies forming intercalations with volcaniclastics and sediments. But they are present in the form of synform layers of several meters thickness. Characteristic are footprints of various (namely swampy) grasses, tree leaves and footprints of various insect.

On the territory of the country there are two areas of the hydroquartzite occurrences: the rim of the Žiarska kotlina basin in central Slovakia, where areally large limnoquartzite positions are known to occur. In the eastern Slovakia the Slánske vrchy and Vihorlat Mts. bear also (but smaller) hydroquartzite occurrences. Except of mentioned central Slovakia primary occurrences, river Hron gravel deposits downstream of the primary occurrences, contain also hydroquartzite gravels.

Due to its hardness and ability to split into thin and sharp partial pieces, hydroquartzite, namely in the Žiarska kotlina occurrences (Cheben and Illášová 2000), served already in the Paleolithic as one of main raw matrial types. Utilization of hydroquartzite is traceable during the whole Neolithic and Eneolithic and for some special purposes it was used till the Middle Age, or even up to now, respectivelly.

Namely in the Stone Age hydroquartzites were used for arrows sharp ends and various types of implements used for cutting. Bárta (1991) from several western Slovakia sites, namely from Brodzany, Žabokreky, Mariánsky vršok-Prievidza and from Veľké Stankovce as well, described the hydroquartzite implements of the Žiarska kotlina basin provenience. So hydroquartzites, along with the most common radiolarites and radiolaria schists, were used by the human communities living namely in the western part of the country.

Opal/chalcedony

Except of hydroquartzite also the other types of precipitates from thermal solution were used in pre-historic period as raw material for various chipped implements elaboration. Irregular nests and veins of various thickness of opal or chalcedony, are known to occur practically from all Late Tertiary volcanics subprovinces. Their maximal concentrations are known from zones of postvolcanic hydrothermal activity. Though small artefacts made from this raw material type were found on numerous sites spread over the whole country, no special attention to this raw material type have been paid in the past by archeologists or geoscientists. Opals (precious opal from the Prešovské vrchy Mts. included) were used for small implements or sharp arrow ends type as well as small cutting instruments. Patination of implements surfaces in the case of some of them make difficulties in distinguishion of individual silex-types.

Various silicified sediments

On the periphery of the central Slovakia Late Tertiary volcanic province Mišík (1975) described several types of silicified conglomerates, limestones, siltstones and vitric tuffs. Based on the archeological evaluation implements made from above mentioned non-traditional materials belong to the Paleolithic inventory. Late Tertiary postvolcanic hydrothermal activity is process responsible for appropriate technical properties (namely hardness) of originally soft, or even non consolited sediments.

Mentioned author (l. c.) listed silicified sediments from the sites in the area of Modrý Kameň town (southern Slovakia) as well as from Prievidza town and its surrounding.

Identification of various silicified sediments as the raw material of the Paleolithic implements enables to conclude that:

a) Paleolithic man was preferrently oriented on the very local or local raw material types. Exchange activities during the Paleolithic were sporadic.
b) Paleolithic „specialists" used also non-traditional or not-yet tested raw material types. It was caused by the lack (though in some time period) of traditional raw material types in the given area (site),
c) All above mentioned raw material types should be ranked among very local/local ones.

Basalt

In the frame of the Late Tertiary/Quaternary central Europe volcanic province two main basalt clans are known to occur:

a) calc-alkali basalts (Fig. 4), and
b) alkali basalts/basanites.

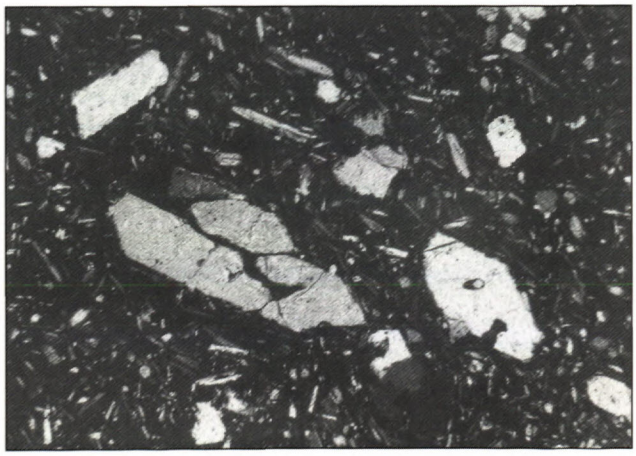

Fig. 4. Phyric (Ol, Plg) calc-alkaline basalt with fine-grained - glassy matrix . X polars, magn. 65x.

Meanwhile calc-alkali basalts (basaltic andesites) represent the most basic type of the calc-alkaline clan, alkali basalts have another magma sources. They form spatially separate occurrences and are generally younger in comparison to the previous one.The Upper mantle spi-

nel peridotite xenoliths are characteristic for them. Alkali basaltic volcanics within the central Slovakia Late Tertiary volcanic province do occur in several individual lava flows (Banská Štiavnica, Kysihýbel, Nová Baňa, Ostrá lúka and Bacúrov). Namely last three occurrences supplyed gravels to the river Hron valley beds, where from they have been picked up and elaborated.

Except of the central Slovakia huger amount of alkali basaltic volcanics are known from the southern Slovakia.

Alkali basalts do occur also on the territory of Hungary as well as in Burgenland (Austria).

Namely in the Hungarian lowland area individual basaltic occurrences form positive morphological elevations with various sized blocks on their slopes. Such natural conditions of basaltic occurrences are in favour to be gathered and elaborated.

For utilization Neolithic/Eneolithic communities selected aphyric, or even fine-phyric types of basalts of both clans. Occurrences of calc-alkali basalts in the central Slovakia Late Tertiary volcanic province are more abundant in comparison to the alkali basalts ones. In contrats to that in the set of microscopically studied artefacts, from the alkali basalts made implements are more often. Implements made from massive and also unpronouncedly fluidal basaltic types were documented. Alkali basalts are the raw material namely of bored axes and hammer-axes (Illášová 2001) found in the form of individual pieces practically in all documented western Slovakia sites. An exception represents big (approx. 3 kg of weight) not finished hammer-axe from alkali basalt found nearby Kozárovce (central Slovakia) on secondary deposition.

Based on the fact that central and namely southern Slovakia alkali basalt occurrences are in distant areas to the western Slovakia alkali basalt implements occurrences, northwestern Hungarian and Burgenland alkali basalt bodies we suppose to be supplyers of the given raw material type.

As dealts with calc-alkali basalt use of local or semilocal raw material is more favourable. Numerous primary occurrences together with the river pebbles offer great amount of appropriate types of this raw material.

Andesite

The most abundant product of the Late Tertiary volcanic activity are just andesites. They are the most widespread among volcanic rocks of the central Slovakia volcanic mountains as well as those of the eastern Slovakia.

Among numerous andesite textural types and types distinguished on the base of their mineral (and consequently chemical) composition, Neolithic/Eneolithic man selected suitable andesitic raw materials applying namely the following criteria:

a) among andesite types for practical use those of fresh appearance (plagioclase phenocrysts of high glance and general fresh appearance of the rock) were selected. Propylitized varieties, during this process loss its original properties. Except of this in the proces of hydrothermal/pneumatolytic alteration nests or even veins filled up by secondary minerals represent places of consequent splitting of ready made implements into partial pieces.
b) Types with abundant phyric phases (dark minerals, plagioclases) were excluded from following elaboration. The presence of phyric phases namely during closing proces of smoothing or following application of ready-made tool conditioned its destruction - falling out mentioned phyric phase from the tool in its narrow parts,
c) for small tools (and weapons) construction compact raw material was used (Fig. 5). Types with porous pattern have been excluded. On contrary such types (or types with numerous phyric phases) were used as the raw material for bases and smoothers construction,
d) from elaboration Neolithic man excluded also andesite types, in which substantial part of the matrix was glassy. Such matrix has generally dark color and high lustre. Raw material types with substantial presence of glass being rock forming phase, are highly fragile.
e) The spatial distribution of centres of Late Tertary volcanic activity is highly favourable. Late Tertiary volcanics of the central Slovakia region supplies by products of volcanic activity human tribes living in the central as well as in the western part of novadays Slovakia. Volcanic mountains of the eastern Slovakia were source of raw material of discussed types over the eastern part of the country (Hovorka and Šiška 2000).

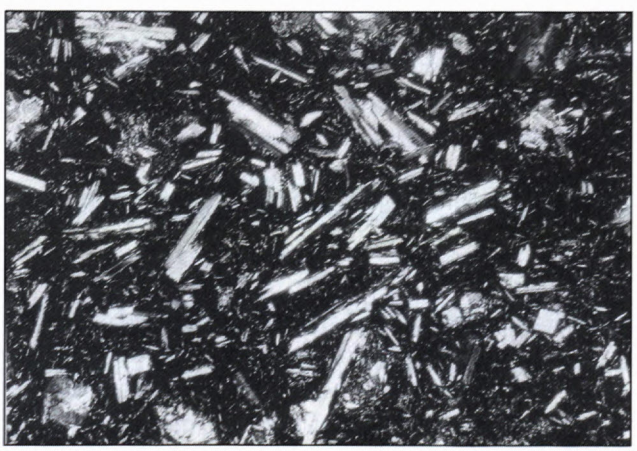

Fig. 5. Andesite with fine-grained (plagioclases laths) - glassy matrix. X polars, magn. 75x.

Contact-thermic hornfels

Among fine-grained hornfelses, which originated by contact-thermic recrystallization of various protoliths, namely the following varieties were studied by the use of polarizing microscope (Hovorka et al. 2001a):

a) amphibole-plagioclase-clinopyroxene hornfels,
b) biotite-plagioclase-clinopyroxene hornfels,
c) clinozoisite hornfels.

All mentioned raw material types represent very hard and very fine-grained types. Implements of the hammer-axe morphology of type a) and b) were found on site Svodín, meanwhile fragment of axe or hammer-axe made from the raw material ad c) was studied from site Ivanka by Nitra. It is curious that from the hornfels of the type a) 4 small non-bored axes were made. Their identical microscopic view documents their elaboration from just identical block of the raw material of the given type.

Above hornfelses we (Hovorka and Illášová 2002) locate to the province of the Late Tertiary volcanics. They originated by contact-thermic recrystallization. Needed heat was supplyed by (andesitic?) lava flows, from which surrounding individual blocks of thermic hornfelses were liberated and found the most probably on secondary deposits among river Hron blocks. So contact-thermic hornfelses represent local raw material type transported from „one day walking distance".

MESOZOIC SEDIMENTARY COMPLEXES

Mesozoic sedimentary complexes of various lithology form rock filling of various tectonic units covering the major part of the country. Their complicated geological history reflects their composition and from archeological point of view namely different physical properties as well. Though the volume of the Mesozoic rock sequences is enormous, as the raw materials in the Stone Age only selected rock types were used. They are as follows.

Radiolarite/radiolaria shale

These organogenic sedimentary rocks represent deep water accumulations of radiolaria opal-made shells. The quantitative proportion of shells vs. clay (mostly illite and smectite) matrix reflects the denomination of the given rock. Radiolaria shales (Fig. 6) contain less than 50 per cents (this limit is not accepted univocaly) of radiolaria, meanwhile radiolarites are composed of prevailing radiolaria.

Radiolaria developed since the Precambrium. Maximal extention is known from the Triassic and namely Jurassic. Their accumulations are present in the form of lenses and beds in limestones of several Mesozoic tectonic units. Among such it ought to be mentioned Meliata unit, in which radiolarites are known as interlayers in the Upper Triassic limestones up to Jurassic ones. Widely used by the Stone Age communities were radiolarites from the Kysuce and Pieniny units of the Western Carpathians Klippen belt. They have been picked up as river Váh gravels namely downstream of the Trenčín town. Radiolarites are known to occur also in other tectonic units namely of the Western Carpathians central zone. Late Cretaceous and Tertiary (Alpine) tectonic processes intensively reworked competent radiolarite beds in more

Fig. 6. Radiolaria shale of the Upper Triassic age. X polars, magn. 65x.

plastic carbonate strata, so their practical use (because of their jointing) is excluded. More information in detail on radiolarites used during the Stone Age is in paper by Mišík (1975). The only documented prehistoric place of radiolarite excavations is near Bolešov (Cheben et al. 1995) in western Slovakia.

Chert

Cherts belongs to the sedimentary rocks which originated by the local SiO_2 mobilization namely in not yet consolited limy mud. Cherts are present in the form of individual lenses or irregular bodies of various size and various colors. But they do form also synsedimentary positions (beds) in limestones of various age. Based on the stratigraphy of given cherts they have special denominations.

From cherts made small implements are rarely documented. They were used as cutting implements or sharp arrow and jevelin ends and were documented from several western Slovakia archeological sites (for informations in more datail see Hovorka and Illášová, 2002).

Flint

The most probably in the communities of archaeologists as well as geoscientists special type of chert - flint (composed mostly of chalcedony) - is the best known. It was one of the leading raw material types during Paleolithic, and its use prolongs deep to Neolithic and Eneolithic. Classical flint occurrences are bound to originally non consolited Cretaceous strata, in which it forms irregular nests and bulbs. They occur in the form of belt on the northern periphery of European continent and in Scandinavia.

Within the limit of the last continental glaciation numerous very resistent flint pebbles and blocks are member of morraines and fluvioglacial deposits, where from they were picked up by the raw material gatherers. But in many places in European countries (France, Germany, Poland), well documented and studied in detail

are prehistoric flint mines (up to 10 metres deep pits etc.).

For the majority of flint made implements characteristic is the presence of milky-white rind of approx. 1 mm in thickness. It represents the product of chalcedony hydration.

Owing to the flint hardness and ability to split into thin blades which served as one of the most important cutting tools in the whole Stone Age. Also on the territory of Slovakia individual implements made from flint were documented in the past. Interesting are from flint made small axes (deposits of museums in Poprad and Zlaté Moravce).

Metamorphosed limestone (marble)

In processes of metamorphic recrystallization fine-grained even cryptocrystalline limestones of various origin and different stratigraphy change into medium- up to coarse-grained aggregates of calcite crystals (Fig. 7). Such rocks are known under denomination crystalline limestones (term used by geoscientists) or marble (term used by non in geosciences educated people).

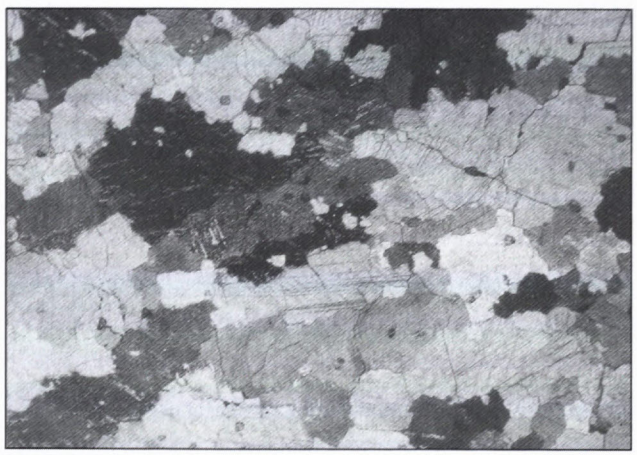

Fig. 7. Crystalline limestone. X polars, magn. 25x.

Though limestones on the territory of Slovakia belong among widespread rocks, their metamorphic equivalents are scarse. Known are namely so called Tuhár marbles of Carboniferous (?) - Triassic (?) age characterized by typical pinkish color and by the presence of darker veins and veinlets. Locally they are also of banded pattern. Another type of crystalline limestones represent those of the Meliata Unit occurring on surface in the southeastern part of the country. They belong mostly to the Middle up to Upper Triassic. Classical area of their occurrence is South Slovakia Karst (namely area of Silická Brezová village).

Ornamental implements of various shape, sometime bored, found on the country territory, are made from crystalline limestones non identical with mentioned main types. As decorative products made of discussed raw material type appear namely during Eneolithic and as they do occur on the western Slovakia sites, we suppose the Bohemian Massif (namely geological units of it eastern rim) being the raw material supplyer.

Metaquartzite

In several Western Carpathiains geological units Lower Triassic sandstones are present in the form of their metamorphosed equivalents, e. g. metaquartzites. Such are known to occur in the Slovenské rudohorie Mts. as well as in the Tribeč Mts.

Relativelly increased number of documented, from metaquartzite made implements, namely bases and crushers, appear in the Nitra river valley southward of the Tribeč Mts. Based on this we suppose that metaquartzites of this mountain range supplyed Neolithic and Eneolithic communities by this raw material type. But other raw material sources of metaquartzites, namely in the other parts of the country, are highly probable.

Metaconglomerates

Slightly metamorphosed microconglomerates (size of individual clastic constituents being of the range 1-3 mm) do occcur in the Lower Triassic as well as Permian strata. The dominant clasts are those of quartz of transparent up to violet colors. The other clastic constituents are represented by green and violet schists and seldomly also micas and feldspars. Matrix of conglomerates has composition of fine-grained sand. Metamorphosed microconglomerates of mentioned characteristic appearance are known to occur namely in the western Slovakia core mountains: the Malé Karpaty Mts. Považský Inovec Mts. and Tribeč Mts., as well.

Bases with traces of use made of microconglomerates we have documented on several western Slovakia sites, namely those in the broader vicinity of the Tribeč Mts. So heavy bases (1-5 kg) made of described raw material type have been transported on short or very short distances.

MESOZOIC ERUPTIVES

Though sedimentary sequences, belonging to different tectonic units, represent their highly prevailing part, in several Mesozoic partial basins also volcanic activity took place. Units with known volcanic activity are namely:

a) in the Middle Cretaceous of the Silezian unit of the Flych belt numerous subvolcanic and in less amount also volcanic bodies forming together alkali suite are known. They form classical area of „the teschenite-picrite province", including type localities of both, teschenite as well as picrites. In the very last years the whole volcanic province have been reclassified for lamprophyres (Dostal and Owen 1998).

b) In the Krížna nappe Middle Cretaceous occurring in various mountain ranges also alkali basalts do

occur. They form areally small occurrences of lava flows, hyaloclastites, lava breccia and the other forms (Hovorka a Sýkora 1979).

c) Characteristic are also tholeiitic basalts (Fig. 8) being part of „incomplete or tectonically dismembered ophiolites" (Hovorka 1979) of the Meliata Unit of the Triassic-Jurassic stratigraphy. Basalts of discussed provenience are known to occur in the form of small (several decametres long) bodies cropping out between Margecany and Košice.

d) From geological point of view very important are under high pressure metamorphosed tholeiitic basalts (= blueschists) of the Meliata Unit.

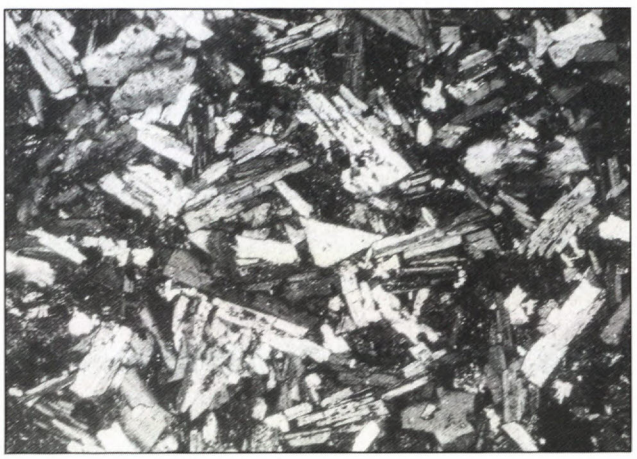

Fig. 8. Paleozoic basalt (diabas). X polars, magn. 45x.

As concerns above volcanic provinces we have identified implements made of: ad a) one fragment of axe made of the teschenite found on the site Cífer-Pác (Hovorka et al., in print), ad c) several implements documented from sites in the Poprad basin (Hovorka and Soják 1997) should be derived from the Meliata Unit thleiites, and ad d) blueschists as the raw material of Neolithic/Eneolithic implements were documented (Hovorka et al. 2002) from several sites located in the Poprad basin (l. c.) as well as in the western part of the country.

PRE-CARBONIFEROUS METAMORPHIC COMPLEXES

Pre-Carboniferous metamorphic complexes, along with variscan magmatites of the granite suite, form the backbone of the individual mountain ranges. Among metamorphites those of sedimentary, as well as of the magmatic origin are known to occur. Their surface areal distribution is in individual mountain ranges very different. Also intensity of (mostly variscan) metamorphic recrystallization differ among the main tectonic megaunits. Taking into account character of the protolith, intensity of its regional metamorphic recrystallization, as well as its recrystallization in contact-thermic aureoles of the variscan magmatites, very colorfull set of metamorphic rocks is known from the Western Carpathians mountain ranges. In the following main rock categories, used as the raw material, are characterized.

Leptynite

In the very last years within pre-Carboniferous metamorphic complexes in several mountain ranges leptynite-amphibolite complex was described (Hovorka et al. 1994). The main textural pattern of the above mentioned complex is manyfold alternation of light - leptynitic, and dark - amphibolitic layers of mm-cm thickness.

Light - leptynite - portion of the above complex was identified as the raw material of several, mostly big, hammer-axes and axes. Their appropriate technical properties are based on the low content of micas and chlorites resp., in the given rock type.

As in the other raw material types with developed foliation, also in the case of leptynite made artefacts their long sides are conform to planes of rock schistosity.

Amphibolite

This rock lithology belongs among the most common ones in the pre-Carboniferous complexes of the central Western Carpathians as well as in the veporic units of the Slovenské rudohorie Mts. From genetical point of view they are : a) members of the leptynite-amphibolite complex (see above), or b) they form individual bodies located within gneisses or mica schists of the mentioned geological units.

Among amphibolites several petrographic varieties should be defined. For amphibolite varieties used as the raw material for implements construction, mostly fine-grained amphibolites s. s. or melaamphibolites, both of weak and well pronounced schistosity, were used by the Neolithic/Eneolithic tools and weapons producers. Only fresh types (no types with signs of diapthoritic recrystallization) were used. Garnet amphibolites were from sets of raw material blocks excluded.

From amphibolites/melaamphibolites namely axes, hammer-axes and chisels were made. With regard to the distance of this raw material sources, amphibolites should be classified as very local or non pronounced distant raw material. In the majority of implements made from this raw material type, river pebbles ought to be considered as the direct source of the raw material used.

Increasing amount of plagioclases in amphibolites cause their gradual alternation to amphibole gneisses, which in several cases have been also detected as the raw marerial of the Neolithic hammer-axes and axes.

Greenschist

Among Western Carpathians metamorphites greenschists belong to less occurring raw material types. Majo-

rity of them is concentrated in the Malé Karpaty Mts. crystalline core as well as in the Paleozoic of the Spišsko-gemerské rudohorie Mts. (= Gemeric Unit).

Based on appropriate technical properties greenschists in the whole Neolithic/Eneolithic represented one of the most common raw material type of polished industry (Figs. 9, 10).

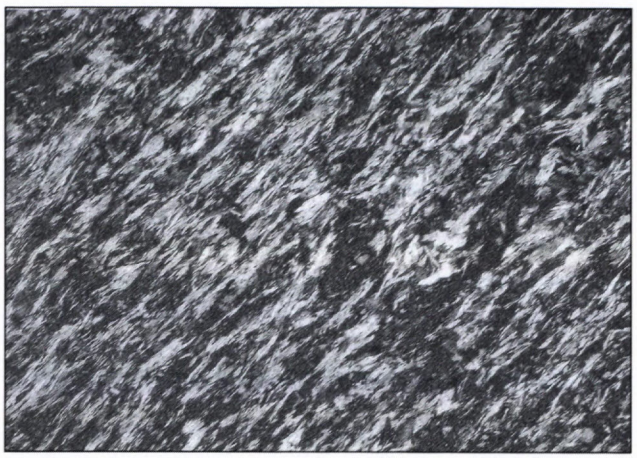

Fig. 9. Fine-grained actinolitic greenschist of planparallel pattern. X polars, magn. 45x

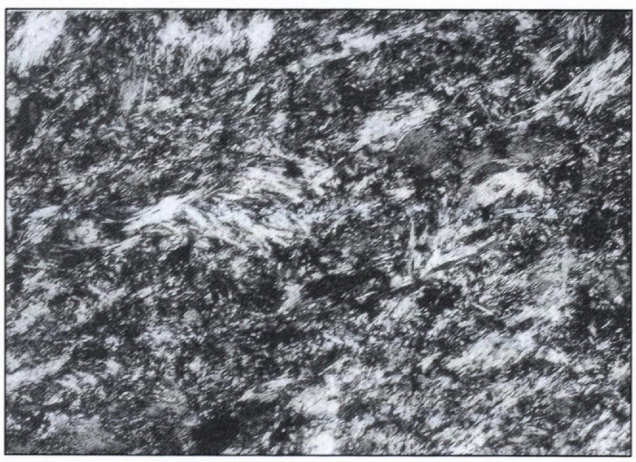

Fig. 10. Greenschis with local fan-like orientation of actinolite needles. X polars, magn. 75x.

To the category of greenschist belong rocks of various protoliths (pre-metamorphic material) which originated under limited pT conditions. Among the greenschists those composed of columnar up to hair-like amphiboles were mostly used. Felty pattern of amphibole needles make given raw material hard enough on one side, and elastic on the other one.

So various greenschist (composed of dominant amphibole needles, but not chlorites) was favourable raw material type during the Neolithic and Eneolithic in the whole central Europe.

Various types of this raw material were used for elaboration of different implements both of practical, as well as in less amount also ornamental destination. Though implements made from the greenschists are documented practically from all archaeological sites studied, their maximal concentration is known to occur on the western Slovakia sites.

Among several petrographic varieties of the greenschists described in detail by Hovorka and Illášová (2002) several of them are peculiar, or very rarely occurring types. To this category belog greenschist with green (Al-rich) spinel present in the amount of substantial category (Hovorka et al. 1997). Greenschists of this type have not been described in geological literature from the central Europe yet. So source geological bodies of this raw material type are unknown. Implements (mostly bored axes) made from this raw material type are known to occur in practically all western Slovakia archeological localities. Based on very fine-grained character of this raw material type, for its identification thin sections studies are needed.

Another characteristic variety of greenschis is that one with evidences of postmetamorphic biotitization (flogopitization). Mentioned process yielded in irregular fine-flaky nests of dark mica in the actinolite aggregates or even in origination of tiny veinlets filled up by pleochroic dark fine-flaky aggregates of mica. Veinlets are often of oblong up to perpendicular orientation to the general metamorphic foliation of the given rocks. As Early Paleozoic metamorphic complexes of the Malé Karpaty Mts. are characteristic for mentioned process, which represents the influence of late magmatic pneumatolytic-hydrothermal activity of the variscan Modra tonalite massif, we rank discussed type of the greenschist among very local/local or on short distance transported raw material type.

Antigorite serpentinite

Based on petrological aspects in the last decades two main categories of serpentinites are distinguished:

a) lizardite-chrysotile serpentinites which originate through hydration process of original peridotites. Process took part under temperature lower as 350°C.
b) The other serpentinite type is composed of prevailing antigorite with talc, tremolite, Mg-chlorite ao. present in lower amounts. Antigorite serpentinites originate under higher temperatures.
c) Both types of serpentinites are known to occur on the country territory.

Serpentinite bodies of the a) type represents members of the Triassic-Jurassic Meliata Unit, of the oceanic provenience, while b) type serpentinites are known to occur within the Tatric and Veporic metamorphic complexes.

Based on the fact that lizardite-chrysotile serpentinites have not been identified (which is the consequence of the presence of chrysotile veinlets in this rock type. They represent „weakened" zones or zones of splitting of ready made implements during their practical use), only implements made from the antigorite serpentinites were identified in thin sections.

Antigorite serpentinites are known to occur in mountainous areas of central and southeastern Slovakia. Antigorite serpentinite made implements (namely hammer-axes) are documented namely from the western Slovakia sites. Based on known occurrences of antigorite serpentinite bodies in the geological units on the eastern rim of the Bohemian Massif, and namely in the Lower Silesia (SW Poland) we suppose that the majority of implements made from the antigorite serpentinites have their sources in above mentioned units.

Metaquartzite, quartzitic gneiss

Original quartz sands or subgraywackes under high temperature greenschists or amphibolite facies pT conditions have been recrystallized to metaquartzites and quartzitic gneisses. Among limits of their practical use low till null amount of mica is basic one.

Bases made from quartzitic gneisses up to quartzites have been reported by Březinová et al. (2002) from the Neolithic/Eneolithic site Golianovo.

IMPORTED AND PECULIAR RAW MATERIAL TYPES

Among set of raw material types used during the Neolithic and Eneolithic on several archeological sites individual implements made from peculiar (imported) raw material types have been documented in the past (Hovorka and Cheben 1997, Hovorka and Illášová 2000). Such raw material types are represented mostly by one implement (or its fragment) only. Among such raw materials we rank:

soapstone/talkschist - one by morphology „ornamental" small axe, the most probably of symbolic or ornamental destination is deposited in Senica town museum,

graphitic schist - has been detected as the raw material of bracelet of the ring form (Podtatranské Museum in Poprad: Hovorka and Illášová 2002),

eclogite - two eclogite implements of genetically different raw material types, of the hammer-axes typology have been documented in the last years (Hovorka and Illášová 1996, Hovorka et al. 2001). In the both (Figs. 11 and 12) cases distant sources (the most probably from the Bohemian massif) are considered,

transparent quartz crystal - small implements of ornamental purpose have been reported (Illášová and Hovorka 2002),

melaphyre (paleobasalt) of the Permian - Lower Triassic in age due to its pronouncedly phyric pattern represents only seldomly for implements construction used raw material type (Hovorka a Illášová, 2002),

quartz porphyry - as the raw material of individual implements this rock type was used already in the Paleolithic (Mišík 1975),

limestone as the raw material for various, mostly ornamental or symbolic small implements was described from several Neolithic/Eneolithic localities (Hovorka a Illášová 2002),

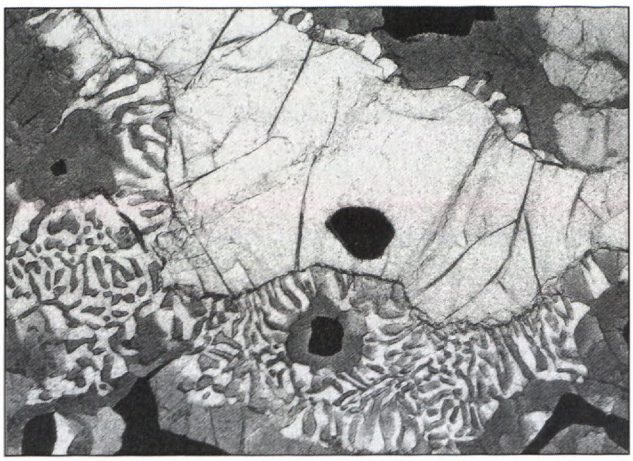

Fig. 11. Symplectitic eclogite composed of Gar, Cpx, Hbl, Ab, Rtl. X polars, magn. 75x.

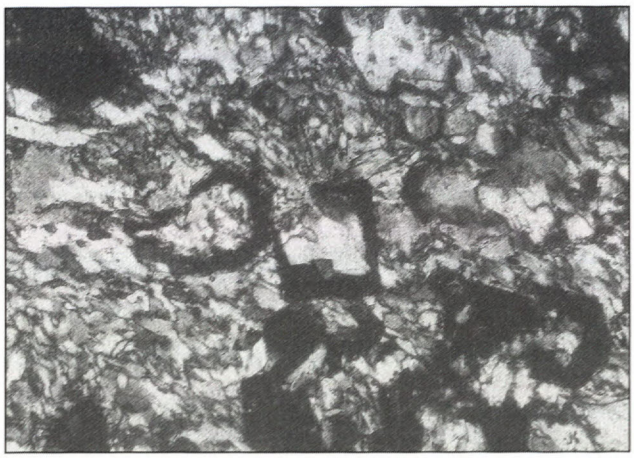

Fig. 12. Garnet-omphacite eclogite. Atoll-like garnets are of almandine composition. X polars, magn. 168x.

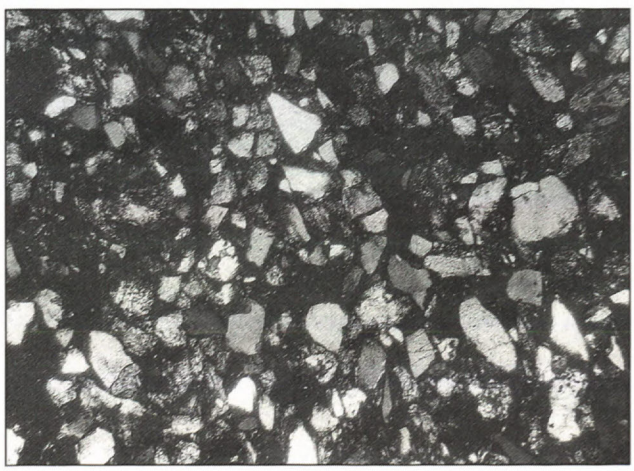

Fig. 13. Metagraywacke. X polars, magn. 45x.

metagreywacke made implements have been documented from Cífer-Pác site only. Local source (the Malé Karpaty Mts.) of this raw material type (Fig. 13) is supposed,

limy mudstone of Paleogene age represents the very local raw material type e. g. on site Šarišské Michaľany (Banská et al. 1998),

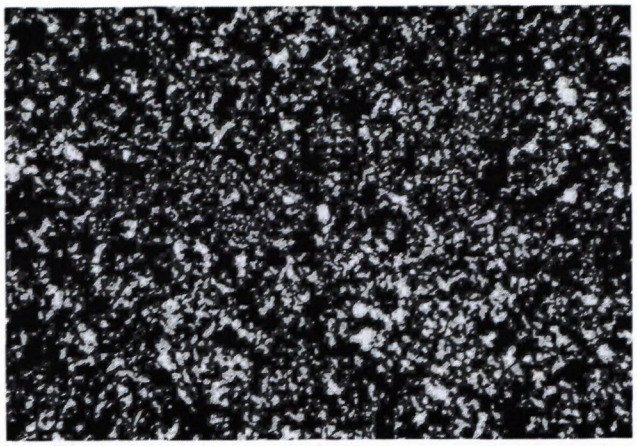

Fig. 14. Siltstone. X polars, magn. 85x.

siltstone (Fig. 14) is also one of seldomly used raw material type. Its Paleogene age is supposed. Several small implements made from this raw material type have been documented on the eastern Slovakia sites,

jadeitite was identified (by the use of electron microprobe) just in the case of one non-bored small axe found nearby the Senica town (Hovorka et al. 1998).

DISCUSSION AND CONCLUSION

Adequate quantity and quality of raw materials available substantially influenced the whole development of the mankind. In the whole Stone Age inorganic raw materials represent determinative *agens movens* for the mankind development.

Territory of the nowadays Slovakia since the Middle of the Early Paleolithic was inhabited. Evidences for it represents namely crane of the *Homo neanderthalensis* (the Gánovce man: 105000 b. p.), the Moravany Venus (made from the mamooth tusk: around 40000 years b. p), part of the Paleolithic human crane found in the river Váh depositions nearby Šala town ao.

Similarly as in the other part of the Old Continent determinative raw material types during the Paleolithic also in the territory of nowadays Slovakia were various silexes (submicroscopic quartz and its hydrous forms) together with radiolarites and obsidian. All of them have natural occurrences on the country territory. In the case of obsidian from the eastern part of Slovakia (Zemplín Hills) there exist evidences on its export to the northwest and west. For the central and western Slovakia Paleolithic as well as Neolithic sites characteristic are implements, used for cutting, made from hydroquartzite (limnoquartzite) which occurs on several places in the Žiarska kotlina basin (central Slovakia). But from several Paleolithic sites instruments made from nontraditional, we should say that for the Paleolithic progressive, raw material types were documented. Among such unexpected raw material types we rank implements made from porphyroids, from various silicified sediments of different lithology and the others. They all document that local, though nontraditional raw materials were mostly used by the Paleolithic communities.

The spectrum of raw materials used in the Neolithic/Eneolithic is much wider. All three main genetic rock clans were used, e. g. igneous, sedimentary as well as metamorphic rocks. For all of raw material types used there should be defined limits of their practical use: raw materials for implements production were mostly very fine-grained types, without substantial amount of sheet silicates, often with felty pattern. They were aphyric, or even fine-phyric types without any signs of cracks or material inhomogeneities present. In the case of effusive rocks evidently fresh types were used. Majority of raw materials documented have their sources on the country territory, or in geological units of neighbouring countries. Among them namely eastern rim of the Bohemian Massif seems to be supplyer of substantial amount of raw materials used namely in western Slovakia.

During the Neolithic there exists evident progress in technology of raw materials elaboration. For boring both nowadays known techniques were aplied: the whole hole boring and core boring. For both types of boring we have (Hovorka and Illášová, 2002t) well documented examples. But till now time succession priority of type of boring applied is not solved yet.

Characteristic inorganic raw material for so called *ceramic Neolithic* are various genetic types of clays or loesses used for ceramic pastes production. Though raw material for ceramic production offer numerous information on the raw material used, its provenience as well as ready made vessels have high informative value on the temperature of ceramic burning, use or not use of potter´s wheel and the other informations. During the whole Neolithic/Eneolithic various natural colors were used. From the material point of view they mostly represent metal oxids and hydroxids being the main constituent of ore gossans. Another type of natural colors are those of the „colored clays" character. Colors have been used for human bodies coloring and for the decoration of the produced ceramic. During the Eneolithic also for walls painting or for expression of artistic feelings.

During the very end of Eneolithic also seldom ornamental products made of gold and copper were documented from the eastern Slovakia. They represent precursors of the coming Bronze Age.

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