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Siliceous artefacts from Neolithic and Copper Age settlements within Romania: An integrated study

Artefacte silicioase din aşezări neolitice şi ale epocii cuprului din România: un studiu integrat

(Thesis Abstract)

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Cluj-Napoca
2014

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Key words: geoarchaeology; Neolithic; Copper Age; microcrystalline quartz

CHAPTER 1
INTRODUCTION

Surveys of lithic raw material sources are of major importance in archaeology, particularly prehistoric research. Archaeologists must reconstruct as much as possible regarding economic, social and spiritual life. Knowing the sources of raw materials in a certain area and observing their usage at various different sites allows us to interpret the choices made by prehistoric people. It also makes it possible for researchers to determine more accurately the strategies of exploitation and resource management employed by communities which were located at different distances from the sources. These would have been important aspects of regular life and subsistence within a region. Knowing the sources, it is possible to trace settlement and migration patterns, and discover routes followed in the transportation and trading of both raw and worked materials. It is also possible to draw conclusions regarding the means of provisioning lithic material and through this the mobility of populations and notions of territory in prehistory.

Scope

The geographical region of this study was primarily the Transylvanian Basin and surrounding mountains, i.e. Apuseni Mts., Eastern Carpathians and Southern Carpathians - essentially, the areas of modern day Romania. Additional research has been conducted on high quality chert from sources in adjacent regions: Banat, Danube area, Dobrogea and Moldavian plateau. The main focus of this study is the Neolithic and Copper Age settlements, in particular siliceous raw materials and artefacts found therein. Mention of Late Palaeolithic and Early Bronze Age sites is also made, for the purpose of chronological comparison.

Objectives

The first objectives of this study were: a) the creation of a system of characterising siliceous materials (chert, jasper, opal) which were used in prehistory for producing knapped tools and b) the creation of a database of knappable materials within the study area. It was necessary to develop methodological means to characterise and distinguish between varieties of knappable materials of different geographical locations and different geological origins. A large part of this study documents the distribution and characteristics of knappable resources found in Romania. The survey focuses on those cherts that have, or may have been used by early inhabitants of the region as raw materials for the manufacture of tools. The ultimate objectives were to determine patterns of trade during the Neolithic and Copper Age within the territory of modern day Romania - the Transylvanian Basin and the areas just outside of the Carpathian Mountains - based on analysis of knapped lithic artefacts and comparison with raw materials by the same methods used to analyse the raw materials. In order to approach these questions, this study has been arranged into three major directions, as follow.

a) The application of physical, mineralogical and chemical characterisation methods to the knappable geological samples and knapped archaeological artefacts in order to establish the best means of their application.

b) Research into geological sources and characterisation of the materials which they contain in order to know the regionally available lithic resources. The distinguishing macroscopic and microscopic characteristics of cherts were described and illustrated in detail. These provide the basic information needed to identify such material found in the field, or at archaeological sites, and to assign them to a particular stratigraphic, geologic provenance and to a specific location (occurrence).

c) The study of whole archaeological assemblages by classic examination (by naked eye and a hand loupe) in order to obtain qualitative and quantitative results regarding the usage and origins of the raw knappable materials of which the industry was comprised. Based on the characterisation of raw material sources, it is often possible to pinpoint the sources of knappable raw materials collected and used by the early people of this region.

These three routes of investigation form the structure of results of this study and lead to the fourth part in which the results obtained are discussed to identify their archaeometric and archaeological implications.

The thesis paper is 510 pages long, has 409 figures, 81 tables and 1259 reference titles. Siliceous artefacts came from 83 archaeological sites (of which 72 were described and a further 11 briefly analysed). Of all the site lithic assemblages, five were studied in detail (Tărtăria - Gura Luncii, Răcătău - Piatra Tomii, Limba, and Alba Iulia - Lumea Nouă in Alba County, and Târgu Frumos - Baza Pătule in Iași County). The number of siliceous artifacts in each site assemblages varied. Many of the sites had 1000s of artefacts but they were studied only over a period of 1 or 2 days each. As well, many of the artefact lithic assemblages were comprised of very few pieces (from 1 to 20 in some cases). The artefacts were compared with material coming from 217 geological sources (occurrences) within Romania (313 if foreign soruces and sources with more than one type of material are included).

From the more than 16,000 artefacts macroscopically studied, 219 were also investigated by polarized light optical microscopy (thin sections), 10 were analized by prompt gamma activation analysis (PGAA) and 2 by Fourier transform infrared spectroscopy (FTIR). Electron paramagnetic resonance spectroscopy (EPR) was also performed on three obsidian artefacts by the results were inconclusive.

From the geological samples, numersous samples from each source were macroscopically analysed. Microscopically (in thin section), 238 samples were studied (some of which came from the same sources). Additionally, 106 were analysed by PGAA, 28 by XRPD and 20 by FTIR.

Overview

In addition to the scope and objectives of this study, the first chapter of this paper also gives an introduction to the concepts of chert characterisation, trade (particularly within the field of prehistory), provenance and the sourcing of artefacts. A brief overview of similar sourcing research conducted in and near Romania in the past is introduced in this chapter (and elaborated on in later chapters). The chapter finishes by defining some terms which are used frequently throughout the paper but for which there are no standard definitions for terms specific to characterising siliceous artefacts and materials. These terms are defined in the text so that readers are not confused by their meaning throughout the rest of the paper. Some were necessary due to varying definitions among researchers and a few were necessary because they were translated from Romanian words which do not have exact equivalents in English.

CHAPTER 2
ARCHAEOLOGICAL BACKGROUND

This chapter provides a background into the archaeological side of this study, in order to put the results, discussion and conclusions of the later chapters into proper perspective. The background on the cultures looked at in this study is divided chronologically and geographically. A chronology of the Neolithic and Copper Age of Romania is provided as well as a general chronology of the Balkan region. The first section of this chapter deals with Neolithic cultures while the second deals with cultures of the Copper Age. This is followed by an introduction to lithic technology in general. A large part of the chapter presents the archaeological sites from which the artefacts came. The chapter finishes with an overview of the methodology used in this study.

This chapter starts out by giving an introduction to the Neolithic in the study area. This includes a description of the origins of the First Temperate Neolithic and the transition from Mesolithic to Neolithic in the Lower Danube region. Attention is then given to the Early Neolithic cultures of the study area, specifically the Starčevo and Criș cultures. During the Middle and Late Neolithic there were more cultures within the study area. Here they are compared to each other and similarities are indicated. Finally, the Copper Age cultures of the study area are described, again taking note of their similarities.

The Starčevo, Körös and Criş cultures were three contemporary culture groups (Starčevo representing the Early Neolithic of modern Serbia; Körös and Criş are very similar culture groups occupying SE Hungary and S, SW and E Romania, respectively). These cultures are among the earliest food producing communities in a temperate climatic zone (Greenfield, 1993). Although 'Starčevo-Criş' represents two contemporary but distinct culture groups, for the purpose of this study, they have been combined and presented together. The reasons for combining these two culture groups are the strong similarities in the material culture, and the apparent overlap in the distribution of Starčevo and Criş sites.

Although numerous cultures occupied the territory of present day Romania during the Middle and Late Neolithic, this presentation focuses in more detail on cultures present at the sites from which the lithic artefacts of this study came. The main cultural groups of this area during the Middle Neolithic were the Vinča, Linear Pottery and Dudești cultures and during the Late Neolithic were the Vinča, Vădastra, Boian and early Precucuteni cultures.

The term "Copper Age" refers to those cultures whose economy and material culture were supposedly different from both the Neolithic and the Bronze Age cultures, and thus require a "stage" of their own (Chapman, 1981). The following Copper Age cultures were described: Vinča, Petrești, Foeni culture group, Coțofeni, Banat culture group, Cucuteni-Tripolye, Gumelnița, Stoicani, and Hamangia.

After describing the cultures of this study, an introduction to lithic technology is presented. This includes an overview of terminology and stone tool production methods, prehistoric raw material extraction. The lithic technology section ends with a presentation on the various historical uses of chert (and other similar materials).

Sites investigated in this study

This study looked at 83 archaeological sites in Romania. (See Figure 1 and Table 1.) These can be divided into three groups. The largest group is sites along or near to the Mureș Valley from Banat to the Eastern Carpathians. These sites range in time from early Neolithic to the end of the Copper Age. On the opposite side of the Carpathians are a group of sites occupying the area from the Eastern Carpathians to the Prut River. These sites are all associated with the Cucuteni-Tripolye culture (with the exception of the Bistrița Valley sites which are late Palaeolithic). The third group are sites along the Lower Danube and its tributaries.

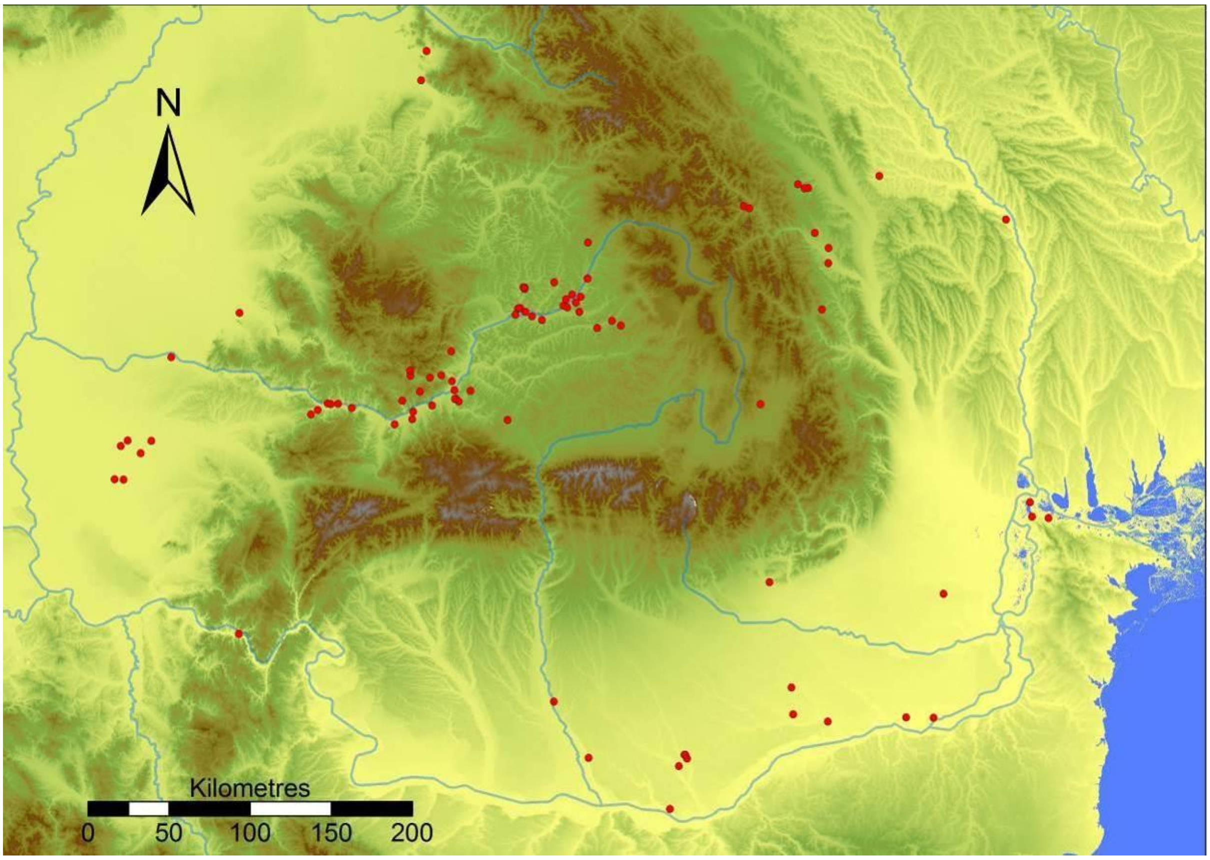

Figure 1. Map of sites where artefacts in this study came from. Names of sites are given in detailed maps in the thesis.

CHAPTER 3
GEOLOGICAL SETTINGS

The first part of this chapter considers siliceous material successively as, 1) a mineral material, in order to discern the intrinsic properties that will permit a differentiation between the multiple varieties dispersed spatially; then 2) as a raw material worked by prehistoric people and an object of a scientific study. It also defines the main lithic resource types that were encountered. The second part provides a summary of previous geological research that deals with or mentions these materials. It also covers the general origins of the host formations, providing a brief history of the geological formation of the region. This information is accompanied by maps.

Terminology

Before discussing the categories of siliceous raw materials, it is necessary to define the terms used for their description. Both geologists and archaeologists use a large variety of descriptive terms applied to rocks made of fine grained silica (SiO_2). Various researchers have provided definitions of chert and related materials (Klein et al., 1993; Knauth, 1994; Hallsworth & Knox, 1999; Rapp, 2009). All of these materials are siliceous sedimentary rocks whose most variable macroscopic characteristics are colour, grain and opacity. They occur as hard rock which fractures conchoidally and are composed of more than 90 wt.% silica. Most prehistorians use the term ‘chert’ to refer to all forms of microcrystalline quartz. Within the field of geology however, several more specialised terms are used. The term ‘chert’ may refer to all microcrystalline quartz or it may refer specifically to a rock that resulted from the replacement in limestone, marl or chalk, of calcium carbonate with quartz. When this process occurred in chalk or marl the resulting material is usually referred to as ‘flint’, i.e. a sub-variety of chert according to some researchers (e.g. Cayeux, 1929; Spears, 1979; Bromley & Ekdale, 1984; Brandl, 2010; Přichystal, 2010). Throughout this paper, the term ‘microcrystalline quartz’ (abbreviated MCQ) will be used as a general term to refer to all sedimentary microcrystalline silicastones and thus will include materials elsewhere called chert, flint, jasper, agate, and chalcedony. Although materials such as chert, flint, jasper and chalcedony have distinct natures, in this study they will often be considered together.

"Source," as used here, means the area or location from which the material was originally obtained as raw material and includes primary sources (bedrock deposits) and secondary sources (glacial, stream, beach, and slope deposits). A proper understanding of the characteristics of MCQ must be based on an understanding of its physical characteristics, including its origin, properties, and modes of occurrence.

Geological background on materials

This chapter does not focus much on all the specific raw materials or their sources but rather on general categories of siliceous materials encountered during this study. The macroscopic, microscopic and mineralogical characteristics of MCQ are presented along with their degrees of variation. The text goes on to present the various models of petrogenesis of MCQ and similar materials, i.e. nodular chert (from limestone), jaspers (hydrothermal related to volcanics, and biogenic radiolarites), and agate (or chalcedony). These are followed by an outline of the stages of formation of the main modes of occurrence of MCQ. Additional brief mention is made of the other common silica-rich materials used for knapped tools, such as obsidian, quartzitic sandstone, quartzite (metamorphic), opal, as well as some volcanics (rhyolite and andesite).

Previous work on sources of raw materials and artefact provenance

In Romania a few researchers have recently worked on the problem of describing sources of lithic materials. The first major work was by E. Comşa in the 1970s and 1980s. In the late 1990s, A. Păunescu discussed potential sources of raw materials that may have been used by Palaeolithic communities throughout Romania. In the past few years Dimitru Boghian summarised the work on 'Moldavian flint' and other knappable materials in Romania (Moldavian Plateau), Moldova and Ukraine. M. Gurova has been researching varieties of 'Balkan flint', particularly from outcrops in Bulgaria. Numerous studies have been made on obsidian sources in the Western Carpathians (Petrougne, 1960; 1972; Thorpe & Nandris, 1977; Thorpe et al., 1984; Biró, 2006).

Provenancing studies have only been carried out relatively recently in Romania. In the 1980s, Eugen Stoicovici sourced the lithic artefacts from several sites in Transylvania based on analyses of the artefacts (Stoicovici, 1985; 1986). Since the mid-1990s, a few archaeologists have made attempts to source entire lithic assemblages from Cucuteni-Tripolye sites in NE Romania, based on visual descriptions provided by other researchers (Boghian & Tudose-Ţurcanu, 1994; Boghian, 1995; 1996; Ursulescu & Boghian, 1998; Petrescu-Dîmboviţa et al., 1999).

Overview of past research methods

The last section of Chapter 2 presents quantitative and qualitative methods of characterisation applied to lithic samples in archaeological studies. Those involving qualitative criteria are most common because they require very little equipment. This section therefore starts with approaches which are conventionally used to discriminate the types of raw materials and find their geographical origin. They form the basis of the work done in this study and are a necessary step before dealing with the issues of characterisation of lithic materials and determining their origins. There are four main categories of methods of analysing a sample of chert for provenance studies: macroscopic, microscopic (or petrographic), mineralogical and geochemical. Each is discussed in a separate sub-section. Being the most readily available, as well as cheapest method, macroscopic observation is the most commonly used method of characterising chert. The characterisation of cherts by petrographic means is justified in that the genesis of chert is a processthat preserves characteristics of the sedimentary medium in which it was formed. Geochemistry is difficult to apply to chert because of its complex geochemical signature. The discrimination of cherts by their mineralogical composition appears on the other hand less applicable given their very limited variation in characteristics. Previous studied have shown limits of this approach (e.g. Masson, 1981*;* 1982*;* Girty et al., 1996*;* Huang et al., 2010*;* Brilli et al., 2011) or that at least in some areas this method can be used to discriminate among chert sources *(*e.g. Lazenby, 1980*;* Gauthier et al., 2012*;* Graetsch & Grünberg, 2012). Another group of methods of analysing and characterising material is chemical analysis (also known as geochemical analysis). These analytical methods determine the percentages or ratios of different elements or compounds in the materials being analysed.

CHAPTER 4
METHODS, SAMPLES, RESULTS, & DISCUSSIONS

This chapter contains the main presentation of information gathered during this study.

Characterisation methods of this study

This section presents the methods which have been adopted for the description of material types (and proposed for standardisation of such descriptions) which are found within the study area. The methods section reviews the current problems faced by researchers characterising lithic materials and goes on to outline the requirements for a good system of macroscopic and microscopic descriptions. The paper proposes standardised descriptions or characteristics requiring descriptions for macro- and microscopic studies. These are followed by additional attributes to describe artefacts and geological sources. The method section finishes with descriptions of how (and why) information was recorded in a database and the organisation of the accompanying physical collection of samples - the lithotheque.

It is necessary to give objective descriptions of the raw materials and artefacts. To do this, researchers need a standardised method of analysing artefacts and raw materials, as well as a standardised set of terminology for describing those same artefacts and materials. For this study, it was necessary to create such an objective system of characterising MCQ, based on common mineralogical characterisation. Where possible, terminology common to both archaeology and geology has been utilised. As well, use has been made of terminology and characteristics described by previous researchers (e.g. Luedtke, 1992; Morrow, 1994; Andrefsky, 2005; Rapp & Hill, 2006; Rapp, 2009).

Analyses of geological samples

A total of at least 217 geological sources within Romania were investigated and characterised. Some of these sources had more than one type of material available within a very short distance. The source locations with more than one material in close distance are considered multiple sources (one for each material present) and the samples from outside of Romania (e.g. Hungary, Slovakia, and Bulgaria) are all counted, then 313 sources were studied. The sources of materials are listed in Table 2. All samples were analysed macroscopically. In addition many (238 samples) were examined microscopically. Some were also analysed by PGAA (106 sample), XRPD (28 samples) and FTIR (20 samples). Here it should be noted that these are samples, not sources. In many cases, as the table shows, more than one sample was analysed from individual sources but some sources were not analysed other than macroscopically. There were various reasons for this (see the section on geochemical and mineralogical studies for explanations) but most often multiple samples from individual sources were analysed in order to more clearly characterise variation.

In the third section of this chapter, macroscopic and microscopic descriptions are made of the raw materials and their sources which were studied during this project. The materials are grouped first by region and for regions with a large number of surveyed sources, they were then organised by material type. The descriptions start with the three main, high quality materials used at the archaeological sites from which the artefacts came - 'Balkan flint', 'Moldavian flint', and 'West Carpathian obsidian'. The rest of the section lists and characterises raw materials and sources from the following areas: Banat, Middle Mureș (in particular Hunedoara and Alba Counties), the Northern Apuseni and Someș area, Maramureș region (in particular the Oaș and Baia Mare Depressions), Eastern Carpathians, the eastern part of the Southern Carpathians, and the Lower Danube area. Sample locations are indicated in Figure 2.

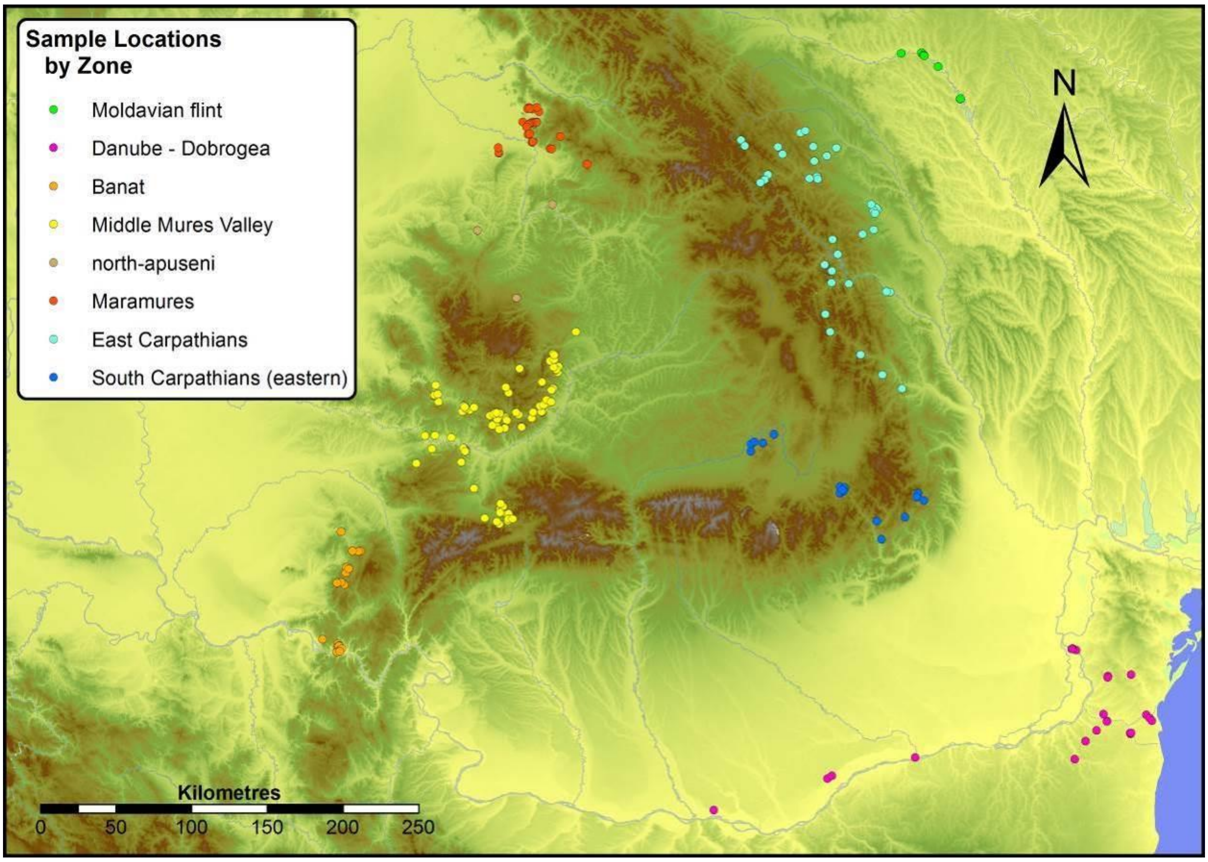

Figure 2. Map of locations where samples mentioned in this study were collected. (Relief map produced from data provided by the SRTM (2000)).

The majority of geological samples used in this study were collected by the author during the field work stage and many were also borrowed from the collection of the Mineralogy Museum of Babeș-Bolyai University. Sources of lithic materials (in particular from sources not available in the museum collection) were sought by researching geological references (articles, reports, maps). Locations with a high potential to contain sources of useful lithic materials were visited and samples were collected. Based on similar macroscopic and microscopic (petrographic) characteristics, geological origin, contiguous spatial distribution, the raw materials and their sources were grouped into source areas (e.g. Trascău chert, West Metaliferi jasper, Eastern Carpathian chert, etc.). In addition to the geographically spread out sources, there are also numerous small, localised sources of materials.

Lithotheque

The raw material samples collected for use in this study were retained for future use. This *lithotheque* and the associated database are useful to archaeologists and archaeometrists for making analogies with artefacts and identifying raw material sources, thus helping to determine trade routes and trade directions (Crandell, 2009; 2012). Although the main objective of this stage (cataloguing and characterising raw materials) was to produce a comparative set of data to which the artefacts from this study could be compared, and thereby aid in identifying their provenance another objective was to create a collection that would be useful to future researchers as well. By creating this collection, other researchers can easily compare the artefacts from other archaeological sites to the physical rock samples from this collection, as well as to written descriptions and photographs.

Analyses of artefact assemblages

Analyses of artefacts and of the different MCQ varieties found in the areas around the prehistoric sites from this study and suspected of being the sources of artefact raw materials, were used to help determine the actual or likely sources of these artefacts.

It should be noted that some site assemblages in this study were analysed in more detail than others. Similarly, the amount of information available on each of the sites and the excavation from which the artefacts came varies widely. In particular, the oldest sites seem to have the least amount of detail on the sites and stratigraphy from which the artefacts came. Sometimes because of the excavation methods of the time or the objects of the excavator, certain types of information were not considered necessary to record, or certain categories of artefacts were not deemed necessary to thoroughly collect. In other cases, information has simply been lost over time. The size of the excavations also varies from simple fieldwalks to test pitting, to excavations of one or more year, sometimes involving specialists from a variety of fields. The extent of the field research (whether surveys or excavations) plays a part in how much is known about the site, in addition to affecting the size of the lithic assemblage.

There is also a question, particularly for older sites, regarding how much of the actual lithic assemblages were recovered. It seems that excavators unfamiliar with lithic materials have a tendency to discard chipped stone artefacts (particularly flakes and debitage) as being a natural component of the soil. Thus, many lithic artefacts blended in with the soil, go unnoticed and hence are discarded. Here it will be presumed that the ratio of artefacts kept and those discarded was generally the same for all types of knapped materials.

The artefacts from this study came from 72 sites (Table 1), among which the most intensively analysed, in terms of detail and large assemblages, are: Limba, Tărtăria-Gura Luncii, Alba Iulia-Lumea Nouă, and Răcătău-Piatra Tomii in Alba County, and Târgu Frumos-Baza Pătule in Iași County. Like the raw material sources, the archaeological sites were separated into the following areas: Banat, Middle Mureș Valley (Hunedoara and Alba counties), Upper Mureș Valley (Mureș County), Maramureș area (Satu Mare and Maramureș counties), Moldavia (Carpathian to Prut area), and the Danube and Dobrogea area.

Although macroscopic and microscopic analyses (as with most analyses) cannot always predict where a material came from, they can narrow down the possibilities. In the absence of known cultural influences, practical or functional influences were used to decide on the most likely sources of artefacts. In other words, if there was no reason to think otherwise, the nearest possible source was assigned.

Geochemical studies

A common method of identifying geological sources is based on determination of the major, minor and trace element content in both the artefacts and the raw material. The amount of the constituent elements in a lithic artefact can be compared to known proportions in geological samples taken from suspected quarrying sites (or outcrops in general). The difficulty in analysing chert or quartzite is the extremely low quantities of diagnostic minor and trace elements. Chert and especially quartzite are almost pure silica (SiO_2). Sourcing studies are further complicated by the fact that these materials are generally heterogeneous, meaning that different parts of an artefact or geological sample will contain different proportions of different elements. These factors make sourcing studies very difficult and time consuming.

To analyse the geochemical data several statistical methods were be used. Factor analysis, discriminant analysis, and cluster analysis. Each was used (separately or in combination with other analyses) for a different way of describing, displaying, and interpreting the data.

Prompt gamma activation analysis

In this study, several similar appearing groups of materials (lithic artefacts and geological samples) were compared using PGAA to determine the effectiveness of this method. Jaspers from the western part of the Metaliferi Mts. were compared to jaspers from the eastern part of the Metaliferi Mts. and Trascău Mts because they are of different ages. Flints (Moldavian and Balkan) were compared to each other and to chert from other limestone formations throughout Romania. Lastly, jasper, sinter and opal were compared because they often look similar and may form under similar conditions.

PGAA shows limitations in measuring very low levels of trace elements in MCQ varieties (Crandell, 2011). Additionally the number of trace elements which can be measured by PGAA is restricted. Due to these, the method might produce inconclusive results for discriminating between similar varieties of MCQ originating from different sources (e.g., West Metaliferi jasper and East Metaliferi jasper). Some categories of materials with similar macroscopic appearance but distinctly different petrogenesis may be distinguished from each other (e.g. opals, jaspers, siliceous sandstones) with a higher degree of certainty. Hence, although PGAA may not be well suited to accurately distinguishing between sources of the same type of rock, it may be able to more accurately identify what type of rock it is. PGAA may also help to explain some of the characteristics observed during microscopic analyses or may be able to distinguish between two particular source areas (e.g. Moldavian flint and Balkan flint).

A higher number of geological samples may increase the accuracy of the predictions as well as make the indicated probability more realistic. Although PGAA is useful in the identification of lithic sources, with only a small number of geological samples for comparison, results should be verified by other means such as optical microscopy.

Mineralogical and physical analyses

This study utilised X-ray diffraction (XRD) and Fourier Transform Infrared spectroscopy (FTIR) to determine the viability of these two methods for sourcing of MCQ artefacts. XRD analyses of raw materials looked at comparing various siliceous rock varieties together, two types of jasper (from West Metaliferi Mts. and from Maramureș) from each other, and microcrystalline quartz from opal rich sinter. There was almost no distinction between different varieties of MCQ but a few cherts containing calcite appeared distinct. The jasper varieties showed no difference, with the only identifiable being quartz. Some of the sinters from the Oaș area appear to contain amorphous opal (opalA) as well as quartz.

Various materials were analysed by FTIR (the same as those from the general XRPD comparisons) but no distinction could be seen. In general, it is hard to do mineralogical analyses on these rocks due to the 'dilution' effect produced by the high proportion of quartz which they contain and comparatively low proportions of other minerals.

Interpretation of results and discussion

Comparison of cultural connections: artistic vs. economic

1. Banat

Although the main economic connections seem to be to the east in the Transylvanian Basin, pottery typology show contact to the south. While some of the ceramics from these sites resemble the Foeni culture group artefacts found in the Transylvanian Basin at Lumea Nouă (Alba County), the majority are in fact typical of the cultures from Banat and Serbia. From the Transylvanian Basin the Foeni and Vinča-Turdaș ceramics are the only ones that show some similarities, such as decoration, with the pottery found at the sites in the study. The Foeni type red painting which is found at Foeni, Parța and Sânmihaiu Român is also found at the Lumea Nouă site. There are no significant differences between the ceramics from these sites in Banat and those found at sites in Serbia (Bánffy, 2006). The pottery from these sites in Banat shows no similarity with that found in the northern or western part of the Carpathian Basin or from the Moldavian Plateau. This use of the artistic styles from the south contrasts the idea that materials were imported from the east and the north. This highlights the importance of reconsidering the definition of cultures based primarily on pottery styles. Clearly other factors must be used to define cultural areas and the current ideas about cultural territories must be reconsidered and possibly changed.

2. Transylvania

Judging by the artefacts from the Late Neolithic and Copper Age, it seems that the amount of lithic tools made from local materials increased although imported long distance materials were still coming from the same areas (only in smaller quantity). This decrease in imported materials seems to have occurred over time.

Studies of artefacts from Coțofeni sites (Late Copper Age to Early Bronze Age) in Alba County, particularly along the Ampoi Valley and further north along the Trascău Mt. range, found that the materials used were almost exclusively local chert. This material is of a lower quality than the Metaliferi Mts. jasper and other, more distant, materials. It should be noted that there are chert outcrops located within 3 kilometres of each of the sites (sometimes even within the archaeological sites). It may suggest that during this period the decrease in the import of lithic materials was caused by a decrease in communication with distant communities. In other words, settlements may have become more self-sufficient during this period.

Precucuteni-Cucuteni and Gumelnița interaction

The discovery of lithic artefacts made of Balkan flint that came from trade with Gumelnița communities is not limited to the Precucuteni settlements from this study. Trade between these two cultures likely developed with the emergence of the Gumelnița culture somewhere near the end of phase II of the Precucuteni culture. Balkan flint, in the form of finished products only, have been found at other large settlements (Sorokin, 2000).

The phenomenon of exchanging artefacts between the two cultures should also be considered in light of the existence of the Stoicani-Aldeni-Bolgrad communities (Sorokin, 2000; Vornicu, 2011). The ceramic imports in Precucuteni settlements are discussed in the literature (Sorochin, 2001; Ursulescu & Boghian, 2001). The Stoicani-Aldeni-Bolgrad communities are considered to be a mixture between Cucuteni and Gumelnița cultures (Dragomir, 1983). However, they do not have many Precucuteni elements in their early stages, Gumelnița elements being predominant (Sorokin, 2000). Clearly there is a necessity for future research involving the analysis of early Stoicani-Aldeni-Bolgrad lithics, both petrographic and typological in order to compare the results with Precucuteni and Gumelnița lithic assemblages.

CHAPTER 5
CONCLUSIONS

Conclusions regarding characterisation studies

Without a standardised system of describing chipped stone artefacts, a large aspect of the study of prehistoric cultures, e.g. their lifestyles, their resource procurement methods and their inter-settlement interactions will be greatly limited. Characterisation studies allow researchers to take a look at large scale activities such as trade and procurement studies. Researchers can investigate questions regarding how far people travelled to obtain raw materials, which types of lithic materials they were receiving through trade and who were likely trading partners and possibly even whether the material was being re-traded several times before arriving at a certain destination. Characterisation and provenance studies also open the possibility of attempting to reconstruct trade routes based on distribution of artefacts of different types of microcrystalline quartz.

Standardised characterisation of MCQ would improve inter-site comparisons. Researchers could more easily and more accurately describe the artefacts that they find. This in turn will allow them to easily exchange more accurate data with colleagues and to make comparisons with other sites. By being able to compare sites, researchers can look for more analogies and patterns among sites and thereby gain better insight into prehistoric ways of life.

By adopting a standardised methodology and terminology for the macroscopic and microscopic analysis of MCQ, archaeologists can improve the efficiency, the ease and the dissemination of their research. When a standardised system, such as the one outlined in this study is adopted and data openly shared among researchers, the level of our knowledge regarding prehistoric cultures will increase significantly.

Conclusions regarding geochemical characterisation

For elemental analyses, the grouping of MCQs of different origins can only be made based on statistical interpretations of a large number of geological samples. As well, the method of chemical analysis must be very detailed. If not, there will likely be too much overlap between the source groups. Many methods are unsuitable for measuring well the levels of trace elements in MCQs. Nevertheless, in some cases (even with low accuracy analyses) interpretations of the data may be used for general assessments of provenance. Each method of analysis has advantages and disadvantages. Used individually predictions of provenance may be limited and even erroneous. The discrimination between different source locations has to be made by combining macroscopic, microscopic, geochemical, mineralogical and geological data.

Conclusions regarding regions and specific sites

The largest part of the conclusions chapter looks at the specific regions of the study area. Banat and Transylvania had strong economic ties with the north. Transylvania had an intense connection to the Moldavian Plateau sites. As one might expect, the Maramureș region was influenced by the nearby sources of obsidian. Perhaps unexpectedly, it also appears to have had more contact with the south (as evidenced by the amount of Balkan flint) than with the Moldavian Plateau. Still, not many Balkan flint was recovered in these sites and those pieces observed were already in the form of tools. The sites from the Eastern Carpathians to the Prut are influenced by the nearby source of flint in the Prut and further to the east. Obsidian appears to be very rare, suggestion a lack of contact with the Inner Western Carpathian area. This coincides with the lack of Moldavian flint found in the Maramureș region. The Danube and Drobrogea area are, as expected, connected to the outcrops of Balkan flint nearby. Obsidian is present in small amounts and may represent the other end of trade with Maramureș.

General movement of lithic artefacts and raw materials

The three main high quality materials from the study area, i.e. Moldavian flint, Balkan flint and obsidian, each have their own trade patterns. They also appear in different quantities in the various different regions (see Figure 3).

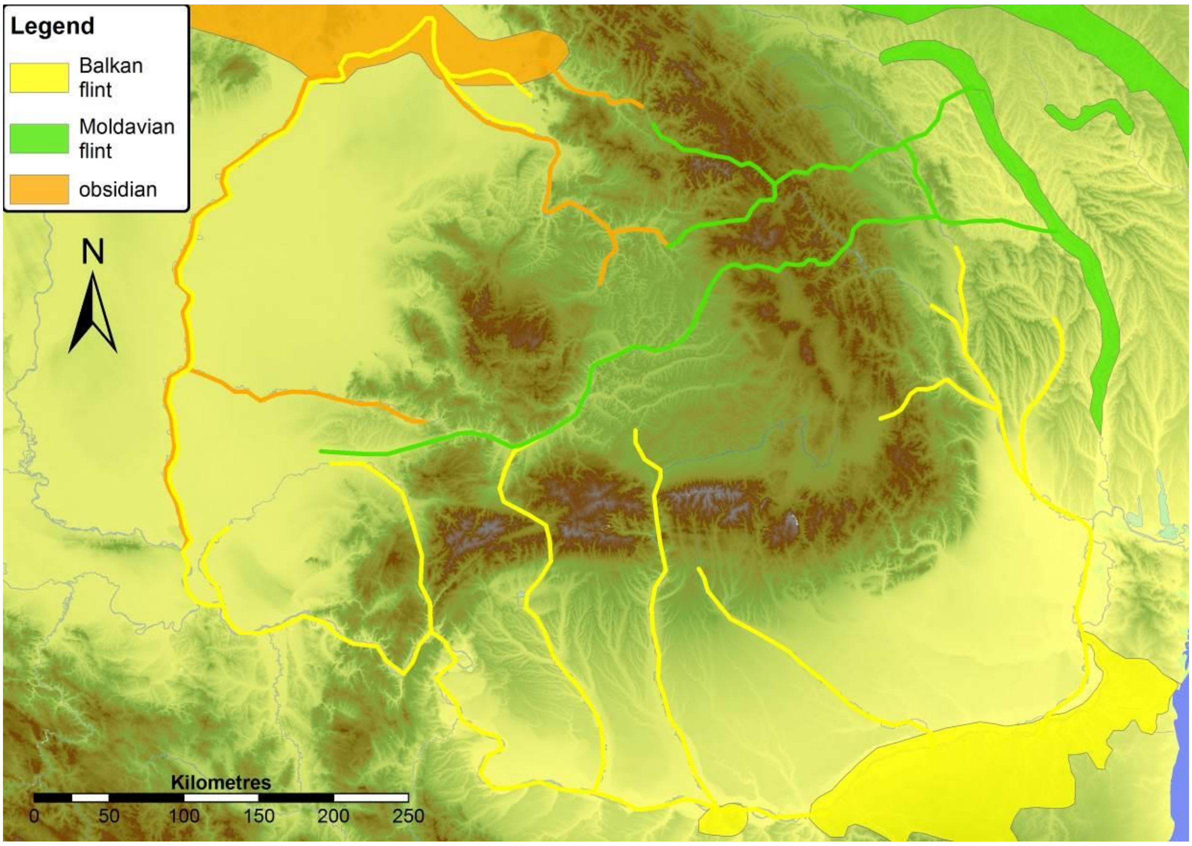

Figure 3. Long distance trade patterns of Modavian flint, Balkan flint and obsidian, within the study area.

Moldavian flint was the primary high quality material used in the area between the Carpathians and the Prut River. From this region it was transported westward across the Eastern Carpathians and into the Transylvanian Basin. For most of the Neolithic and Copper Age settlements in these areas, it was the second most used imported material (Crandell, 2013).

Balkan flint was the primary high quality material used along the Lower Danube and in the Dobrogea region. From there it was transported north into the Moldavian Plateau but its usage diminished with distance from the sources. Balkan flint was also transported up the Danube into the Banat area and likely from there into the north-central part of the Carpathian Basin (NW part of the Transylvanian Basin and NE part of the Pannonian Basin). This material was also used throughout the Transylvanian Basin but it is unsure which route the material or artefacts took to get there.

Obsidian is the main high quality material used throughout the Transylvanian Basin. Its usage was followed closely by Moldavian flint. It was likely brought into the region from sources in the Western Carpathians. Obsidian artefacts from sites in the Banat region were likely also brought south (possibly along the Tisza) from the Western Carpathians. The few obsidian artefacts found at sites in the Lower Danube area may have come from the Western

Carpathians (possibly along the same routes that Balkan flint was transported north) but without chemical analyses, this is hard to demonstrate. The same possibilities exist for obsidian found at the Moldavian sites from this study. In both regions though, obsidian was used very little (or possibly not at all at some settlements).

Local materials are used in all areas but aside from at sites where the local material was a high quality material, the local materials were not the primary materials used during the Neolithic (although they increased in usage significantly by the end of the Copper Age) and were not transported far, with the exception of being transported into areas with few local resources (e.g. parts of the Banat region) (Figure 4).

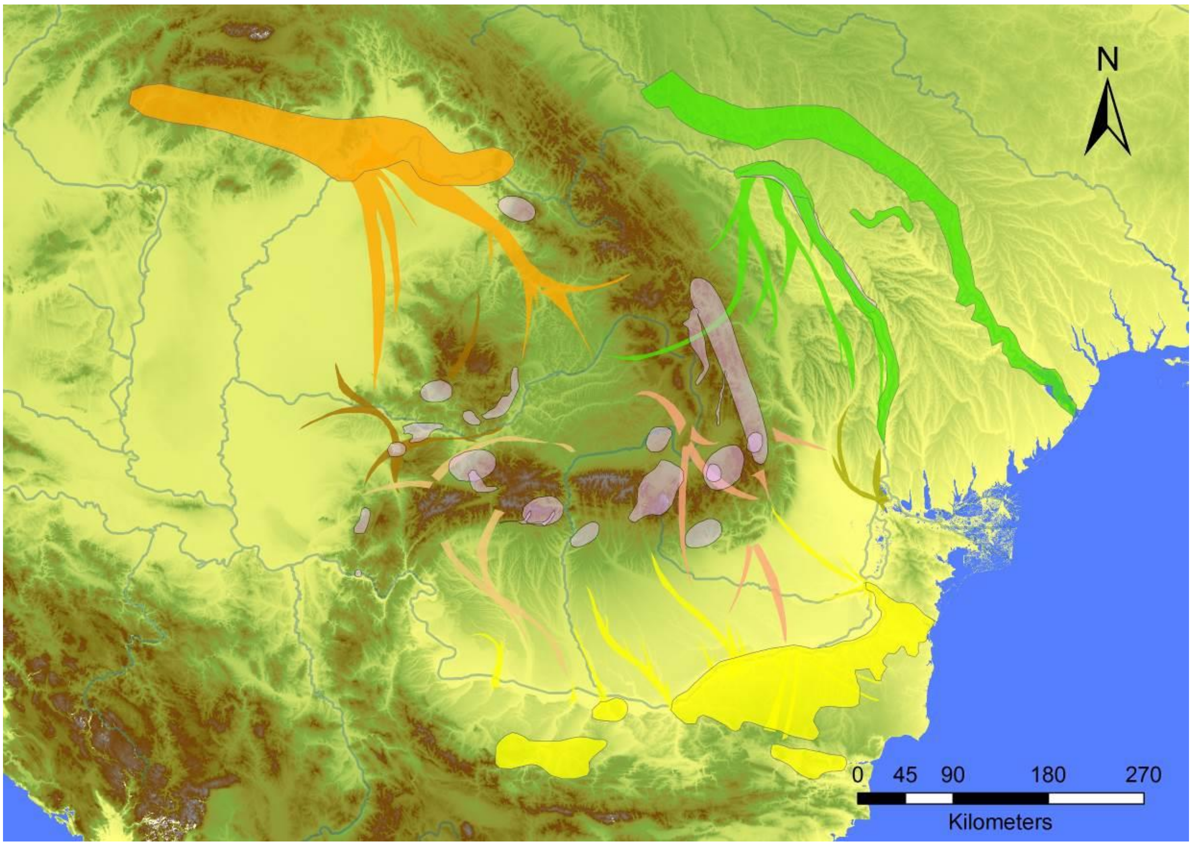

Figure 4. Short distance (local materials) trade patterns within the study area. Material movement lines are indicated in different colours. Legend as in Figure 3.

Import in the proportions observed indicates that the people of the settlements throughout the study area knew about various non-local high quality materials available in adjacent regions. These materials were well known to most people and a demand for them existed. If people were not travelling to the sources themselves to get materials, then it is likely that there were established long distance trade routes in existence by the early Neolithic and maintained throughout this period. More importantly, these trade routes were intercultural. This is an important observation because has generally been believed that long distance trade did not appear until the end of the Copper Age or beginning of the Bronze Age. Along with the proportions of imported materials, the continuation of these trends over time suggests regular contact and interaction with neighbouring cultures. As economics is an aspect of culture, if these cultures were interacting economically then this type of discovery requires researchers to reconsider the current definitions of the cultures of that time period and what separates them.

Possible specialised occupations

Judging from the high percentage of the imported tools and the disposal of the imported items at the study sites, it is believed that tools of these materials were probably widely available and accessible to everyone at the settlements. Although there are numerous raw materials available in close proximity to most of the sites (or at least at a medium distance), and people did not need to import materials, they still chose to use non-local materials (again, aside from sites close to high quality material sources). Instead of simply being opportunistic and using the nearest available materials to their settlements, they chose mainly to use better quality material. This demonstrates that they were conscious of the quality difference when choosing raw materials and that they made a distinct effort to acquire materials of high quality. Imported materials and tools were not necessarily regarded as very high prestige goods. However, the fact that they were preferred over functionally adequate local materials suggests that there was at least some desire to possess high quality imported materials. Either way, there was a market demand for these materials.

The long distances that the material would have been transported, combined with the time, energy and knowledge necessary for the materials or artefacts to arrive at the settlements suggests occupational specialisation - someone specialised in providing non-local materials or tools made from such - had already occurred by this point in time. This occupational specialisation related to raw material acquisition and distribution may have taken different forms. There may have been members of each settlement travelling to sources to procure raw materials and bring them back to the site. It is possible that people did travel long distances in search of materials and fabricated the tools or produced cores near the material source and then brought them back. This is unlikely however because it would involve a detailed knowledge of the locations of various different material sources over an enormous geographical area. Direct procurement is particularly possible and probable with local sources though. Another possibility is that materials or tools were traded by travelling merchants or by a series of merchants. Direct procurement may have occurred within a limited area around each settlement in combination with trade with neighbouring groups, at occasional large group gatherings or with merchants in exchange for other goods. These collectors, the merchants or other early recipients of the materials may have knapped the materials into cores or tools before trading them away in order to reduce the weight during transportation (by removing lower quality or unknappable sections) or to produce smaller units to trade with. The merchants may have travelled either short distances or to another region where the material was rarer and could be traded for something else that was locally available. Materials may have even been traded through a series of merchants. Through a series of exchanges (via merchants or simply via members of neighbouring settlements) it is possible for materials to have moved large distances by changing ownership several times. The materials and artefacts may have moved much longer distances than any individual owner ever would have. Trade may explain the lowering quantity of long distance materials over distance as some material remained at each settlement along routes. It is also possible that there was a combination of means by which the materials were moved. The quantity of materials traded though suggests organisation and planning. This in turn suggests specialised merchants - over short distances or long - using fixed routes. In any of these scenarios though, it would have been necessary for the person moving the materials to take time from their own self-sufficiency activities such as farming in order to import or export the materials. The loss incurred by this absence from their home and regular work must have been outweighed by the benefits of the import-export occupation.

The fact that distant materials appear more frequently as finished tools suggests that tools often arrived at settlements ready-made. This in turn suggests that they were knapped by craftsmen earlier in the *chaîne opératoire*. These knappers may have also been the merchants.

Summarizing, the primary initial objectives of this study were to catalogue and characterise MCQ types found within the study area and to consider procurement (trade and direct procurement) patterns of the Neolithic and Copper Age populations of the area. A preliminary catalogue of the main types and many minor types of MCQ has been produced. This study has undeniably demonstrated that long distance trade occurred as early as the Neolithic. In fact, it has now been shown that during the Neolithic, the majority of lithic artefacts were made from high quality materials which were imported if no local high quality materials were available, even in cases where there was an abundance of locally available medium quality lithic raw material. In the Copper Age the amount of imported lithic materials tended to continually decrease up to and into the Bronze Age. The results of this

study also suggest that this long distance trade was an established, organised and on-going phenomenon. This study has also given an overview of the main lithic trade patterns and directions during the Neolithic and Copper Age, many of which crossed into the territories of other cultures. The knowledge, time and energy required to maintain trade at this level suggests the existence of specialised occupations during the Neolithic - in particular merchants.

Notes for future researchers

In the spirit of objectivity, potential sources of error are mentioned. These may at some point in the future be further investigated. In addition, suggestions are made for future aspects of this research which could be elaborated upon.

TABLES

Table 1. Sites and artefacts examined in this study. Abbreviations. Neol - Neolithic (EN - Early Neolithic; MN - Middle Neolithic); CA - Copper Age; BA - Bronze Age (EBA - Early Bronze Age); U - unknown total quantity; Q - qualitative study, artefacts were not counted.

Site Name	Cultures Present	Periods	Total Artefacts	Visual Analysis	Petrographic Analysis	Other Analyses
Banat sites	Vinča, Foeni, Banat	MN to CA	> 400	398	10	
Chișoda-Livezile	Vinča	Neol - CA				
Sânmihaiu Român-Tell La Deal	Foeni group	CA				
Sânmartinu Maghiar-Tell Movila Vie	Vinča	Neol - CA				
Parța-Tell I and Tell II	Banat culture	Neol				
Rudna-Unca	Banat culture	Neol				
Foeni-Feodora	Foeni group	CA				
Mureş Valley (HD)						
Branișca-La Tau	unknown	Neol - CA	28	28		
Aurel Vlaicu - Romoş-lan porumb terasa	unknown	Neol - CA	8	8		
Aurel Vlaicu-Pct A	unknown	Neol - CA~	11	11		
Ilia-Bacea-Saraturi	unknown	Neol - CA	8	8		
Turdaş-La Luncă	Turdaş, Petrești, Coțofeni	CA	U	Q		
Bozeş-Bozeş Valley	possibly Coțofeni	CA to BA	U	12		
Mureş Valley (AB)						
Tărtăria-Gura Luncii	Vinča C, Petrești, Coțofeni	MN to CA	308	308	15	
Răcătău-Piatra Tomii	Vinča C, Petrești, Coțofeni	MN to CA	111	111	15	FTIR (2)
Limba	Criş III, Vinča A-B	EN TO MN	447	447	30	PGAA (5)
Alba Iulia-Lumea Nouă	Vinča B-C, Petrești	MN to CA	>1000	1009	8	ESR (3)
Ampoița-La Pietre	Coțofeni	CA - EBA	168	168		
Meteş-Piatra Peşterii	Coțofeni	CA - EBA	18	18		
Zlatna-Măgura Dudașului	Coțofeni	CA - EBA	11	11		
Sebeş-Râpa Roșie	Coțofeni	CA - EBA	13	13		
Sebeş-Papuc	Coțofeni	CA - EBA	14	14		
Sebeş-Valea Janului	Petrești	CA - EBA	6	6		
Ghirbom-La Fața (AB)	Petrești A and AB	CA	193	193		
Cetea-Picuiata (AB)	Coțofeni	CA - EBA	U	238		
Mureş County sites						
Bezid-Loț	unknown	Neol	U	2		
Pănet	unknown	Neol	U	1		
Târgu Mureş-Dombkanyar	unknown	Neol	U	1		
Iernut-Gorotar	Tisza III	Neol	U	4		
Cipau-Gară	unknown	CA	U	1		
Sângeorgiu de Pădure	unknown	CA	U	15		
Cristești	Vinča-Turdaş	CA	U	10		
Zau de Câmpie	Vinča-Turdaş	CA	U	13		
Gornești	Petrești	CA	U	1		
Goreni-La Hrean	Petrești A, AB, B	CA	U	77		
Cuci-După calea ferată	Petrești B-IIa	CA	U	54	1	
Crăciunești	Cucuteni- Ariușd	CA	U	1		
Luduş	Tisza or Coțofeni	CA	U	2		
Săngeorgiu de Mureș-Căpâlna	Coțofeni	Late CA	U	12		
Șincai-Cetatea Păgânilor	Coțofeni	Late CA	U	7		
Târgu Mureş	unknown	unknown	U	3		
from unknown sites in Mureş County	various	Neol to CA		27		
Maramureş area						
Seini-"Ferma 7 IAS"	Tiszapolgár	CA	U	23	22	
Călinești Oaş-Dâmbul Sfintei Mării	Starčevo-Criş III-IV	EN	U	94	1	
Bistrița Valley			U	46	45	
Bistricioara	Gravettian	Palaeolithic				
Ceahlău-Dârțu	Gravettian	Palaeolithic				
Eastern Subcarpathian sites						
Săcăluşești-Dealul Valea Seacă	Precucuteni III, Cucuteni A	CA	U	380	15	

Topolița-La Ilioi	Precucuteni II	CA	U	98	5	
Târpești-Râpa lui Bodai	Precucuteni II-III, Cucuteni A & B	CA	U	1032		
Izvoare-Izvoare	Precucuteni II-III, Cucuteni A	CA	U	150		
Traian-Dealul Fântânilor	Precucuteni III, Cucuteni A-B	CA	U	200		
Bețești-Dealul Buruienești	Precucuteni III	CA	U	63	1	
Poduri-Dealul Ghindaru	Precucuteni II-III, Cucuteni A2 & B2	CA	>3000	175	9	
Moldavian Plateau						
Târgu Frumos-Baza Pătule	Precucuteni	CA	5338	5338	15	PGAA (5)
Isaiia-Balta Popii	Cucuteni A	CA	U	866	4	
Danube sites (Teleorman)						
Măgura-Boldul lui Moș Ivănuș	Starčevo-Criș I, Dudești, Vădastra	Neol	>1000	Q	2	
Măgura-Buduiasca	Starčevo-Criș III, Dudești, Vădastra	Neol	>1000	Q	1	
Beciu-Rusca Scărișoreanu	Dudești	Neol	>500	Q	2	
Poroschia-La Râpe	Dudești	Neol	>500	Q	3	
Vitănești-Măgurice	Gumelnița B1, A2	CA	>1000	Q		
Danube sites (Comșa's excavations)						
Liubcova-La Ornița	Starčevo-Criș IIIB, Vinča A, B, C	Neol - CA	U	18		
Ipotești-La Conac	Dudești	Neol	U	48	1	
Radovanu-Gorgana I	Gumelnița A1, Boian / Spanțov	Neol- CA	U	46	1	
Vărăști-Grindul Grădiștea Ulmilor	Dudești, Boian, Gumelnița	MN, CA	U	20	1	
Glina (Bobești)-Via lui Poleașcă	Gumelnița	CA	U	5		
Călărași-Grădiștea	Boian and/or Gumelnița	Neol- CA	U	1	1	
Bogata-Lac Gălățui	Boian	Neol	U	58	4	
Dudești-Malul Roșu	Dudești	Neol	U	22	1	
Izvoarele-Fântânele	Gumelnița	CA	U	153	1	
Bucov-Tioca	Boian (Banat-Bucov group)	Neol	U	2		
Garvăn-Mlăjitul Florilor	Gumelnița	CA	U	68	2	
Garvăn-Dinogeția	Gumelnița	CA	U	93	3	
Luncavița-Cetățuia Tell	Gumelnița A2	CA	U	23		

Table 2. Geological material sources examined in this study.

Region	Group	Material	Location	Analyses: Microscopy	PGAA	XRD	FTIR
				238	106	28	20
Moldavian Plateau	Moldavian flint	chert (flint)	Prut R., Rădăuți-Prut, BT	1	1		
			Miorcani flint mine, Miorcani 1, BT	10	6	4	4
			Miorcani flint mine, Miorcani 2, BT				
			erosion bank, Crasnaleuca, BT	2	1		
			quarry, Ripiceni, BT	2	1		
			Prut R., Ripiceni, BT	2			
			Soroca (along Dniester R.), Republic of Moldova	3	1		
			Dniester R., Ukraine		1		
	miscellaneous	chert	Prut R., Păltiniș, BT	1			
Lower Danube	Balkan flint	chert (flint)	quarry near Hârșova, CT	3	1	3	3
			Șipotele, CT				
			Ovidiu, CT				
			Palazu Mare, CT	1			
			Peștera, CT	2	1		
			Remus Oprean, CT	2	1	3	3
			Murfatlar Basarabi Quarry, CT	3	1	4	4
			Mircea Voda, CT	1	1		
			Nikopol, Bulgaria	1			
			Ravno, Bulgaria	1			
			Chakmaka, near Isperih, Bulgaria	1			
West Carpathians	Carpathian obsidian	obsidian	Mád-Kakashegy, Hungary	1	1		
			Tolcsva-Nagypatkó, Hungary	1	2		
			Bodrogolaszi, Hungary		1		
			Cejkov, Hungary		1		
			Kasov, Hungary		1		
			Brehov, Slovakia	3			
			Vinicky, Slovakia	2	2		
			Hran, Slovakia	1			
Ba na	Anina chert	chert	Carașova 1, CS	1	1		

			Caraşova 2, CS	1	1		
			Anina, CS				
			Bocşa, CS				
			Secu, CS	1			
			Cuptoare, CS				
			Doman, CS				
			Moldova Nouă, CS				
			Steierdorf 2, CS				
			Steierdorf 1, CS	1	1		
			Marila, CS				
	Almăj Sandstone	siliceous sandstone	Gornea, CS	2	2		
			Sicheviţa 1, CS	1	1	1	1
			Sicheviţa 2, CS	1	1		
			Cruşoviţa 1, CS	1			
			Cruşoviţa 2, CS	1	1		
	Almăj various	jasper	Glimboca, CS		1		
		silicified wood	Gornea, CS				
Middle Mureş Valley	West Metaliferi Jasper	jasper	Bulza 1-3, HD	1	1		
			Fintoag 3, HD	1			
			Ohaba 2 & 2b, HD				
			Lăpugiu de Sus 1 & 2, HD	1			
			Râşcani Valley, Mihaieşti 1a, HD				
			Glodghileşti 1, HD	1			
			Burjuc 1, HD				
			Tataraşti, HD				
			Gurasada, HD	3	4	2	
			Bacea 1 & 3, HD	1	2		
	East Metaliferi Jasper	jasper	Almaşu Mare, AB	1			
			Brădet, AB	1			
			Agatul Valley, Techereu, HD	1	3		
			between Almaşu de Mijloc & Almaşu Mare, AB	1			
			Almaşu de Mijloc 1, AB	1	2	1	1
			Almaşel, HD	1	1		
			Galbina, HD	2	1		
			Balşa 27, HD	2			
			Mada 2, HD				
			Băcâia 1, HD				
	Trascău Jasper	jasper	Ampoiţa 1, AB		2		
			Ighiel 1, AB	1	1		
			Ţelna 1, AB				
			Cricău, AB	1	2		
			Poiana Aiudului 2, AB	1	1		
			near Colţ Castle, Colţeşti, AB				
			Râmeţi (near Aiud), AB		1		
			Poiana Ampoiului, AB	1			
	Trascău Chert	chert	Cetea, AB	1			
			Băcâia 2, HD	1			
			Piatra Tomii Hill, Răcătău, AB	4	2	1	1
			The Valley of Paul 3a, Zlatna, AB				
			Bulbuc Hill, Feneş, AB	1			
			Poiana Ampoiului, AB	1			
			Vioarea Peak, Micu Hill, Meteş, AB	2	2	1	1
			Ampoiţa 5, AB	2	2		
			Presaca Ampoiului, AB	1	1		
			Râmetea Hill, east of Râmetea town, AB	1			
			Craiva 2, AB				
			Vălişoara Gorges, Vălişoara, AB				
Criş Valley	Criş Valley Sinter	sinter	Hălmagiu, HD				
			Basarabasa, HD	1			
			Pravaleni, HD	1			
			Crişcior, HD	1			
			Barza, HD	1			
			Bucureşci, HD	1			
			Prihodiste, HD	1			
			Marinarului Valley, Ociu, HD	1			
			Brotuna, HD	2			
			Sanitoriu, Brad, HD	3	1		
Strei Valley	Strei Siliceous Sandstone	siliceous sandstone	Veţel, HD	4			
			Nandrului Valley, Nandru, HD	2			
			Ţapului Hill, Silvaşu de Jos, HD	2			
			Cozia, HD	2			

Şureanu Mts.	Haţeg chert	chert	Cerbului Valley, Banita, HD				
			Baru, HD				
			near Cioclovina cu Apa cave, Cioclovina, HD				
			near Gaura lui Oana cave, Crivada 1, HD				
			Crivada 2, HD				
			near Sura Mare cave, Ohaba Ponor, HD				
			near Stiubei & Fandatura caves, Ohaba Ponor, HD				
			Palariei Hill, Petros, HD				
			near Sura Mica cave, Ponor, HD				
			Serel, HD				
			Valea Lupului, HD				
South-West Transylvania	Small sources	rhyolite	Cetea	1			
			Valea Geoagiului (near Geoagiu de Sus), AB	2		1	1
			Poiana, HD 1	1			
			near Râmeţi Monastery, near Râmeţi, AB	2			
			Bodii Valley, Techereu 3, HD	1	1		
			Agatul Valley, Techereu 2a, HD	6			
		quartzitic sandstone	Craiva 1, AB	1			
		siliceous shale	Dealul Cremenea, Poieni, TM	9	2	1	1
			Cremenea Valley 2, Rachiş, AB	2			
			Valley of Paul 3b, Zlatna, AB	2			
		agate and opal	Şcolii Valley, Gurasada, HD	2	1		
		agate	Almaşu de Mijloc 1, AB	1			
			near Brad towards Rudna, HD				
			basalt quarry, Bretea Mureşana, HD	3			
			Bucium, AB				
			Burjuc, HD				
			Cib 1-3, HD				
			Gurasada, HD	1			
			Mada 1, HD				
			Râşcani Valley, Mihaieşti 1b, HD	1			
			Nandrul Valley, Nandru, HD	1			
			Poiana Aiudului 1, AB				
			Cremenea Valley 1b, Rachiş, AB	3			
			Râmetea, AB				
			Agatul Valley & Bodii Valley, Techereu 2b, HD	6			
			Valea Bradului, HD				
			Valley of Paul 1, Zlatna, AB				
			near Poiana Aiudului towards Aiud 3, AB				
			Brâdet, AB	3			
			Sălciua Valley, AB	1			
			Bulza 3, HD				
		silicified wood	Arieş Valley, near Baia de Arieş, AB	1	1		
			petrified forest, Ociu, HD	1			
			Turda, CJ				
North Apuseni	N.A. chert	chert	Someş R., SJ	1			
			Corneştiul Valley, Corneşti, CJ	1			
			Aghireş quarry, Corneşti, CJ	2			
	N.A. jasper	jasper	Capuşu, CJ	1	1		
	N.A. sandstone	quartzitic sandstone	Corneştiul Valley, Corneşti, CJ	1			
	N.A. agate	agate	Capuşu Mic, CJ	4			
			Şimleu R. (between Virşolt and Craşna), SJ				
Maramureş	Maramureş sinter and opal	opal	Iricau Peak, Baia Mare, MM				
		sinter	Borcut Valley, near Baia Mare, MM				
		sinter	Firiza, MM	4	4	2	
		sinter	Alba R., Negresti-Oas, SM	3			
		sinter	between Vama and Racşa, SM				
		sinter	Racşa, SM	1			
		sinter	Cremenea Hill, near Racşa, SM	5	2	2	
		sinter	Seini, MM	3			
		sinter	Ilba, MM	2		2	
		sinter	Vama, SM	1			
		opal	Baia Sprie, MM		1		
		sinter	Bixad, SM		2		
		opal	Cavnic, MM		1		
		opal	Valea Chioarului, MM		2		
	Oaş perlite	perlite	Orasu Nou, SM		1		
	Maramureş agate	agate	Trestia, MM	1			
			East of Racşa, SM				
			Rosie Valley, Baia Mare, MM	1			
			Valea Chioarului, MM	1			

East Carpathians	East Carpathian chert	cherty limestone	Ozana R., Târgu Neamț, NT				
		chert & cherty limestone	Agapia R., Agapia, NT				
		chert	Voroneț Stream, Voroneț, SV	1			
		chert & cherty limestone	Humor R., Gura Humorului, SV	1			
		chert	Soloneț R., Soloneț, SV	1			
		cherty limestone	Solca R., Solca, SV				
		chert & cherty limestone	Voievodeasa R., Voievodeasa, SV	1	1		
		chert	Moldovitei R., Vatra Moldovitei, SV				
		chert	Demacuşa R., Demacuşa, SV				
		cherty limestone	Cailor Stream, Fundu Moldovei, SV				
		chert	Nicanul Stream, Durau Station, NT	1			
		chert	Izvorul Muntelui, NT	1			
		chert	Tarcau R., Tarcau, NT	1			
		cherty limestone	Iapa Stream, Piatra Soimului, NT				
		chert	Iapa Valley, near Piatra Siomului, NT	1			
		cherty limestone	Valea Rece (town), HG				
		chert	Ceahlău (town), NT		1		
	East Carpathian jasper	jasper	Humor R., Gura Humorului, SV				
			Cailor Stream, Fundu Moldovei, SV				
			Dămuc Valley, Puntea Lupului, NT	1			
			between Pojorata and Valea Putnei, SV				
			Haul Stream, Valea Putnei village, SV				
	E.C. siliceous sandstone or lydite	siliceous sandstone	Agapia R., Agapia, NT				
			Secat Stream, Ortesti (Draganeşti commune), NT				
			Culeasa R., Poiana, NT				
			Seaca R., Boroaia, SV				
			Voroneț Stream, near Voroneț Monastery, SV				
			Suha R., Doroteia, SV	1			
			Humor R., Gura Humorului, SV				
			Soloneț R., Soloneț, SV				
			Hinata R. & Soloneț R., Pârțeștii de Jos, SV				
			Voievodeasa R., Voievodeasa, SV	1			
			Moldoviței R., Vatra Moldoviței, SV	1			
			Demacuşa R., Demacuşa, SV				
			Suceava R., Izvoarele Sucevei, SV				
			Moldova R., Sulița Moldovei, SV				
			Tarcau R., Tarcau, NT	1			
			Iapa Stream, Piatra Soimului, NT				
			Uzului Stream, Darmaneşti, BC				
			Sulta Stream, Sulta, BC				
			Valea Rece (town), HG				
			Culeasa R., Poiana, NT				
	E.C. quartzitic sandstone	quartzitic sandstone	Agapia R., Agapia, NT				
			Târzia Stream, Draganeşti, NT				
			Culeasa R., Poiana, NT				
			Voroneț Stream, near Voroneț Monastery, SV				
			Suha R., Doroteia, SV	1			
			Humor R., Gura Humorului, SV				
			Soloneț R., Soloneț, SV				
			Solca R., Solca, SV				
			Sucevița R. & Voievodeasa R., Sucevița, SV				
			Moldoviței R., Vatra Moldoviței, SV	1			
			Cailor Stream, Fundu Moldovei, SV				
			Hangu R., Hangu, NT	1			
			Bolatau R., Petru Voda, NT	1			
			Neagra R., Neagra, NT				
			Tarcau R., Tarcau, NT	1			
			Iapa Stream, Piatra Şoimului, NT				
			Iapa Stream, Piatra Şoimului, NT				
			Uzului Stream, Darmaneşti, BC				
			Sulța Stream, Sulța, BC	1			
			Valea Rece (town), HG	1			
			Culeasa R., Poiana, NT				
	East Carpathian menilite	menilite	Ozana R., Târgu Neamț, NT	1			
			Agapia R., Agapia, NT				
			Voroneț Stream, near Voroneț Monastery, SV				
			Voroneț Stream, Voroneț, SV	1			
			Humor R., Gura Humorului, SV	1			
			Soloneț R., Soloneț, SV				
			Hinata R. & Soloneț R., Pârțeștii de Jos, SV	1			
			Solca R., Solca, SV				

			Sucevița R. & Voievodeasa R., Sucevița, SV				
			Voievodeasa R., Voievodeasa, SV				
			Iapa Stream, Piatra Şoimului, NT				
			near Slanic Moldova, BC	1			
	E.C. jasper	opal	Reghin, MS		1		
			Toplița, HR		3		
	E.C. agate	agate	Secat Stream, Ortesti (Draganeşti commune), NT				
			Soloneț R., Soloneț, SV				
South-Eastern Carpathians	Carpathian Chert	chert	Ciumernic 1, Intorsura Buzaului commune, CV	4	2		
			Ciumernic 2, Intorsura Buzaului commune, CV	4	2		
	Carpathian Menilite	menilite	Jitia, VN				
			Neculele, VN				
			Vintileasca, VN				
			Lopatari, BZ				
			Valea Sibiciului, BZ				
			Vinetisu, BZ				
	Perşani jasper	jasper	Comana de Sus, BV				
			Cuciulata, BV				
			Fantana, BV				
			Bogata Olteană, BV				
			Apata, BV				
Lower Danube	Danube alluvial deposits	alluvial deposits	earth quarry near Ciuperceni, TL	1			
			earth quarry near Ghizdaru, GR				
			earth quarry between Balanoaia and Cetatea, GR				
			Danube bank, Oltenița, CL	1			
			Danube bank, Hârşova, CT				
	Dobrogea chert	chert	Lumina, CT				
			Cheia, CT	1			
			Remus Oprean, CT	1			
			Hârşova 1, CT				
			Galbiori, CT	1			
			quarry near Hârşova, CT	1			
			Crucea, CT				
			Hârşova 2, CT	1			
	Danube chert (Bulgaria)	chert	Tetovo (Bulgaria)	1			
			Kriva reka (near Novi Pazar, Bulgaria)	1			
			Kiukato (north of Razgrad, Bulgaria)				
Adjacent regions	Hungarian materials	limnic quartz	Arka, Hungary				
			Gyöngyösoroszi-Dögkút				
			Hejce-Püspöktábla (secondary source)				
			Kács				
			Rátka-Hercegköves				
		geyserite	Gyöngyöstarján-Kövesdomb				
		chert	Budapest-Denever str.				
		flint	Nagytevel	1	1		
		radiolarite	Hárskút-Édesvizmajor				
			Szálka-Pincehegy (secondary source)				
			Szentgál-Tűzköveshegy				
			Tata-Kálváriadomb				
			Városlőd-Savóvölgy				
	Czech flint	flint	Marsovice		1		
	West Carpathian opal	opal	Kozelnik, Slovakia		1		
			Cervenica, Slovakia		1		
	Polish flint	chert (regular & flint)	Ojcow (Cracow flint)				
			Saspow (Cracow flint)		1		
			Bębło (Cracow flint)		1		
			Gliniany (Chocolate flint)				
			Wierzbycza (Chocolate flint)		1		
			Ożarów (Ożarowski flint, a.k.a. Zawadzki flint)				
			Ruda Kościelna (Striped flint)				
			Krzemionki (Krzemionki flint)		1		
			Swieciechow (Swieciechowski flint)		1		
			Baltic Sea coast (Pomerainian flint)				
			Makow (Erratic "Baltic" flint)		1		
			Mielnik (Mielnicki flint, a.k.a. NE flint)				
Distant obsidian	obsidian	obsidian	Milos, Greece		1		
			Lipari, Italy		1		
			Monte Arci, Sardinia, Italy		1		
			Auvregne, France		1		
			Sevan, Armenia		1		

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