MACROSCOPIC AND MICROSCOPIC ANALYSIS OF CHERT. A PROPOSAL FOR STANDARDISATION OF METHODOLOGY AND TERMINOLOGY

1. INTRODUCTION

1.1. *Problems of Current Descriptions*

Descriptions of chert in archaeological reports are plagued by three main deficiencies. These are a lack of details, a lack of objectivity and an absence of standardisation. These descriptions generally lack details. A general colour is often all that is mentioned. If a distinctive pattern exists, it might be included, but other more diagnostic details are often either ignored or overlooked. Details given are often subjective. Few or no objective empirical measurements are given which could be easily interpreted by readers who are unfamiliar with the artefacts. A researcher may write that an artefact is brown or yellow but not indicate the hue, value or intensity. Other researchers might be a bit more descriptive and say that a piece is the colour of coffee or honey. This is still a very subjective description with a large amount of variety. Readers may have trouble interpreting such descriptions if they have never eaten breakfast with the writer. What one researcher calls opaque, another might call transparent. What one calls high or low quality, others may call medium quality. Without indicating what is meant by these terms, readers are unable to know what the writer means and how the artefacts appear.

1.2. *Results of These Problems*

These deficiencies produce several undesirable results. Without detailed, subjective standardised descriptions it is difficult for another archaeologist to realise what the chert artefact in question looks like. This in turn makes it difficult to compare finds between sites without actually seeing the artefacts. This leads to the difficulty of reconstructing large inter-site connections and activities.

When lithic artefacts are described, the description often is simply colour and distinct markings. More often though, archaeologists simply mention a chert "type" and it is assumed that the reader will be familiar with what these types look like. Due to a lack of descriptions or descriptive catalogues, readers outside Romania would not likely know of these types. In fact, due to a lack of training in chert types, many archaeologists even *in* Romania do not know what these types look like. Banat or Banat Nord type chert is a good example. Some archaeologists (within Romania) believe that this is a dark brown-black, semi-opaque, high quality chert from the Poiana Ruscă area. Others believe it is the yellow, opaque jasper from north of the

Mureş river, in the Apuseni Mountains. Others still believe that it is a light yellowish brown (without intense colour), translucent, medium course grained chert with whitish speckles from the Apuseni Mountains. Many archaeologists have so little training in rock determination in general that they are unable to distinguish between chert, andesite, and marl-limestone. Some can not distinguish a transparent chert from obsidian. Clearly a set catalogue of chert types and their descriptions is needed.

In addition to measurable data, archaeologists need a standardised set of terms and measures. Readers and researchers must know what is meant by terms such as opaque and transparent, fine and course grained, dark and light, "with lines", milky, and others. With a standardised set of descriptive points and terminology, readers can much more easily understand what writers are describing and researchers can easily exchange information.

1.3. *Recent Macroscopic Research Methods and Achievements*

Comşa started to make descriptions of cherts but his work on the topic was not extensive. In the late 1980s, Eugen Comşa made the first attempt to objectively describe chert types in Romanian. His descriptions were basic and he only described a few major types, but his work can be considered a beginning. Two of Comşa's descriptions are as follows. "Balkanic" chert - the colour of honey, with whitish spots, opaque. "Banatean" chert - the colour of coffee, opaque, with black small lines and spots[1]. One has to wonder whether his descriptions were perhaps written while at the breakfast table. Unfortunately, this work was not continued.

A key problem with Comşa's (and subsequent) descriptions is that they only describe archaeological chert. The problem with this is that archaeological samples of chert can be altered from the original geological materials and each artefact is not always altered in the same way. As well, many archaeological chert descriptions do not note the sources of the materials. The types which are referred to are in fact named after zones where that type is more often found in archaeological settings. Because of this method of naming the cherts, sometimes more than one chert type is given for the same name, for example, Banat Nord (Northern Banat) type.

Prior to Comşa, in 1904 another researcher, Schafarzik, also published descriptions of chert in Transylvania and Banat. Schafarzik included not only descriptions but also known geological sources of the types. Unfortunately Schafarzik's work has gone relatively unnoticed in Romania because he published in Hungarian.

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[1] E. Comşa, *Neoliticul pe teritoriul României. Considerații*, Bucureşti, Editura Academiei R.S.R., 1987, p. 88-89.

1.4. *Microscopic Analysis*

To date, the majority of chert studies in archaeology throughout the world are macroscopic only. They are described based on visual characteristics which can be observed without the aid of a microscope. Outside of Romania, a large number of researchers, particularly geoarchaeologists, have also conducted microscopic analysis of cherts and published their descriptions. A large amount of microscopic analyses have been carried out in France, Canada and America. The benefits of microscopic analysis are that it is often easier to distinguish between two visually similar chert types, it allows more detailed analysis of samples, and the characteristics described in microscopic analysis are more easily described in objective terms and quantifiable measurements. A minor disadvantage of microscopic analysis is that it requires samples to be prepared in a specialised lab as well as access to a microscope suitable for mineralogy and training in how t interpret the results. Such laboratories and microscopes are widely available and the training required to interpret results is minimal.

1.5. *Chemical Analysis*

Another group of methods of analysing and characterising chert is by 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. The benefits of this type of analyses are that the results are often very detailed, completely quantitative (which allows easy statistical analysis), and they show very clear distinctions between chert types.

The largest downside to chemical analysis are related to practical aspects. Analyses are generally expensive, fewer analytical laboratories exist, and more specialised training is necessary to interpret the date to its full potential. There exist also several difficulties related to ease of use. Chert is a relatively heterogeneous material, unlike obsidian (a homogenous material). This means that more geological samples must be analysed for a comparative database to be accurately used. As well, the difference between geological formations is very small, therefore a very sensitive method of analysis is required. There are several methods known to successfully work in these analyses, such as NAA, PAA, ICP-MS, LA-ICP-MS and PIXE (among others). Some other methods more commonly available though are known to be less effective, or ineffective, such as XRF and microprobe.

Chemical analysis studies of chert are still relatively infrequent. In North America where this type of study began, the field is more developed and the literature on the subject more extensive. Notable researchers in the

field of geochemical analysis of chert in North America are Leudtke[2] and Julig[3]. Although this field is less developed in Europe some initial studies have been made. Bressy's work on a database of chemical analysis of cherts in Southern France[4] is a good model for the progress of this field in Europe.

2. PROPOSAL FOR STANDARDISATION

Having discussed some of the shortcomings of current chert analysis and it's developments a system of analysis and description should now be considered. For the study of chert to be of use to archaeologists, researchers must adopt a standardised method of analysing, describing and cataloguing geological chert types and chert artefacts. In France, Canada and the U.S.A. researchers have begun to objectively describe chert using variations of descriptions used in geology, mineralogy and petrology[5]. The advantage of this is that in geological sciences, such descriptions and the necessary terminology have already been developed and standardised. They are currently in use and are understood throughout that domain. Only slight modifications need to be made for them to be applicable to archaeological studies and sciences. It is the primary purpose of this article to propose a standardised system of analysis of chert in archaeology. It is hoped that such a system will be adopted and applied to both artefacts as well as geological samples of known provenience. The characteristics described in this article appear on the example forms provided in Appendices E and F.

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[2] B.E. Luedtke, *Chert Sources and Trace Element Analysis*, in *American Antiquity*, 43, 1978, p. 413-423; Idem, *The Identification of Sources of Chert Artifacts*, in *American Antiquity*, 44, 1979, p. 744-756.

[3] P.J. Julig, *The Sourcing of Chert Artifacts by INAA: Some Examples from the Great Lakes Region*, in *Journal of World Archaeology*, 1(2), 1995; P.J. Julig, L.A. Pavlish and R.G.V. Hancock, *INAA provenance studies of lithic materials from the western Great Lakes region of North America*, in *Archaeometry `90*, E. Pernicka and A.W. Gunther (eds.), Heidelberg, 1991, p. 435-444; P.J. Julig, L.A. Pavlish, C. Clark and R.G.V. Hancock, *Chemical Characterization and Sourcing of Upper Great Lakes Cherts by INAA*, in *Ontario Archaeology*, 54, 1992, p. 37-50; D.G.F. Long, B. Silviera and P. Julig, *Chert Analysis by Infared Spectroscopy*, in *A Collection of Papers Presented at the 33rd Annual Meeting of the Archaeological Association of Canada*, J.-L. Pilon, M.W. Kirby and C. Theriault (eds.), Ottawa, Ontario Archaeological Society, 2001, p. 256-267.

[4] C. Bressy, P. Bintz and G. Poupeau, *La caractérisation géochimique appliquée aux questions de circulation du silex dans les massifs de Chartreuse et du Vercors (Alpes occidentales, France)*, in *Circulation et identités culturelles alpines à la fin de la préhistoire - Matériaux pour une étude*, A. Beeching (ed.), Cap Valence, Centre d'Archéologie Préhistorique de Valence, nr. 2, 1999, p. 141-150.

[5] B.E. Luedtke, *An Archaeologist's Guide to Chert and Flint. Archaeological Research Tools 7*, Los Angeles, Institute of Archaeology, University of California, 1992; G. Rapp, *Archaeomineralogy*, Heidelberg, Springer-Verlag, 2002, passim; G. Rapp and J Gifford, *Archaeological Geology*, in *American Scientist*, 70, 1982, p. 45-53, passim.

2.1. *Macroscopic Analysis*

Macroscopic analysis should look at the following categories of characteristics: *Appearance*, *Colour*, *Pattern* and *Cortex*. Within each of these categories is a set of characteristics, each with specific means of measurement and terminology for recording measurements.

2.1.1. *Colour*

Although colour is the most commonly used characteristic at present, it is in fact the least diagnostic means of describing chert, especially for comparison between artefacts or with geological source samples. Although the colour of an artefact or geological samples may be quite distinctive, researchers should be careful of relying too much on it for identifying a chert type. Some materials show a very restricted colour range but most do not. As well, the chroma of even the most distinctive chert types may change due to various factors, such as heat treating. The surface colour of an artefact may also be altered by other factors such as patination, leaching or bleaching due to soil conditions, or exposure to the weather for many years.

To record colour, the Munsell colour system should be used. It is used as a relatively international standard in geology and soil sciences. Many archaeologists also use this colour system for recording soil stratigraphy. The two most convenient set of charts produced by the Munsell Foundation are the Soil Chart and the Rock Chart. Both are widely available for sale These contain tables with sample colour chips for the colours most commonly encountered in those domains, which facilitates easy identification of exact colours. Colour in the Munsell system consists of three aspects: hue, value and chroma. Hue is the general colour (e.g. red, yellow, green, blue, purple). Chroma is the intensity of the colour. (e.g. from a neutral grey with no evidence of the hue, to a very intense expression of the hue.) Value is the lightness or darkness of the colour (e.g. from white to grey to black)[6].

2.1.2. *Appearance*

Appearance is comprised of five characteristics – *fabric*, *lustre*, *translucency*, *feel*, and *grain*.

Fabric and lustre are simple characteristics. *Fabric* can be either *homogenous* or *non-homogenous*. *Lustre* can be termed *shiny*, *medium* or *dull*. In addition, the type of shine could be described as *silky*, *greasy*, *pearly* or *waxy*.

Translucency is the degree to which light can penetrate a material, and is measured in the maximum thickness that light can noticeable penetrate. Translucency can be described in two ways. Preferably both methods should be used - a *general description* or a *quantitative description*. A general description can be done in the field without any equipment by holding it up to the sun or a

[6] *Munsell Soil Color Charts*, New York, Munsell Foundation, 2000 (*Munsell Soil Color*), passim.

bright light source. If the chert is transparent or near transparent then it should be recorded as *highly translucent*. If in thin sample, silhouettes can be seen through the sample, and/or light passes through thick parts, then it should be recorded as *translucent***.** If light only passes through thin parts, it is *sub-translucent*. If no or almost no light passes through, it is *opaque*. A quantitative measure should also be recorded if possible. To do this, the artefact or sample should be help approximately 30 cm from a 100 watt light. The greatest thickness where light noticeably penetrates, the thickest part through which light can still be discerned, should be measured in millimetres using a callipers.

Feel can be described as either *rough* or *smooth*. A fingernail should be dragged across the sample's surface. If nothing can be felt (as would be experience with a window or a glass bottle) then the sample is *smooth*. If there is a slight rough feel (similar to the surface of a black board), then the sample is *semi-smooth*. If the sample is distinctly rough, then it should be recorded as very *rough*. Feel is related to grain.

Grain can be described as *fine*, *medium*, or *course*. *Course* grained materials have large and noticeable grains, and individual particles can easily be discerned. *Medium-coarse* grained materials have a smaller but still slightly noticeable grain. Individual particles may not likely be discerned. *Medium* grained materials are smoother and the grain may not be noticeable, but a fingernail will grate detectably when drawn across it. A *fine* grained material will have no noticeable grain, and when running a fingernail across it, no resistance will be noticed. For more detailed descriptions of grain, a microscope should be used. (See the "*texture*" category of microscopic analysis.)

Materials may also be observed with a magnifying glass and additional observations made. If so, then the magnification power of the lens should be noted. Most fossil and non-fossil inclusions are visible with an unaided eye. A magnifying glass or x10 magnification microscope may be used for a closer examination of potential inclusions and to search for the presence of some of the smaller varieties. These can be noted along with the macroscopic grain description but should also be described in detail with the microscopic *grain composition* description.

2.1.3. *Pattern*

Pattern refers to the distribution (whether even or uneven) of colour, grain, lustre and translucency. Pattern may result from depositional processes (linked to original sedimentary context of deposition, see *structure* below) or from diagenesis (appearing during the process of chert formation). A material's pattern or patterns can often be it's most distinctive characteristics or set of characteristics. Pattern can be divided into categories of characteristics, *spots* and *lines*. The characteristic (e.g. the colour, grain, lustre, translucency or

other) of the lines or spots which differs from the rest of the material should be noted as well as how it differs.

Spots can be described based on size and regularity. *Spotted* (circles) and *splotched* (irregular shapes) patterns are both less than 30% of the surface area. *Broad mottling* consists of large irregular blotching, covering more than 30% of the surface. They are often connected together. *Marbled mottling* consists of large relatively round shapes. They also cover more than 30% of the surface and may be connected together. *Speckling* and *flecks* are small dots. Speckles are well distributed over the surface whereas flecks are often grouped together. In all cases of spots, researchers should also describe whether the spots are *regularly* (evenly) or *irregularly* (grouped) *spread over the surface*. Note should be made of the *size* of the spots in millimetres (as either an average or a range). Researchers should also note what *percentage of the surface* the spots occupy (see Appendix C).

Lines may be described as *streaked*, *banded* or *laminated*. *Bands* (or banding) are regular lines greater than 1 cm thick. *Streaking* is a less regular, wider form of banding. *Laminated* lines are less than 1 cm. *Finely laminated* is used to refer to a series of lines less than 1 mm. Lines may occur *horizontally* or in *concentric* circles from a central point. Individual lines less than 2 mm in thickness should be referred to as *lamellae* (or lamellas). Lines may be *straight* or *irregular*, *parallel* (if more than one), *overlapping* or *branching*. In addition to lines being *solid* with distinction between them, they may also be *blended* from one to the next, or *speckled* or *flecked*. Speckled or flecked refers to a band of small dots. In speckled bands, the dots cover more than 30% of the area of the band, whereas with flecked bands, less than 30% of the band is represented by dots, the rest being either the colour of the adjacent band or a different colour altogether. Speckling and flecks are common with streaking (e.g. speckled streaking).

Artefacts seldom fit any of these categories exclusively, and notes should be made describing individual patterns. Often, more than one colour pattern may be evident on samples. Other terms may be used to further describe the pattern, such as *cross-bedding*, *convoluted lines*, etc.

2.1.4. *Cortex*

If cortex is present, researchers should note its *nature*, *aspect*, *colour*, *thickness* and *transition* (*sharp* or *gradual*). Knowing something about the parent rock may help identify artefact sources.

2.2. *Microscopic Analysis*

Microscopically visible properties should be observed with a binocular microscope, at a magnification of 40X, preferably with a polarised filter. In advance, a thin section needs to be prepared. There are five categories of

characteristics to describe when viewing the thin section – *structure*, *texture*, *matrix*, *grains* and *grain composition*.

2.2.1. *Structure*

Structure is the way in which the elements (grains) are arranged. This is conditioned by the original sedimentary context of deposition. There are many ways to describe the structure. Some examples are, *stratified* or *bedded*, *finely laminated*, *with cross bedding*, *in the form of graded bedding*, or *convoluted*. It can also be described as *well* or *poorly sorted* (see Appendix D). If it shows a fluidal arrangement of grains then it can be described as *oriented*. The present of *micro-vugs* or *pores* should be noted.

2.2.2. *Texture*

Texture refers to the nature of and the relationship between the different constituents of a particular rock. This should be specified in terms of Dunham's classification of carbonate rocks (Dunham 1962). Samples could be classified as *mudstone*, *wackestone*, *packstone* or *grainstone*. See Appendices A and B for details of this classification.

2.2.3. *Matrix*

Matrix refers to the general translucency of the sedimentary material (the matrix) found between grains within a rock. General colour and any patterning should be noted.

2.2.4. *Grains*

Researchers should note a mean estimate of *proportion*, *colour*, *shape* (morphology), and *size* of the grains. An example chart for estimating proportions is provided in Appendix C. Grain shape comprises attributes which refer to the external morphology of particles. These include *roundness* and *form*. General roundness (or angularity) can be determined by comparing the roundness of the grains in a sample to prepared charts (see Appendix D). Form refers to the variation in proportion of the three axes (three dimensions, e.g. short, intermediate, long) which define the geometric shapes of the grains. The most popular measures used are *sphericity* and *Zingg diagrams*, but others also exist and may be used. Sphericity describes the proximity in shape to a sphere. This is normally visually estimated using charts. Zingg diagrams plot the ratios of the axes (short: intermediate – c: b) vs. (intermediate: long – b: a). The shape terms often used are *blades*, *rods*, *disks* and *spheres*[7]. It is sufficient to make a visual estimate instead of actual measurements. Example charts for estimating roundness and form are provided in Appendix D. *Size* (an average and/or a range) can be measured while looking through the microscope. The variation in grain size is commonly known as *sorting*. A well sorted material

[7] T.H. Zingg, *Beitrag zur Schotteranalyse*, in *Schweizische Mineralogie & Petrographie Mitteilungen*, 15, 1935 (Zingg, *Beitrag*), p. 39-140.

has mainly grains of similar size. A poorly sorted material has a variety of different sizes[8]. There is a general correlation with shape. Well sorted grains tend to be more well rounded whereas poorly sorted grains tend to be more angular. The sorting can be computed from a histogram of the grain size distribution but can also be estimated using a visual chart (see Appendix D).

2.2.5. *Grain Composition*

Grain composition is the material(s) of which the grain is composed. Some materials such as fossils are often highly characteristic of specific lithic materials. Determined by their geological origins, grain compositions are highly indicative of material source. Some inclusions can particularly diagnostic of materials found in specific locations. Here are some common examples. *Brachiopods* are a type of bivalve mollusc, and parts of their shells may be found in cherts. *Bryzoans* form lacy colonies that can be seen in chert. *Crinoid columns* are seen as long shafts or in round cross section. *Fusilinids* have a small rice like form and have a snail shell like appearance in cross section. *Solitary corals* (spiral in shape) and *sponge spicules* (tiny pointed fragments) are also to be found in some cherts. A few cherts, such as Galena, have faint *fossil borings*, left by the holes of ancient worms. Some cherts have *oolites*, which are small round grains formed by calcium carbonate.

Grains can be organised into several groups:

- *coated grains* (ooliths, ooids, oncoids), *grain aggregates*, *clasts*, and *peloids/pellets*;
- *skeletal gains* (e.g. from foraminifera, bryozoans, sponges, ostracods, brachiopods, gastropods, lamellibranchia/pelecypods, echinoderms, radiolarians, serpulids, corals, incertae sedis, &c);
- *algae*;
- *organic mater*; and
- *other elements* (e.g. quartz, glauconite, pyrite, mica, iron oxides, etc.).

2.3. *Chert Artefact Attributes to Describe*

In addition to a description of the material that an artefact is made of it is important for researchers to record some other data pertaining to the artefact itself and the context in which it was found.

After consulting a database of chert types, particularly those of the immediate vicinity, or from comparison with geological samples which the researcher has seen, the most *likely type of chert* should be suggested. The "Chert ID" and "Chert Name" should be used. Both of these are described below in the section on geological source descriptions. As well, if the researcher is unsure of the type of chert, he or she should indicate other *possible*

[8] K. Simpson, *Siliciclastics: Grain Size*, 1995 (Simpson, *Siliciclastics*), passim.

types of chert. This should also be noted if there exists other chert types that match (or closely match) the description of the artefact, no matter how remote the possibility.

Some background information about each artefact should be recorded. The *site where the artefact was found* should be noted. One should record both the geographic location and the name of the site or excavation where found. Other information, such as culture and time period of the culture, trench/section number and depth, year of discovery, and site director may also be recorded. This information may be used later for two functions. Firstly, it will help to understand the connection with other similar artefacts and possible sources. Secondly, it will be useful in cases in which someone later wishes to find the artefact or excavation notes in storage or the archives. The *context in which the artefact was found* should be noted. This encompasses the environmental conditions of the site where the artefact was found. This is also of use in drawing connections with artefacts found at other sites and with geological sources. The *size of the artefact* is important to know for other researchers who may not have seen the artefact. Small artefacts may not exhibit all of the characteristics typical of their source materials. For this reason, one should not the length, width and thickness of the artefact.

2.4. *Geological Source Descriptions*

2.4.1. *Formation Identification*

The main thing that should be established for each geological chert sample is the formation identification. This is comprised of several forms of identification – *chert name*, *chert ID*, *other known names*, *geological material* and *possible connections*.

Each chert type should have a common *name*. If one does not exist, for example if a new type of chert is being catalogued, then a name should be given to it. The name of the chert should be the most commonly used and accurately descriptive name used in the literature. If more than one name exists, the oldest should be used. In addition to a common name, each type should have a *chert ID*. This is made up of 1 or 2 letters based on the geological period of the strata in which it was located, plus a 2 digit number used to distinguish it from other cherts of the same geological period, and 2 letters to identify which country the formation is located in.

Other known names of the chert or names used in the literature to refer to this chert should be listed. This is important for future researchers who may be presented with several names in the literature used for the same chert type.

The *geological material* should be recorded. This is the information written on geological maps to refer to this chert. Typical pieces of information

include geological period of the formation (e.g. Late Cretaceous – Early to Middle Oxfordian) and material type (e.g. chert, jasper, chalcedony, opal, etc.).

Possible connections to other cherts from similar formations with similar attributes which might be of a similar origin to this chert should be noted. This is particularly useful in cases where several chert types may either be semi-distinct parts of a larger formation or in fact identical parts of a single formation.

2.4.2. *Mode of Occurrence*

The mode of occurrence should be noted in type descriptors. This describes how and where the chert occurs. This includes the outcrops when in primary context, morphology, size of cherts, etc. The following information should be recorded for geological sources: *locality*, *site names*, *geographical descriptions*, *geographical co-ordinates*, *precision of coordinates*, *geology*, *type of source*, and *other types of chert in the area*.

Under *locality* one should record the country, county and the nearest city, town or village. In addition names given to this site (*site names*) should be noted. This includes official names, such as on maps, or locally given names. When researchers are in the field at source locations, they should make a *geographical description* of the area. One should give a physical description of where the sample was collected so that other researchers can more easily find the location later if they are searching. For example, "at the bottom of a steep slope, at a bend of the Ampoi river just before it goes under a road bridge, approximately 2km west of the village of Miceşti, which is located just to the north-west of the city of Alba Iulia".

As accurately as possible, *geographical coordinates* of outcrops should be indicated. If possible, latitude and longitude readings from a GPS should be used. The *precision of the coordinates* should be indicated so that later researchers know how far from the coordinates the location may be. One should note how accurate the coordinates listed are. For example, "within 5km", "within 20m", etc. It is also useful to know how the coordinates were derived (e.g. "from a handheld GPS unit", "from visual analysis of a map", "by triangulating position relative to other landmarks", etc.). For ease of later researchers, it is useful to note which *topographic map* (or maps) this location can be found upon.

The *geology* of the location should be noted. This is the formation according to the geological maps to which the substrate belongs. This information is written on the legend of the map. To better understand how the samples may have travelled or how widely material might naturally occur, it is useful to indicate the *type of source* for samples found. For example, primary, secondary, fluvial, alluvial, glacial deposit, erratics, etc. Finally, *other types of chert in the area* should be noted. One should list and briefly describe, what

other chert types are located nearby, how far away they are, and whether there is a possible connection to these other cherts.

2.5. *Recording Descriptions*

The benefit of having a standardised system of analysis and description is that it can easily be entered into a database. The information that researchers collect should be recorded on a paper form or in an electronic database. Examples of forms for artefact and geological samples appear in Appendices E and F respectively. Descriptions initially recorded on paper should at some point be transferred to an online database. In an electronic format, it is much easier for researchers to combine data from other researchers with their own. It also makes it possible to consult, compare with and add to larger centralised databases. A standardisation of information entered into databases would make it easier for the data to be converted into other languages without having to translate the entire database.

3. CONCLUSIONS

Without a more standardised system of describing chert artefacts, a large aspect of the study of prehistoric cultures, 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. By comparing artefacts to geological samples of known provenance, archaeologists can better determine the provenance of those artefacts. With a large database of geological samples, it is much more likely for archaeologists to determine the source or possible source of chert used to make tools found at a site. Researchers can investigate questions regarding how far people travelled to obtain raw materials, which types of chert they were receiving through trade and who were likely trading partners and possibly even whether the chert 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 chert.

Standardised characterisation of chert would improve inter-site comparisons. Researchers could more easily and more accurately describe the artefacts that they find. This in tern 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 so gain a better insight into prehistoric ways of life.

When it is possible to describe artefacts and assemblages in detail with a standardised method then it will be much easier for international studies.

When descriptions can be entered into a database then it is much easier to convert that data from one language to another. Researchers from one country will more easily be able to compare their finds to finds found in other (often neighbouring) countries, even if there exist minor language barriers. Since the areas occupied by many past culture groups extends beyond modern borders it is advantageous to be able to consider research and discoveries made in various countries. It would be possible for researchers with little or no language skills to gather information from a country where they do not know the local language. Foreigners could also read descriptions made locally and understand them, even if they do not have a lot of experience with local chert types.

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

OTIS NORMAN CRANDELL
"1 Decembrie 1918" University, Alba Iulia

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APPENDIX A: Dunham's Classification of Carbonate Rocks
(based on Dunham[9]).

Mudstone:

Fine-grained rocks containing between silt (62.5 µm - 3.90625 µm) and clay (< 3.90625 µm) sized particles, but not less than 33% of either.

-less than 10% grains
-rest is silt and clay sized particles (matrix)
-matrix supported

Wackestone:

Rock composed of greater than 10% grains. Wackestones are matrix-supported, i.e., grains do not support one another with matrix simply filling in between grains.

-more than 10% grains
-matrix supported

Packstone:

Rock composed of grains and matrix. This is grain-supported and matrix simply fills in spaces between grains that are in contact with one another.

-grain supported
-contains matrix but matrix simply fills in spaces between grains that are in contact with one another.

Grainstone:

Rock composed of grains, but lacking matrix. Spaces between grains are filled with cement.

-grain supported.
-lacks matrix
-spaces between grains are filled with cement

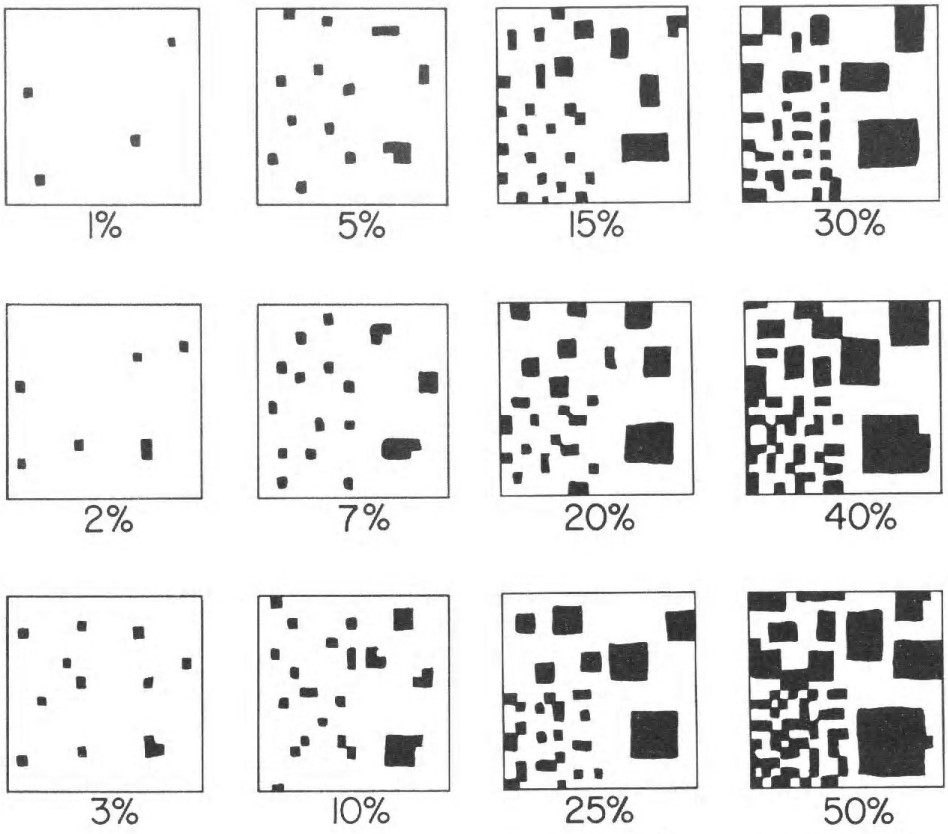
[9] R.J. Dunham, *Classification of Carbonate Rocks According to Depositional Texture*, in *Classification of Carbonate Rocks*, W.E. Ham (ed.), American Association of Petroleum Geologists Memoir, 1962, p. 108-121, passim.

APPENDIX B: Grain Size Scales
(based on Wentworth[10]).

Size	Wentworth Size Class	Sediment Name
2 mm	Very Coarse Sand	Sediment: SAND
1 mm	Coarse Sand	
500 µm (1/2 mm)	Medium Sand	
250 µm (1/4 mm)	Fine Sand	
125 µm (1/8 mm)	Very Fine Sand	
62.5 µm (1/16 mm)	Silt	Sediment: MUD
3.90625 µm (1/256 mm)	Clay	

[10] C. K. Wentworth, *A Scale of Grade and Class Terms for Clastic Sediments*, in *Journal of Geology*, 30, 1922, p. 377-392, passim.

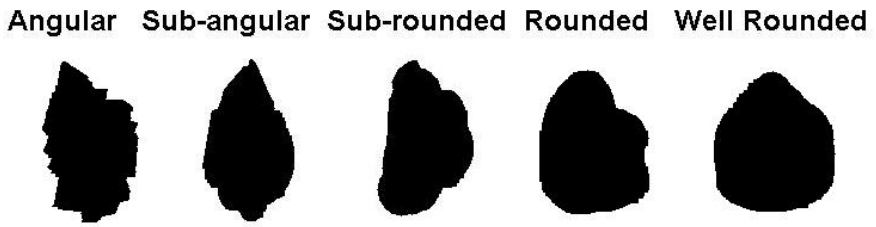
APPENDIX C: <u>Charts for Estimating Proportions of Spots and Grains</u>



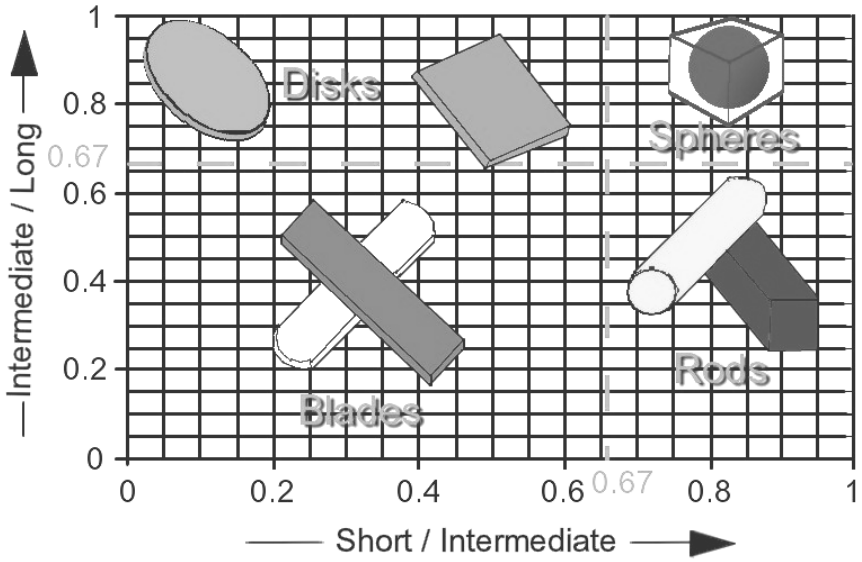
Each fourth of any one square has the same amount of black
(from *Munsell Soil Color*, p. 10).

APPENDIX D: <u>Diagrams for Estimating Morphology and Sorting of Grains</u>

Roundness

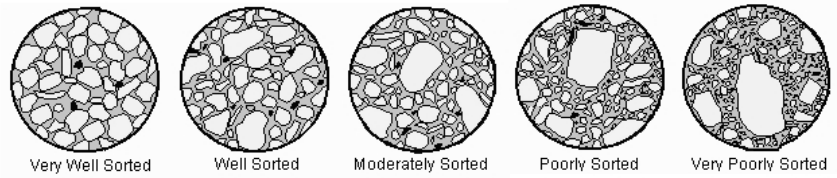


Form



(based on Zingg, *Beitrag*, passim).

Sorting



(from Simpson, *Siliciclastics*, passim).

APPENDIX E: Geological Chert Sample Form

-1-

Artefact / Sample Number: _____ Date: _____ Recorder: _____

Collection: _____ Artefact Type: _____

Photo (Y/N): _____ Diagram(s) (Y/N): _____

FORMATION IDENTIFICATION:

Chert name: _____ **Chert ID:** _____

Other Known Names of this Chert: _____

Material (geologic): _____

Possible Connections: _____

MODE OF OCCURRENCE:

Locality: *Country* _____ *County* _____

Nearest city, town, village _____

Sample Site Names: _____

Geographical Description: _____

Geographical Coordinates: _____

Precision of Coordinates: *Accuracy* _____

Source of Coord. _____

Topo. Map _____

Geology: *Formation* _____

Type of source: _____

Other types of chert in the area: _____

How far away? _____

Possible connections _____

Context in which the sample was found: _____

Size of the sample:

Length _____ *Width* _____

Thickness _____ *Mass* _____

Diagram(s):	**Digital Photo:**

Notes: _____

Geological Chert Sample Form
- 2 -

MACROSCOPIC VISIBLE PROPERTIES

Appearance:

Fabric: (*homogenous / non-homogenous*)

Lustre: (*shiny, medium, dull*) *Description*: _____

Translucency: *General: (highly translucent, translucent, sub-translucent, opaque)*

Quantitative: _____ mm

Feel: (*smooth, semi-smooth, rough*)

Grain: (*fine, medium-fine, medium, medium-coarse, coarse*)

Inclusions: _____

Colour: *Hue* _____ *Value* _____ *Chroma* _____ *General* _____

Pattern:

__ solid

__ colours (or characteristics): _____

__ spots

- spread over surface: regularly / irregularly
- size of spots: average: _____
  range: _____
- percentage of surface: _____

__ spotted / splotched

__ mottling (broad / marbled)

__ speckling / flecks

__ description _____

__ other: _____

__ lines

- thickness (mm) _____
- streaked / banded / laminated
- horizontal / concentric
- solid / blended / speckled / flecked
- parallel / non-parallel
- straight / irregular

__ lamellae: thickness: _____

- parallel / overlapping / branching

__ other: _____

Cortex: *Nature* _____ *Aspect* _____ *Colour* _____
Thickness _____ *Transition* _____

MICROSCOPIC VISIBLE PROPERTIES

Structure: _____
Sorting: _____ *Orientation:* _____
Texture: (*mudstone / wackestone / packstone / grainstone*)
Matrix: translucency: _____ colour: _____ pattern: _____
Grains:
Proportion: _____ *Colour:* _____
Shape: Roundness: _____ *Form: (blades / rods / disks / spheres)*
Size: (µm) *average:* _____ *range:* _____ *Sorting:* _____
Grain composition: (groups and descriptions of each)
-group: _____ description: _____
-group: _____ description: _____
-group: _____ description: _____
-group: _____ description: _____
Other Info.: _____
_____

APPENDIX F: Chert Artefact Form

Artefact / Sample Number: _____ Date: _____ Recorder: _____
Collection: _____ Artefact Type: _____
Photo (Y/N): _____ Diagram(s) (Y/N): _____

Most likely type of chert: _____
Other possible types: _____
Site where the artefact was found:
Name of site: _____
Location of site: _____
Context in which the artefact was found: _____
_____

Size of the artefact: *Length* _____ *Width* _____
Thickness _____ *Mass* _____

Diagram(s):	**Digital Photo:**

Notes: