Implications of crushed pottery in prehistoric pottery

■ **Fig. 4**
Volume of ceramic matter used for making of one of the groups of vessels.

This contribution presents an experiment attempting to address the problem of loss of ceramic material as grog when used by prehistoric societies in the production of new pottery.

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The use of grog, crushed pottery used as temper, has been a part of pottery manufacturing from the beginning of pottery manufacture to the present. In prehistory grog presence in matter is a feature of many cultures. The use of this material can be purely practical but we also have to allow for reasons related to the spiritual concepts of prehistoric populations.

Starting points

While analysing ceramic finds from a long term research of the Neolithic settlement at Mohelnice (Moravia, Czech Republic) members of the research team gained a subjective impression that the majority of about 90,000 pottery sherds contained crushed pottery fragments. This developed into a discussion on the possible impact on the interpretation of the archaeological material. If the presence of large volumes of grog is confirmed, it would be necessary to consider the 'shredding' of large amounts of pottery during the Neolithic. As a result much of the pottery would not have entered the formative processes and therefore the archaeological record. This would surely affect archaeologists' conclusions about any given site. We have to state though that archaeologists only estimate the proportion of ceramic remains transferred from a living culture into the archaeological culture to about 1 to 10 %.

Use of grog in various periods

At the moment our knowledge of grog use is based on the analyses of about 2,000 microscopic mounts with ground sections of pottery from the late Palaeolithic to modern times from the Czech Republic. During the Neolithic we commonly found an admixture of pottery fragments, although not as often as in the Aeneolithic. In the Bronze Age and the Early Iron Age, grog appears usually in storage jars and vessels of rough shape. During the Late Iron Age grog was used only in some regions. In Eastern Slovakia there has been observed an interesting phenomenon of adding crushed graphite pottery into sandy pottery. During the time of the Roman Empire grog appears rarely. During the Middle Ages this phenomenon appears only in certain production centres. During the High Middle and New Ages crushed highly fired pottery is used to temper kiln furniture – for example crucibles.

Possible reasons for grog use

The use of crushed pottery as temper can be due to a number of reasons. One of them is the lack of suitable temper materials within a region. Unsuitable materials can cause the cracking of walls, the flaking of surfaces and considerable colour changes. For this reason the easiest solution would be the crushing of broken pottery and using it as a temper. Such temper has a similar characteristic to the new pottery and improves the quality of the vessels. The main advantage of this temper is the fact that it considerably lowers the weight of the pottery in comparison to pottery using a mineral temper.

The use of grog may also have been caused by a need to dispose of pottery waste in a settlement or during production so that it may be possible to consider 'ecological' aspects to this phenomenon but we also have to allow for reasons related to the spiritual concepts of prehistoric populations

We also have to admit the possibility that in some prehistoric cultures pottery fragments entered the new pottery by chance.

Exact research of ceramics containing crushed pottery

In this study we concentrated on the technological significance of grog and attempt to explain the phenomenon by scientific methods. At the beginning we would like to present some basic terminology of pottery technology in connection with the given problem.

Pottery matter is created with two basic components – temper and matrix. Temper is a clastic component consisting mostly of sand (0.05 – 2.0 mm) and less often of grit grains (2.0 – 10 mm). To de-

■ **Fig. 5**
Making of replica Lengyel pottery.

LBK	
Volume of crushed pottery:	0.48 l
Volume of ceramic mixture:	1.33 l
Approximate ratio of experimental volumes:	1:3
Ratio of volumes of original pottery: in LBK sherds were identified as around 5-10% of the determinable pottery fragments, the original volume of grog could have been higher, but could not be determinable with optical microscopy due to the presence of fine particles	
Lengyel culture	
Volume of crushed pottery:	1.20 l
Volume of ceramic mixture:	1.33 l
Approximate ratio of experimental volumes:	1:1
Ratio of volumes of original pottery: in Lengyel pottery siltstone and slate was macroscopically confused with pottery fragments. Their volume in the sherds was about 15%.	

■ **Table 1** Overview of the basic experiment and lab data.

scribe the single particles of the temper we use the term clast or grain. Fragments of rocks (clastic rocks) can be a natural component of the clay or they can be added intentionally (for example waste from knapping or stone polishing). In prehistoric pottery there is usually a wide range of rocks (fragments of mica, gneiss, granulite, aplite et cetera) present. Sand clasts can consist of crushed rocks or weathered surface layers. Further it is possible to identify various technoliths (old crushed pottery or daub, slag from the making of bronze or iron, metal fragments, ash particles et cetera). The matrix is the plastic component of pottery; it consists of clay minerals which when heated recrystalize into a stable mineral phase. These newly created phases enclose the clasts of the temper while creating a relatively firm compact matter. Clay minerals in the matrix cannot be identified by optical microscopy.

Matrix components are commonly and reliably identified with optical microscopy. The content of crushed pottery in a sherd can be reliably determined using thin ground section mounts of 0.3 mm thickness, taken across the wall of the vessel, this means approximately at a right angle towards its surface. Ground section mounts made this way are observed with direct or polarised light in a microscope. This way it is possible to identify the rock fragments which can look like crushed pottery – siltstone, ferric sandstones, some slates, gneiss and iron oxyhydroxides.

Microscopy informs us about other important characteristics of sherds containing grog. On the basis of the ground sections we can say if the shard contains grog of the same matter as the pottery itself or if it contains remains of other pottery. Further we can determine if the fragments added come from pottery fired to higher or lower temperatures and the firing atmosphere of the original pottery (reducing, oxidizing).

Experiment

To develop our ideas on the possible impact of 'shredding' pottery material a simple experiment (**Fig. 5**) was carried out in the Centre of Experimental Archaeology in Všestary (CEA). It consisted of crushing a measured volume of pottery sherds and working it into a known volume (two cubes) of ceramic matter (one of these is shown in **Fig. 4**). From these, several replicas of Neolithic vessels were made (**Fig. 3**).

To allow for a comparison we chose two different volumes of grog (**Fig. 1** and **2**) which should hypothetically corresponded with the use of grog within two Neolithic cultures: LBK and Lengyel culture. Each amount was worked into a cube of clay of 11 cm to a side. From one (LBK) we made two rounded vessels (**Fig. 3**: the two dark vessels on the right), from the other (Lengyel culture) four vessels (**Fig. 3**: the four light vessels on the left).

The sherds of pottery were crushed with replica stone grinders. The result was a mixture of various coarseness from clay dust to small sherds subjectively corresponding to the size of pottery fragments in the original prehistoric pottery. The resulting volume was measured by pouring the crushed pottery into a measuring jug.

The number of pottery sherds entering the process or vessels exiting is not important for the experiment although they show clearly the amount of sherds (every archaeologist has his or her idea if it is a lot or little) and 'recycled' vessels. The relative volumes of grog and ceramic mixture for the making of the new vessels are the important variables. The proportion of the two volumes represents the behaviour of grog in the experimental sample.

The aim of the experiment was to compare the chosen amount of grog in the experimental sample with the amount in the original sherds of LBK and Lengyel pottery from Mohelnice. This analysis took place in Brno at the Institute of Archaeology and Museology, Philosophical Faculty of Masaryk University and the Institute of Geology, Faculty of Science of Masaryk University.

Comparison of grog content

Two samples of pottery made in CEA Všestary were sent for analysis. In one case the sample contained a small amount and in the other a large amount of grog (**Fig. 6**). The samples were not fired but the characteristics of grog in the dried sample were recorded. After preparing ground sections from the dried samples, these were fired in the laboratory kiln at the temperature of 900°C (**Fig. 7**) for four hours. (Note: generally the temperatures of prehistoric pottery firing were between 600 and 700°C. We chose the top temperature limit for pottery firing as it can be presumed that this temperature can affect the characteristics of the pottery more).

The results of analysis of experimental samples were compared with the results from an analysis of more than 60 pieces of prehistoric pottery made within a grant project aimed at recording the finds from Mohelnice. Most of the ceramic finds analysed consisted of Neolithic pottery and within all levels of LBK the pottery contained fragments of crushed pots.

The mentioned experiment was supposed to reconstruct the production process. The ground sections of experimental samples were supposed to show to what degree the reconstruction succeeded. The comparison of microstructures of experimental samples and LBK sherds (**Fig. 8, 9**) shows that the admixture of crushed pottery had to have entered the matter in a different way.

The pottery fragments contained in the ceramic finds from Mohelnice had rounded edges which would indicate that they were weathered and may have entered the matter by chance. Clay for Neolithic pottery production was probably taken from building pits beside the post-built houses. The seasoning of the material, which affects the characteristics of the ceramic mixture positively, may also have taken place in these pits. Ethnographic studies show that this process can take up to several decades. The actual time of seasoning is not possible to determine, it can only be suggested by certain signs. For example charred leaves and roots in the pottery matter could be evidence of long term seasoning, although other explanations are possible. Under the influence of atmospheric conditions harmful matter breaks down and the clay homogenizes. If broken pottery appeared in the same pits it is possible that it disintegrated over winter and the remains entered the material and are still microscopically (occasionally even macroscopically) recordable in finds. In sherds of the LBK it is estimated that crushed pottery made up to about 5% of the overall volume of matter. The Lengyel sherds from Mohelnice contained numerous red and grey fragments, up to 5 mm large (**Fig. 10, 11**) which were macroscopically interpreted as grog. Microscopic analysis of ground section mounts showed that these were fragments of slate and siltstone.

Conclusion

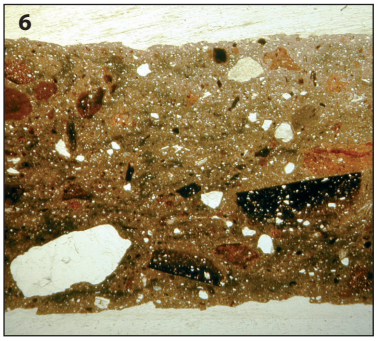
The experiment failed in reconstructing the production process of LBK and Lengyel pottery as presented in the finds from Mohelnice. The analysis though did eliminate the use of grog in Lengyel pottery, the observed phenomenon being fragments of crushed siltstone and slate which look similar to pottery. In LBK the presence of pottery fragments was probably due to causes other than deliberate tempering, in all likelihood a result of contamination of the clay during the process of seasoning. On the other hand the experimental samples from Všestary are, in its character, close to Baden culture pottery (Aeneolithic) where grog often appears. This is shown by micropetrographic analysis of pottery from Těšetice-Kyjovice and Hlinsko where this sort of temper appears in nearly every sherd. The fragments in the Baden pottery have relatively sharp edges and are quite big. They make up to 15% of matter and occasionally more. That brings up the question that if this culture 'recycled' its pottery how does this reflect on the study of its fragments.

■ **Fig. 1** 'Larger' amount of pottery sherds (Lengyel).
■ **Fig. 2** 'Smaller' amount of pottery sherds (LBK).

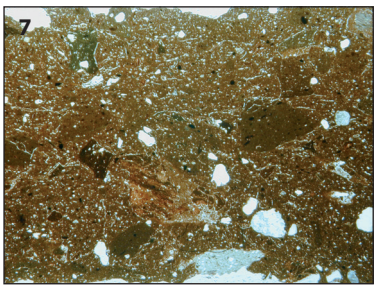
Even after this experiment, the risk of prehistoric pottery 'shredding' is not unambiguously clear. Our experiment shows that we can model the situation where a volume of crushed pottery is added to a larger volume of clay, absorbing a significant amount of pottery fragments. However it must be admitted that the exact volume cannot be determined even with microscopy. This is because when crushing pottery, a very fine dust fraction, not determinable by optical microscope because prehistoric and experimental pottery is fired in relatively low temperatures, develops. These fine particles when mixed with damp ceramic mixture rehydrate and merge into the surrounding matrix.

As was mentioned above, archaeology has to consider a number of obstacles presented by the formative processes. If the risk discussed in this contribution adds to them, we should respect it despite the difficulty of creating means of identifying it.

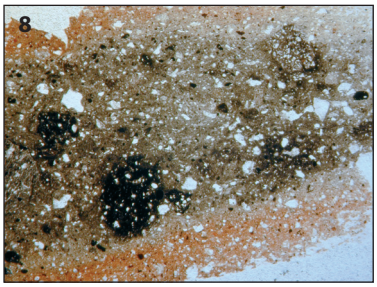
■ **Fig. 3** LBK and Lengyel vessels produced.



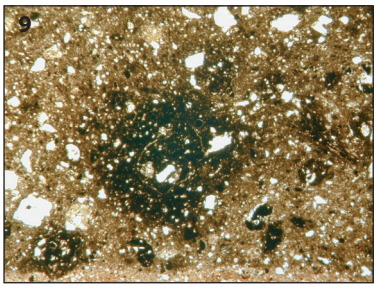
■ **Fig. 6** Section of the experimental pottery magnified with a stereomicroscope. Microstructure of the dried pottery with a sharp edged pottery fragments.



■ **Fig. 7** The same sample of pottery fired to 900°C. Cracks are visible along grains, pottery fragments optically merge with the surrounding matter.



■ **Fig. 8** Mohelnice, LBK. Rounded pottery fragments in the sherd. 10x, PPL.



■ **Fig. 9** Mohelnice, LBK. Detail of a rounded pottery fragment in the sherd. 20x, PPL.

■ **Fig. 10** Mohelnice, Lengyel culture. Fragments of slate intruding into the surface of a pottery sherd fired in oxidizing atmosphere.

■ **Fig. 11** Mohelnice, Lengyel culture. Fragments of slate intruding into the surface of a pottery sherd fired in reducing atmosphere.

Summary

Schlussfolgerungen aus der Existenz zerschlagener Keramik (Schamott) in urgeschichtlichen Keramikgefäßen

Bei der Analyse der Funde des Langzeitprojektes „Die neolitische Siedlung von Mohelnice (Mähren, Tschechische Republik)“ entstand bei den Mitgliedern des Forschungsteams der subjektive Eindruck, dass die Mehrzahl der ca. 90.000 Keramikscherben zerschlagene Keramik, sog. Schamott, als Magerung enthielt. Diese Beobachtung führte zu einer Diskussion über die möglichen Auswirkungen bei der Deutung archäologischen Fundmaterials. Um Ideen zu den Wirkungen der bewussten Zerkleinerung von Keramik zu erhalten, wurde ein einfaches Experiment durchgeführt. Es bestand aus dem Zerschlagen einer jeweils festgelegten Menge an Keramik und der anschließenden Einarbeitung dieses Materials in Ton zur Keramikherstellung. Die auf diese Weise gewonnenen Proben wurden analysiert und die Resultate mit den Daten der Originalfunde verglichen.

Durch dieses Experiment konnte nicht der Herstellungsprozess der bandkeramischen und lengyelzeitlichen Keramik, wie sie aus den Funden von Mohelnice bekannt ist, rekonstruiert werden; die Analyse ergab nämlich, dass das in der lengyelzeitlichen Keramik beobachtete Material nicht Schamott, sondern zerkleinerter Sandstein und Schiefer waren. In den bandkeramischen Gefäßen scheint außerdem die Existenz von Schamott andere Gründe als eine absichtliche Magerung zu haben; vermutlich handelt es sich dabei lediglich um eine beim Magern unbeabsichtigt entstandene Verunreinigung.

Andererseits entsprachen die für das Experiment hergestellten Proben weitestgehend der Zusammensetzung von Keramik der äneolithischen Badener Kultur, wie sie aus Funden der Siedlungen von Tesetice-Kyjovice und Hlinsko bekannt ist.

Eines der Ergebnisse des Experiments ist die Feststellung, dass das exakte Volumen der für die Magerung zerschlagenen Keramik nicht einmal mit Hilfe eines Mikroskops genau festzustellen ist. Dies liegt daran, dass beim Zerschlagen der Keramik ein sehr feiner Staub entsteht. Diese feinen Partikel verschmelzen mit der weiteren Magerung und können nicht mehr als ein beabsichtigter Zuschlag erkannt werden.

Poterie à débris de terre cuite

En étudiant la céramique provenant du site néolithique de Mohelnice (Moravie, République tchèque), fouillé systématiquement dans les années 50 et 60 du siècle dernier, les auteurs sont arrivés à une impression subjective que la plupart de 90 millers de tessons contiennent des débris minuscules de terre cuite. Cette constatation a produit une discussion au sujet d'influences potentielles sur l'interprétation archéologique. Afin d'avoir une certaine idée sur un impact potentiel de ce „rejet au rebut“ céramique, on a effectué une petite expérimentation consistant en broyage d'une quantité connue de tessons et en leur incorporation dans une certaine quantité de pâte céramique. A partir de cette préparation, on a fait des échantillons qu'on a soumis à une analyse micromorphologique. Les résultats obtenus ont été comparés à ceux issus des analyses faites sur des tessons originaux.

Cette expérimentation n'a pas permis de reconstituer le vraie procédé de fabrication de la poterie linéaire et de celle de Lengyel, tel qui s'avère sur les pièces de Mohelnice. L'analyse a éliminé l'utilisation du dégraissant en terre cuite pour la céramique de Lengyel où les particules observées sont en ardoise. Puis, il est probable que la présence de débris en terre cuite constatée sur de la céramique linéaire a été due à d'autres facteurs qu'à l'addition volontaire du dégraissant (peut-être à la contamination de l'argil au cours de la maturation). Par contre, les échantillons expérimentaux ressemblent beaucoup à la céramique de la civilisation de Baden découverte sur les sites de Těšetice et Hlinsko (République tchèque).

Cette expérimentation met en évidence que ni analyse micromorphologique ne permet déceler la quantité précise de débris de terre cuite parce qu'en broyant des tessons, on produit une très fine fraction poudreuse dont des particules minuscules se fondent en liant et ainsi, elles ne sont plus perceptibles.

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