ON THE METHODOLOGY OF STUDIES CONCERNING THE USE OF STONE RAW MATERIAL IN THE NEOLITHIC

Summary

This article substantiates the necessity of expanding the studies on Neolithic economy by investigating differentiations and various patterns of use of stone materials. Such studies are possible and effective only on the basis of mass petrophic evidence. The present work introduces goals and methodological foundations of the program of petro-archaeological studies[16]* prepared in the Poznań Archaeological Museum, in 1971. This program was realized together with the Department of Geology at Adam Mickiewicz University in Poznań. A predominant position in our knowledge concerning raw material economy of the Neolithic stone industry in Central Europe is taken up by thoroughly investigated problems concerning the exploitation, distribution and use of flint raw material. Identical problems concerning other stone materials (primarily crystallic rocks) are still treated marginally, although they involve basic types of tools and weapons. It seems, this was caused by the lack of suitable methodological propositions and — as regards petrographic research — the lack of traditions in comprehensive cooperation between prehistorians and geologists (with the exception of Great Britain[7–11], the Germany[13] and after the war Czechoslovakia[14]).

Following a short discussion on the history of petrographic research dealing with Neolithic stone implements[2], the authors characterize the possibilities of investigating differences in the raw material basis of Neolithic stone industry. The petro-archaeological research program referred to was believed to supplement pure archaeological information with an additional category of data — i.e., the definition of rock material — and to increase considerably the cognitive worth of

* See notes to Polish text.

Neolithic stone tools in relation to more traditional analyses of these implements, which considered only such aspects as morphology, chronology, distribution, cultural status and — though seldom — traseology. It seems that the methodological assumption of the relevant program can be more extensively applied than hitherto (Mid-western Poland, cf. Maps 1–5) and could provide a basis for similar researches in the entire area of the Central European Lowlands embraced by the Scandinavian glaciation. The proposed program is based on three kinds of methods: the archaeological, petrographic and statistical.

The aim of the initial stage of research is to collect petrographic identifications of the respectively rich series of Neolithic polished tools. The investigated series should be relatively differentiated both as regards chronology, culture, geography and typology. The chronological and cultural classification of the complete series of the Neolithic stone implements from a particular territory — considering the generally decisive predominance of loose finds and the inter-cultural character of several types — must be based, out of necessity, primarily on typological criterions[18], which results in a considerable generalization of results (within the framework of cultures and cultural cycles or technocomplexes). This, however, suffices for the relevant program, since we assume that basic changes — of interest to us — in methods of using stone material, as a matter connected with economy, did not occur in the Neolithic suddenly, neither did they last a short period only, but embraced periods of time exceeding the duration of a single phase of a particular culture.

The petrographic characterization of a selected series of implements has been achieved due to the macro- and microscopic method (also known as the thin slices method). The exclusive use of the second of these methods (as has been done in the British research program) would be most advisable, since it yields results of a much greater precision. But a program so intensive can be realized only with the close cooperation of several specialistic institutions which dispose of considerable funds and research possiblities (British researches initiated in 1938 are still in the stage of realization)[7–11]. The choice of the exclusive microscopic method was decided also by the specificity of Great Britain's geological situation, where research was focused principally on the localization of rock quarries exploited in the Neolithic. This task, though complex and requiring arduous research, is anyway easier in areas free from glaciation (and, consequently, deprived of erratic materials), which include most of the British Isles. In such a case it may be assumed, with great probability, that every stone implement found in this territory, was produced from raw materials obtained from the primary quarry. The localization of a quarry is possible only after a thorough investigation of the raw material used in the production of the tool in question. However, as regards the Central European Lowlands, a discrimination of a large part of erratic materials is possible already during a macroscopic analysis. The use of the arduous and expensive thin sections method in the examination of samples of these rocks would not essentially enrich our deliberations. Nevertheless, a complete elimination of the microscopic method may involve a too wide margin of errors[20].

Since we have no possibility to carry out mass microscopic analyses, we have chosen an indirect procedure. We began with an analysis of the entire series, using the macroscopic method; if the surface of the object was badly weathered it was necessary to slightly flake off some of its upper part in order to get a fresh section. A double task was assigned to the thin sections method (Figs. 1–4): a) the control of correct determinations by the macroscopic method, b) a highly precise definition of the petrographic character of raw materials, which would allow to tally them later with specific rock quarries. The thin sections method proved the correctness of macroscopic determinations of most samples, but sometimes it indicated necessary corrections (Figs. 1–4). The true relation between the type of rock and the form of its surface weathering determined by the microscopic method provided the basis for corrections. To correct the whole series it was necessary to repeat a macroscopic analysis and to study the results obtained. Some of the raw materials, at first thought to be basalts, were verified (microscopically) as amphibolites. Further, a macroscopically investigated siliceous Silurian schist, turned out to be a hornblende gneiss.

To achieve the second goal with the aid of the thin sections method specimen thus marked as basalts were further microscopically examined with the use of a microscopic (planimetric) analysis. The obtained mineral contents and the description of particular minerals, based in each case on 300 linear measurements, were compared with analogical data from several basalt quarries in various regions of their appearance. The similarity of proportions and optic properties of minerals provided grounds for conclusions that a sample originated from a specific quarry.

The macroscopic analysis yielded results of a varied degree of accuracy (depending, among others, on the degree of granulation and weathering of the object). To get a comparative scale of those results we have used three indications of the degree of accuracy: A — within the range of a type of rock, most general (e.g., siliceous rock); B — within a group of rocks (granitoide, loam); C — a single type of rock or its variant (banded amphibolite, diabase). As regards the investigated series (1557 objects) it was possible to classify almost 80 % in category C.

The employed archaeological and petrographic classification should at the same time arrange the entire

series in regard to questions which will be put forward in further parts of this analysis. In effect we obtained a list of types of stone raw materials used in the Neolithic in the particular area, which was the first of the principal goals of research. Further analytical operations can be carried out only with a series of implements thus classified.

The second stage of research includes a comparative analysis of archaeological and petrographic data (an internal analysis of the series). Its purpose is to grasp multilateral relations occuring between the type of rock raw material and the remaining features of stone tools. The comparison has been carried out on three basic levels, i.e. the chronological-cultural, the typological (type of tool) and geographical (regional) differentiation. Additional detailed studies were taken into account in each category. The most appriopriate form of such comparisons are tables showing numerical data on the frequency of particular relations, sometimes expressed as relative percentages. Similarities and differences between investigated types should be submitted to statistical tests in order to exclude accidental (statistically insignificant) relations in further studies. A Table illustrating frequencies of perticular raw material groups in successive chronological-cultural categories starts the internal analysis of the series of tools (Table 1). Our program distinguishes five such categories of implements: 1 — the Cycle of Danubian culture (KCW); 2 — the Funnel Beaker culture (KPL) and the Globular Amphorae culture (KAK); 3 — the Corded Ware culture (KCS); 4 — the groups from the turn of the Neolithic and the Early Bronze Age (N/Br); 5 — a group of Neolithic tools of not exactly determined chronology and culture (?).

In the case of relation between the type of tool and the type of raw material the possibility of comparison is, of course, limited by the fact that tools of some typological categories (e.g., hoes, axe-hammers) appear only in assemblages of certain Neolithic cultures. To investigate more thoroughly the links between items listed in this Table, we prepared two percentage compilations. The first calculates the part of particular raw materials in successive typological categories of each of the chronological-cultural groups (e.g., the raw material structure of axes from the Cycle of Danubian cultures). The second compilation is a reverse of the previous one and presents quantitative relations, which occur between implements (uniform as regards raw material) from particular typological categories within successive chronological-cultural groups (e.g., the typological composition of the implements of the Danubian Cycle, made of amphibolite). A similar spatial analysis of the gathered material was based on a division of the research area into six arbitrarily distinguished zones of a mesoregion-like range. It was endeavoured to comprehend differences in the distribution of raw materials imported from rock-bearing areas in the south of Poland and adjacent regions (Maps 1–5). Detailed percentage compilations were used again; the first one answers the question about the intensity of use of a particular raw material in each region in consecutive Neolithic cultures, whereas the second one talls us about regional differences in the raw material structure of particular cultures.

The two final analytical compilations concern detailed technological problems in the manufacture of perforated tools and illustrate the mutual relations of pieces produced in the techniques of a full and empty drill from the raw material aspect, as well as the raw material composition of implements showing traces of repair and secondary use. This relation may indicate a preference for particular types of rocks.

Separate attention was devoted to semi-fabricated implements assuming that they are perticularly useful in studying stone ware production (including the problem of localizing of production centres).

Results of analyses were verified statistically with the aid of two non-parametric tests: χ^2 (*chi*-square) and Smirnov's[24]. The probability of results on the five per cent level was found in both cases. A further advantage of the χ^2 test for our studies is the fact that it not only signalizes the occurrence of a statistically significant connection between particular phenomena but it also measures the strength of these tendencies. In turn, Smirnov's test brings results in the form of a matrix — i.e. a synthetic and legible picture of the comprehensive relations between studied elements (cf. Fig. 5). In consequence of statistical testing the whole of the real relations between the characteristics of tools series was reproduced. A search for the genesis, conditions and the character of particular links is the object of the final, explicite part of the analysis. At this stage we have reached beyond the internal links of the investigated series and taken into consideration — in a degree as extensive as possible — general archaeological and petrographic knowledge, linked with the Neolithic production of stone implements. A division of the list of raw material types into three groups, considering their provenience, has been taken as a starting point: 1 — Fennoscandian erratics appearing in Central European Lowlands on the surface or as secondary deposits (Table 2); 2 — raw materials imported from rock-bearing areas, situated south of the Lowlands; 3 — a small group of rocks from local primary quarries. Emphasis in these investigations was laid on imported raw materials, because — as objects of the long-range exchange — they are of a greater significance for archaeologists, being a determinant of cultural contacts and of spheres of influence; as regards petrography, they are, moreover, the best characterized implements. Detailed petrographic descriptions of certain raw materials from this group allowed to search for their primary quarries. By compa-

ring the description of the microscopic structure of these rocks with petrographic characteristics of known quarries of these materials, we may (if characteristics tally) with great probability determine the position of the primary deposits. It should be emphasized that the presented research procedure, representing the last stage of investigating the problem of the raw materials provenience, is at the same time the most difficult to realize. Nevertheless, even some success in these investigations may supply quite new sort of information, unavailable by other means, on Neolithic stone mining. Positive results of researches from Great Britain confirm the correctness of these presuppositions[7–11].

Conditions necessary for the localization of a rock deposit — on the basis of microscopic samples taken from a Neolithic implement — are as follows: 1 — particular quarries of this raw material differ as regards their distinct petrographic characteristics; 2 — this raw material does not appear in greater amounts in erratic materials; 3 — the practical value of investigated raw material for the production of stone tools exceeds that of the local erratic rocks; thus, it inclined Neolithic inhabitants of Lowlands to import it; 4 — the high frequency of a particular raw material in an investigated assemblage of implements speaks for the mass character of its import.

It seems that basalt is the only rock which fulfills conditions of our list of raw materials used in Neolithic Mid-western Poland (Table 1). Among 23 implements microscopically defined as basalts, three — representing a type of plagioclaso-nephelinitic basalts — show a considerable similarity to the composition of basalt deposits found in the Western Sudeten (Fig. 6)[27, 29, 30], and two others — to olivineless (perodotless) Volhynian basalts at the river Horyń in the Rowno region (Fig. 7)[28, 33]. None of these samples shows characteristics typical for erratic basalts of Scandinavian origin[26]. Achieved results provided a basis for the formulation of a hypothesis on the existence in the Neolithic of a long-range import of basalt raw material from the Western Sudeten and Volhynia to Wielkopolska (Great Poland) and Kujawy (Kuiavia; a distance of about 180–250 kms and 600–700 kms respectively; Fig. 8).

Criterions of choosing rock materials used by Neolithic manufacturers of stone tools represent a separate problem. The list of the types of raw materials and the frequency within the range of each of them results from several factors, the most important being: a) technical traits of the raw material, b) its accessibility to inhabitants of a particular area, c) characteristic traditions in stone industry of a specific culture or region. The degree of optimal selection of rock materials achieved by a particular culture should be viewed as a fragment of the general adaptation on Neolithic communities inhabiting Central European Lowlands to their natural conditions. The investigated assemblage has shown that most types of rocks occuring with high frequency are linked by a common trait, namely their high specific weight. It has been assumed that this influenced the choice of stone material, not only in the narrow meaning (endeavour to achieve at work a high striking power with a possibly small-sized implement), but, above all, because dark rocks could be distinguished much easier among available materials. These rocks were preferred due to complex technical characteristics, primarily because of their satisfactory resistance to crushing, drilling and abrasion (Table 3)[34].

The whole information obtained during the analysis allows to characterize raw material foundations concerning stone industry of particular cultural groups in the Neolithic. This approach makes it possible to systematize achieved data concerning the local exploitation dynamics and further reserves of rock materials, next, the roads, time and intensity of the inflow of imported materials, the problem of a differential selection of raw materials depending on the type of products, the influence of used raw materials on the structure of production and employed treatment techniques. In all, it pictures the development of practical petrographic knowledge in the Neolithic. The comparison of the stone implements of various cultures should bring out differences existing between them. These differences will then be interpreted and elucidated on the basis of the general knowledge of these cultures. Such differences may be due to the origins of these cultures or caused by differences in the technical level of a stone industry, the degree of its adaptation to the resources of the stone raw materials in a specific area, etc.

The discussed research program should be treated as the first, explorative stage of studies on the Neolithic stone industries. Adjusted to mass sources, including not fully representative ones, it may yield only general results. A further specification of the most interesting determinations will have to be based on selected, less numerous but more valuable series of stone implements of defined characteristics.

Translated by Jan Rudzki

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Przegląd Archeologiczny, Vol. 26

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Map 1. Distribution of polished stone implements of the Cycle of Danubian Cultures in Mid-Western Poland with regard to their raw material differentiation.

Map 2. Distribution of polished stone implements of the Funnel Beaker Culture and of the Globular Amphore Culture in Mid-Western Poland with regard to their raw material differentiation.

Map 3. Distribution of the perforated stone axes of the Corded Ware Culture in Mid-Western Poland with regard to their raw material differentiation.

Map 4. Distribution of polished stone implements of the cultural groups from the turn of the Neolithic and the Early Bronze Age with regard to their raw material differentiation.

Map 5. Distribution of Neolithic stone implements of not exactly determined chronological and cultural status, in Mid-Western Poland with regard to their raw material differentiation.

NOTE: Illustrations to figures 1-4 are published in erroneous order. Therefore:

Caption under fig. 1 refers to fig. 3.
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UWAGA: Ilustracje na ryc. 1-4 zamieszczono w błędnej kolejności.

Podpis pod ryc. 1 odnosi się do ryc. 3.
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