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Social and economic interpretations of the chert procurement strategies of the Bandkeramik settlement at Hienheim, Bavaria

1. Introduction

This paper will discuss problems of social organization during a period when permanent settlement and subsistence farming had become part of the traditional way of life, and supralocal communication networks had already been well-established.[1]

The research reported here started with a study of the chert assemblages at the Neolithic settlement site of Hienheim-am-Weinberg (Ldkr. Kelheim, Niederbayern). This site was excavated between 1965 and 1974 by the Institute of Prehistory, University of Leiden (The Netherlands). It lies on the left bank of the river Danube in a rather isolated loess-covered region. The main settlement started in the Early Neolithic at 6200 BP (or 5150 cal. BC[2]) and ended c. 700 BP (or 4600 cal. BC) in the Middle Neolithic (Modderman 1977, 1986; Van de Velde 1979). In the earlier settlement phases Linearbandkeramik (LBK) pottery was in use. Later on we find decorated pottery belonging to the Stich-Strich-Komplex (Van de Velde 1979), also known as the Oberlauterbach Gruppe (Bayerlein 1985) or the 'Middle Neolithic of Southeastern Bavaria' (Nadler/Zeeb *et al*. 1994). This post-Linearbandkeramik group – to be named Middle Neolithic (MN) in this article – is to a large extend contemporary with the Großgartach-, Stichbandkeramik-, and Lengyel-horizon, and may also overlap with the earlier stages of the Rössen Culture. The Hienheim excavation also yielded traces of inhabitation by the Late Neolithic Münchshöfener, Altheim and Cham groups (Modderman 1977, 1986), dating to *c*. 4600-3800 cal. BC, *c*. 3800-3300 cal BC, and *c*. 3300-2600 cal. BC respectively (Matuschik 1992; Tillmann 1993). In terms of house plans, settlement structure, pottery decoration and stone tools there are only differences of degree between Linearbandkeramik and Middle Neolithic (Van de Velde 1979; Modderman 1986; De Grooth 1994c).

2. Chert resources

The subsoil of the area around Hienheim consists mainly of Jurassic Chalk deposits, which contain many varieties of chert (fig. 1). The cherts occur in nodular and in tabular form. Within the site territory of Hienheim, (*i.e*., the area exploited on a daily basis, Bakels 1978) no outcrops of chert are known. In its home range (the area with a radius of six hours' walking distance, exploited extensively together with other groups, Bakels 1978), however, different kinds of high-quality cherts can be found. At Schwabstetten, 7.5 km to the west of Hienheim, the eluvial clays contain grey nodular cherts (Bakels 1978). This same type of chert was also available at many other localities in the region. Eleven kilometers to the north, i.e. north of the river Altmühl, lies the area of Baiersdorf, where brown to greyish brown tabular chert was exploited (Binsteiner 1989). Finally, 9 km to the west, on the other bank of the river Danube, the outcrops at Arnhofen supplied a very fine-grained, banded grey tabular chert.

Table 1. Hienheim: shift in raw material use through time (after De Grooth 1994c).

	Nodules	Tablets Baiersdorf	Tablets Arnhofen	
LBK				
early	81.2	8.2	10.6	100.0%
late	67.2	16.5	16.3	100.0%
Transition	34.3	40.4	25.4	100.1%
MN				
early	9.4	86.4	10.2	100.0%
late	13.2	62.0	24.8	100.0%

All three types of chert were used continuously by the inhabitants of Neolithic Hienheim. The initial preference for nodular chert changed gradually, and in the Middle Neolithic tabular chert was used almost exclusively (tab. 1). The main technological advantages of tabular chert are twofold: cores need little preparation and it is easy to produce standardized naturally backed blades. Although the two outcrops of tabular chert are situated at almost equal distances from the site, over 60% of the excavated waste material belongs to the Baiersdorf variety.

A preliminary analysis of a sample of 138 tabular cores from 12 well-dated MN refuse pits showed little difference in the way both types of tablets were worked (tab. 2).

Figure 1. Early and Middle-Neolithic settlements and important chert extraction sites in the Kelheim region (after Bakels 1978; Bakels/Modderman 1986; Bayerlein 1986; Engelhardt 1990). 1: loess; 2: Jurassic chalks; 3: Hienheim; 4: other – mainly Middle-Neolithic – settlements; 5: extraction points, A=Arnhofen, B=Baiersdorf, L=Lengfeld (from De Grooth 1994c).

Unworked pre-cores occur in exactly the same percentage (5.3%) in both types. There are no significant differences in the average number of negatives (larger than 20 mm) on the core faces, or in the number of planes used as striking platforms and/or core faces. On Arnhofen cores, however, the direction of reduction was changed more frequently: they show a higher percentage of planes serving both as core face and as striking platform. This difference indicates that Arnhofen tablets were worked slightly more intensively, but further analysis is needed to decide whether this raw material allowed for higher technological efficiency or whether it was specially valued in terms of symbolic connotations and/or high costs of acquisition.

3. Procurement strategies

For a better understanding of the chert procurement strategies practiced, the assemblages of settlements should be studied in an integrated approach, together with those of both extraction and workshop sites (Ericson 1984; De Grooth 1991, 1994b; Torrence 1986).

Table 2. Hienheim: comparison of technological data for Arnhofen and Baiersdorf tabular cores from 12 Middle-Neolithic refuse pits (NB the typical 'block-like' tablet has six potentially reducible planes).

	Tablets Baiersdorf	Tablets Arnhofen
Average number of negatives (larger than 20 mm)/tablet	x = 3.2 σ = 2.6 range 0-20	x = 3.4 σ = 2.4 range 0-10
Average number of planes used as striking platforms and/or as core faces	x = 2.9 σ = 1.0 range 2-8	x = 2.8 σ = 0.8 range 2-5
Percentage of cores with planes used both as striking platform and as core face	28%	34%
Average number of bi-functional planes (when present)	x = 1.8 σ = 0.7 range 1-4	x = 1.9 σ = 0.6 range 1-3

For the LBK period some six settlements are known in the Hienheim region (Bakels 1978; Bakels/Modderman 1986; Binsteiner/Pleyer 1987). The inhabitants of Hienheim exploited a number of different resources, seemingly in a rather haphazard way. Access to all regional resources was apparently unrestricted (De Grooth 1994c).

All chert was brought into the settlement in an early stage of the reduction sequence, as precores or as initially prepared cores. In other words, at the various extraction sites the raw material was only tested for suitability. The production of blanks and tools and the use thereof took place in the settlement. In socio-economic terms, this procurement strategy corresponds to a *domestic mode of production*, in which the family, living in a single household, is the main unit of production and consumption (De Grooth 1987; Van de Velde 1979).

The only artifacts arriving from the 'outside world' were adzes made of amphibolite, a raw material stemming from – as yet unidentified – outcrops located at least 100 km to the north of Hienheim (Bakels 1986). If chert circulated at all, this occurred over relatively short distances not exceeding c. 80-100 km (De Grooth 1994a). In this respect Niederbayern seemingly had a somewhat isolated position within the Linearbandkeramik world: elsewhere extensive networks are documented, through which flint and chert were systematically distributed over very long distances. Rijckholt-type flint from Limburg (in the southern part of the Netherlands) was transported as far as Hesse and Baden-Württemberg (Zimmermann 1995), whilst in eastern Central Europe different Polish chert types, as well as obsidian, circulated over distances of more than 1000 km (Lech 1987).

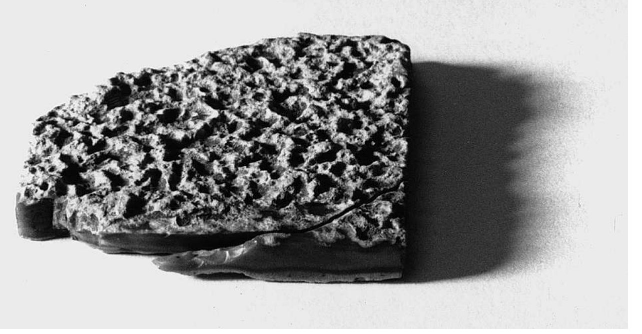

Figure 2. Hienheim, blade core of Baiersdorf chert with refitted borer discarded together in a Middle-Neolithic refuse pit.

Whilst the basic spatial organization of chert production at Hienheim remained the same during the Middle Neolithic (fig. 2), important changes occurred as regards both the acquisition of raw material and the regional distribution mechanism. An increase in the number of settlements in the Kelheim region was combined with a decrease in the number of worked extraction sites. At Arnhofen, a large mining complex with shafts up to 8 m deep, investigated by Engelhardt and Binsteiner, dates from this period (Engelhardt/Binsteiner 1988; Moser 1978). The tabular cherts at Baiersdorf were probably already exploited by open cast mining at this time (De Grooth 1994c).

The regional distribution mechanism changed as well, at least for Arnhofen tabular chert: cores and substantial amounts of debitage are present only in settlements located at a distance of less than 20 km from the mines. Outside this area, Arnhofen striped tabular chert occurs almost exclusively as blades and finished tools. It was transported as far as Eastern Bohemia and Lower Silesia to the north-east (250-350 km, Lech 1987), Thuringia to the north (c. 200 km), and Hesse and Westphalia to the northwest (over 300 km, Binsteiner 1990; Zimmermann 1995).

The estimates on the overall duration of deep shaft exploitation at Arnhofen vary between 700 years (from c. 5000 cal BC to 4300 cal BC) and 250 years. In the former case, this type of intensive extraction was practiced during the younger LBK and the whole Middle Neolithic period (Engelhardt 1990); in the latter case it was limited to the period of the raw material's main use at Hienheim (De Grooth 1994c), during which its long-distance distribution also was at its peak (Zimmermann 1995). The excavation report on the Arnhofen mines allows one to make estimates on both the yearly output of raw material – min. 32, max. 197 kg of tablets, from 12-76 shafts – and on the workforce required for its extraction – a two-person team working for 160 hours per shaft (Binsteiner 1990; Engelhardt 1990).

On the other hand, the evidence from Hienheim and other sites in the Kelheim region may be used for estimates on the available workforce and the rates of chert consumption. The average Middle Neolithic settlement may have consisted of *c*. five contemporary houses, with 20 adults and 30 children (Bakels 1978). Most chert recovered in LBK and Middle Neolithic settlements must be regarded as secondary rubbish (Schiffer 1976), and ideas on its yearly consumption depend mainly on estimates of the amount of material lost because of both depositional practices and post-depositional processes (among which excavation methods, notably the mechanical removal of topsoil, figure prominently). Attempts to refit Middle Neolithic assemblages at Hienheim, showed the loss to have been considerable -at least 75% (De Grooth 1994c).

Combination of these different types of estimates leads to an interpretation in which extraction at Arnhofen was a short-term, seasonal activity, performed jointly by – male – inhabitants of the *c*. 30 known coeval settlements located within a 20-km-radius around the mine (fig. 1; fig. 3). The distribution outside this 'production area' was partly directed at immediate neighbors, i.e. at immediate kin. A structural long-distance circulation, however, was clearly present as well (De Grooth 1994c). This type of exploitation can be practiced under a *lineage mode of production*, where the unit of production and consumption is formed by a group of related families, belonging to the same lineage or 'clan' (De Grooth 1987; Van de Velde 1979) and temporarily aggregated into a larger workforce.

This interpretation differs markedly from the views on the organization of extraction at the Arnhofen mining complex as presented by its excavators (Binsteiner 1990; Engelhardt/Binsteiner 1988). In accordance with most of the existing accounts of Neolithic deep-shaft mining (De Grooth 1991, forthcoming), they depict it as a strongly organized enterprise, run by the inhabitants of just a few privileged settlements close to the mines, who worked them for commercial purposes, and traded the output 'ex works' to eager customers. The alternative interpretation offered here is, however, compatible with the few ethnographic accounts of deep-shaft mining and stone tool production in societies with a 'Neolithic' level of technology and socio-economic integration (De Grooth 1994c; McBryde 1986; Torrence 1986). In the small sample of New Guinean and Australian Stone Age societies, mining and quarrying were never continuous activities, performed by professionals. The ownership of resources was extremely varied. But even where outcrops were recognized as the property of a special group, outsiders could generally acquire permission to use them, for example by the establishment of an alliance relationship of some sort (Dalton 1981). These examples also show that the mere presence of deep shaft-and-gallery mines *per se* is not "a sufficient criterium from which to infer the existence of a complex economic or socio-political organization" (Torrence 1986): simple tribal communities are well capable of performing time-consuming and labor-intensive tasks, requiring a considerable level of technical skill, under informal 'ad hoc' (low level) leadership (e.g. Burton 1987; Gould 1978; Jones/ White 1981; McBryde/Harrison 1981).

4. Interpreting chert mining in the Kelheim region

If one tries to understand the Middle Neolithic deep-shaft mining at Arnhofen in purely economic terms, a rather confusing picture emerges. The acquisition of striped tabular chert was extremely time- and labor consuming – an estimated 160 person-hours were needed for the extraction of 2.7 kg of high-quality tablets. Large amounts of nodular cherts encountered during its extraction were discarded 'out of hand', regardless of their quality (Binsteiner 1990). Moreover, at Baiersdorf an alternative raw material was both known – at least to Hienheim's inhabitants – and available in ample quantities – as witnessed by the fact that exploitation here reached its peak only during the Late and Final Neolithic (Binsteiner 1989; De Grooth 1995).

An attempt will therefore be made in the following to interpret the Middle Neolithic shift in extraction and distribution mechanisms for Arnhofen tablets in terms of social reproduction and ideology rather than in terms of purely economic behavior. To achieve this one must place deep-shaft mining and the creation of long-distance distribution networks in a broader context, combining them with other characteristics of the societies involved. These are: first, the marked increase of Middle Neolithic settlement sites compared with the number of LBK sites in the whole of Southeastern Bavaria.

Secondly, at about the same time all over Southeastern Bavaria and in the adjacent regions, Middle Neolithic groups created a whole series of impressive enclosures (Petrasch 1990). In several cases they are situated at regular intervals, and they seem to have served as a focus point for groups of small settlements in the area. No normal habitation took place in them, nor are the other utilitarian functions recently suggested for them very plausible: e.g. defensive structures, cattle-kraal, central places controlling neighboring lithic resources and the redistribution of commodities. As their construction as well as their regular renewal necessitated the combined efforts of several settlements, they may be seen as examples of episodic, institutionalized, and in this case clearly ritually inspired collective efforts of normally segregated groups.

Thirdly, the originally very uniform Linearbandkeramik pot decorations, which probably served as social and cultural markers (Van de Velde 1979, 1993) had diversified into

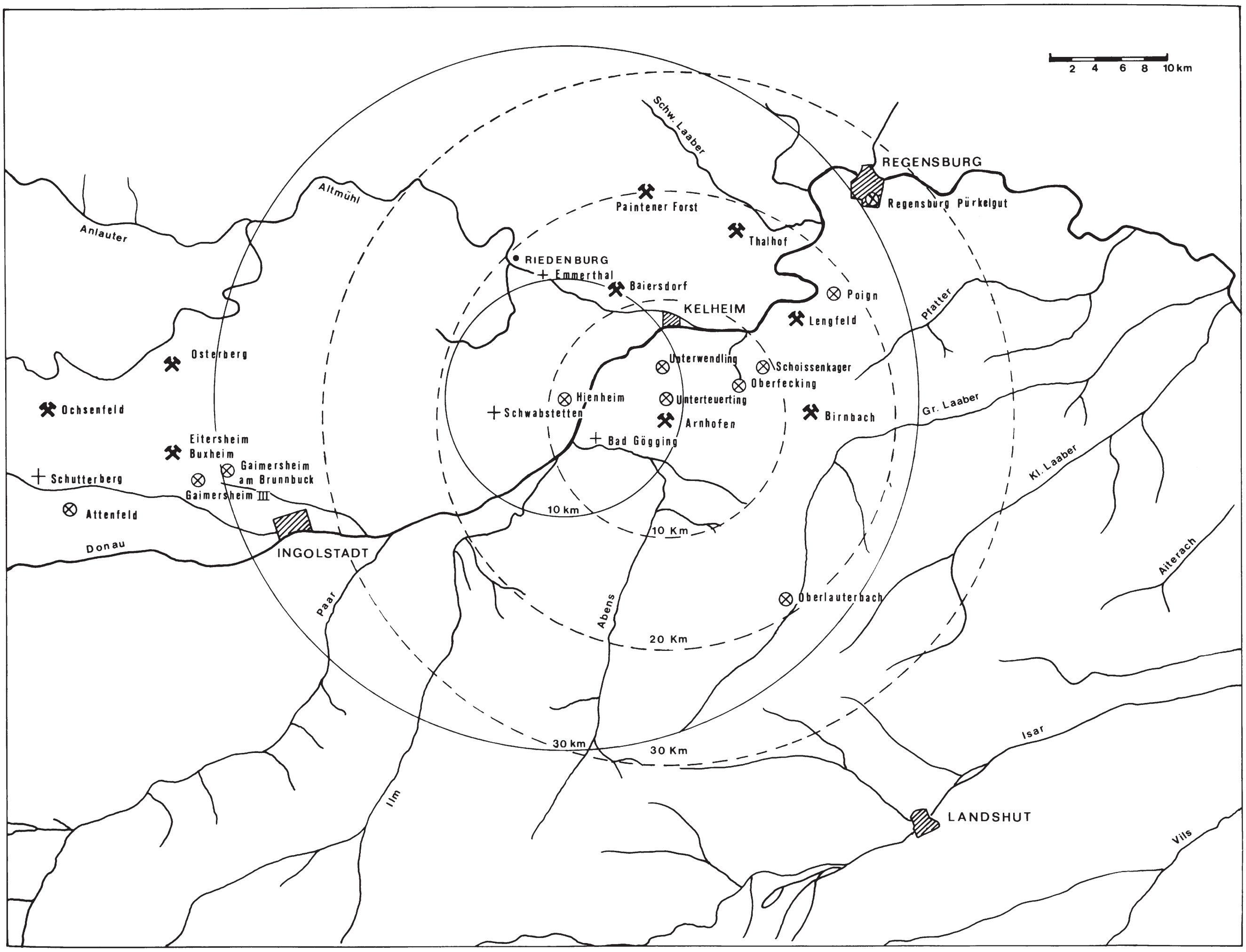

Figure 3. The region around Hienheim showing important settlements, chert extraction sites, and other chert and stone sources (from De Grooth 1994c).

completely separate, idiosyncratic regional traditions. In this case the archaeological distinction of different 'groups' and 'cultures' may well correspond to past expressions of group identity.

As stated above the striped tabular Arnhofen chert has no intrinsic technical qualities, so there does not seem to be any compelling technological reason for its extremely laborious extraction. It is, however, highly characteristic and attractive: once seen, never forgotten. As such it may have served as a means to express the extractors' group identity in their increasingly important communications with the outside world. On the other hand, internally, its controlled extraction would offer a means of maintaining communication, and of regulating social relations between kin groups which had to reconcile the need to uphold a settled way of life in distinct, isolated territories with the need to maintain shared unrestricted rights of access to localized resources, while at the same time strengthening traditional kinship ties. Thus, enclosures, systematic mining, and structured long-distance exchange may all be regarded as efforts to re-define and re-emphasize group identity both internally and externally after a period of rapid change and upheaval visible in large parts of the Bandkeramik world.

Although exploitation at the Arnhofen mines is mainly connected with the Middle Neolithic, the long-distance circulation of chert artifacts manufactured in the Kelheim region continued during the Late Neolithic Altheim and Cham periods. Extraction was concentrated at Baiersdorf and Lengfeld (Binsteiner 1989; Rind 1992). The debris recovered at these extraction sites documents two major changes in technological behavior. Firstly, the tablets were no longer turned into blade cores, but shaped into bifacially worked core implements, such as sickles and knives or daggers. Secondly, both preforms and finished artifacts were made at the mines. I do not think, however, that this change in technological behavior must be regarded as evidence for a change in social organization: in terms of expenditure of raw material, these bifacial tools are no improvement on the Middle-Neolithic blades. Their Cutting Edge/Mass ratio (Torrence 1986) is much lower, as only a single implement can be made from each tablet and the risk of failure during manufacturing is high. Technological advantages may have consisted of an increase in length of the actual cutting edge on single artifacts and a possibly higher potential for the resharpening of these cutting edges by consumers. Making them at the mining sites, then, may have been an efficient strategy to minimize manufacturing risks (Torrence 1989). The domestic tools meanwhile were still made out of flakes, and in regions close to the resources the raw material for these seems to have been brought into the settlements in the traditional way, as nodules or initially prepared cores (Driehaus 1960).

The main reason for this technological change again may have been of a social rather than of a functional nature. The evidence from settlement sites shows that these bifacial tabular artifacts formed only a minor part of the chert assemblage. They circulated, however, over long distances in the same way as did the blades and tools of striped Arnhofen chert, traveling as far as Westphalia and Lesser Saxony, for example (Blank 1994; Werben/Wulf 1992). Thus the bifacial sickles and knives could have functioned as special-purpose tools, forming the reaction of a region lacking in large chert nodules to a pan-European trend in which polished axes and knives or daggers made on long regular blades functioned as prestige objects in long-distance exchange networks (De Grooth forthcoming).

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notes

1 Throughout this paper the term Neolithic (i.e. Early and Middle Neolithic) is used strictly in a chronological sense, without any preconceived economic or ideological connotations.

2 All calibrations were performed by the Seattle/Groningen Method, using *Cal 15* (J. van der Plicht, Centre for Isotope Research, University of Groningen).

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