Connecting Networks

Characterising Contact by Measuring Lithic Exchange in the European Neolithic

edited by

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Preface and acknowledgements

This volume brings together a group of peer reviewed papers, most of them presented at a workshop held at the Institute of Archaeology, University College London. The event took place on 15–17 October 2011 and was part of the European Research Council (ERC) funded project Cultural Evolution of Neolithic Europe (EUROEVOL 2010-2015).

The aim of the EUROEVOL project is to contribute to the new interdisciplinary field of cultural evolution that has developed over the last 30 years, and at the same time use these ideas and methods to address specific questions concerning the links between demographic, economic, social and cultural patterns and processes in the first farming societies of temperate Europe. The aim of the EUROEVOL project is to do that for the first time, and in doing so to provide the basis for a new account of the role of farming in transforming early European societies, c.6000-2000 cal BCE.

The study of lithic exchange is fundamental to this task because it provides a source of direct information on between-group interaction and contact patterns relevant to understanding the patterns of cultural transmission, while at the same time informing us about a key aspect of non-subsistence production in these societies. It is for this reason that we thought it essential for the project to organise a workshop on this subject bringing together a group of leading workers in the field. Not all those present in the event were able to contribute to the publication so we invited further individuals to write papers for the volume.

The meeting itself was a very productive and pleasant occasion and we wish to thank Sue Colledge and Katie Manning, who helped us to set up the workshop, Fiona McLean for organising travel and accommodation, Louisa Goldsmith, George Davies and Ken Walton for their technical support; and Ulrike Sommer and Peter Topping, who made a splendid visit to Grimes Graves such a success. We are also most grateful to the paper referees and to the European Research Council for ERC Advanced Grant #249390 for the funding that made the workshop possible.

Introduction

Neolithic Networking: exotic and common materials

The Neolithic revolution was the most radical change in lifestyle in human history. The new farming way of life came to Europe from the Near East via the Balkans and the Mediterranean, and involved the movement of populations as well as the spread of ideas. Europe became an arena of enormous cultural dynamism as different groups expanded, interacted and exchanged with one another. Thus Neolithic networking laid the foundation of the continent's further development. Moreover, there is increasing evidence that mobility in the Neolithic was much greater than previously thought (see Petrequin et al. Mateiciucová and Trnka in this volume).

Long-distance journeys were one of the many means of raw material procurement. Travelling meant meeting friends and strangers, and it must also have involved talking about it. As well as artefacts, interesting stories and new ideas would have been brought from far away and integrated into familiar practice. Those narrations may have been centred on exotic items, be they prestigious objects of social or ritual significance or previously unknown useful small things then in daily use (see van Gijn in this volume).

The majority of stones in use came from sources close to the settlements. The sheer volume of extraction, as is sometimes visible in the mining fields (Kerig et al. in this volume; Lech 2013), point to at least part-time specialisation and production for exchange networks. Further exchange between inhabitants of the same settlement is more than likely.

Those personal contacts are documented innumerable times by the occurrence of non-local stone material brought in from places, sometimes from a considerable distance, and used for chipped or polished stone tools. Some raw materials are strikingly distinctive and can easily be connected to a single source, clearly indicating a relationship between the origin and the findspot; this makes it possible to reconstruct important elements of the mode of exchange, and of exchange networks.

Time and space (as covered by this volume)

This volume deals with the movement of raw materials in temperate Europe. Examples come from Austria, Belgium, the Czech Republic, France, Germany, Luxembourg, the Netherlands, Poland, Slovakia, and the United Kingdom. The chronological coverage is roughly 8000 BCE to 2000 BCE. It does not only include the Neolithic but also the later part of the Mesolithic period and the beginning of the Bronze Age.

Recently, we have begun to understand the process of neolithisation in Europe as one that was triggered and driven not least by networking activities. European Mesolithic foragers and Neolithic farming populations met each other for several millennia, as is evidenced by the distribution of stone tools and raw materials (e.g. van Gijn in this volume), although ancient DNA and isotope studies are now also beginning to make a contribution to this area of study (e.g. Bollongino et al. 2013).

Early Neolithic exchange networks of Neolitihic Linearbandkeramik (LBK) culture (5500 to 4900 cal. BCE) reflect contact at different spatial scales, where several modes of exchange can be identified: 1) contact following the descent of a group over hundreds of kilometres (Kerig 2008), 2) contact between neighbours, 3) contact between those separated by larger distances, connected with distinct sources of recognisable raw materials, which were in all likelihood of significant ideological importance (van Gijn, de Grooth, Hauzeur, Mateiciucová and Trnka, Přichystal in this volume).

The later Neolithic networks in particular show remarkable differences in many respects; differences between archaeological cultures and stages (Allard and Denis, Nowak in this volume), and also between landscapes, between villages, and even within a single settlement. Networks evolve and crash (Kerig et al. in this volume). Towards the beginning of the Bronze Age most exchange distances become remarkably less far reaching and the new availability of metal was accompanied by a change in use of raw materials, including flint and ground stone.

Raw Materials: some information for the non-expert reader

According to different Neolithic tasks, several classes of stones can be distinguished pragmatically. Flint was used for a wide range of implements from chisels and picks, through to small hafted tools to axe and adze blades. Ground stone was mainly worked for mortars, grinding stones, axe and adze blades, including so-called battle-axes and mace-heads. For practical reasons we exclude sculpture stones and casting moulds. Furthermore, the contributions to this volume do not deal with gemstones or minerals for medical, hygienic or magical purposes, even though aesthetic and metaphysical aspects may well have provided a rationale for the utilisation or rejection of particular flint and ground stone varieties (cf. Pétrequin et al. in this volume).

Readers who are not familiar with European lithic studies should be aware of some archaeological common places listed below (introductions to the field include in English: Odell 2004; Andrefsky 2005; Butler 2005; Danish: Vang Petersen 1999; Dutch: Beuker 2010; French: Brézillon 1983; Inizan et al. 1995; German: Floss 2013; Hahn

1993; Polish: Ginter and Kozłowski 1990; Wąs 2005, on Swedish material: Knarrström 2001).

The archaeological use of the term flint remains problematic. For the present we adopt the broadest meaning of the term, including all varieties of siliceous stone suitable for chipping due to their predictable conchoidal fractures. American archaeologists sometimes use the term chert in a roughly similar way, even though it has a much more specific meaning in petrology (Luedtke 1992). Here flint equals siliceous stones of a wide range of varieties, and includes all flint and cherts in the strict as well as in the broadest sense, everything called 'silex' in French and German, quartzites, jasper, frost stone, radiolarites, rock crystal, obsidian and all other kinds of natural glasses.

It is also important to take into account that there is no coherent use of the terminology of specific siliceous raw materials (see Mateiciucová and Trnka in this volume) in European archaeology or in this volume. The same term may be in use for flint of different geneses, ages or regions. The fact that with the distance from possible sources the range of uncertainty and ambiguity of nearly any raw material identification grows, often leads to the use of relational categories ("of Northern origin").

Most individual pieces of flint have not been the subject of mineralogical or micro-paleontological observations, or of any other kind of compositional studies: the abundance of flint tools and of debitage from most regions is simply too enormous. Putting less emphasis on scientific analyses may cause severe archaeological problems, but in most cases archaeologically established groupings of materials are constantly checked by informed archaeologists and geoscientists. The archaeological terminology in use, e.g. "light-greyish Belgian Cretaceous flint", is partly descriptive (e.g. colour, fossil content), and partly with reference to the sources (e.g. geological system and / or region). At the same time earth science-based flint studies have made great progress in identifying the mineralogical content and the micro-fossils which now gives much more precision in reconstructing the facies, and in typifying the sources (see Brandl et al. in this volume; e.g. W Europe: Affolter 2002; Bressy 2002; M. and M.-R. Séronie-Vivien 1987 and 2003; Surmely et al. 1998). It is the back and forth between pragmatic archaeological grouping and scientific analysis that drives the whole field. Important regional research traditions have led to regional standard references of handbook and atlas character (eg. Biró 1988; Féblot-Augustins 1997; Floss 1994; Ginter 1974).

Flint is very unevenly distributed and accessible over the continent (Duke and Steele 2010; www.flintsource.net). This is not only due to the geological conditions of flint formation but also to the survival of the primary deposits and to the availability of the deposits near to the surface. Undisturbed flint can be expected foremost in marine as well as in limnic limestones, especially of Meso- and Cenozoic age. Geomorphology also influences the detectability of deposits: while Cretaceous flint is frequently found at the foot of modern-day marine cliffs, it may be invisible on top of those cliffs.

The qualities of flint differ greatly between the natural deposits. As a rule of thumb, larger flint nodules mined from undisturbed primary layers represent the highest quality in terms of size, homogeneity, and humidity, in contrast to small pebbles washed out and transported by glaciers or streams before being effloresced to the surface again. Even if flint is available it may be too small to produce larger items like daggers or axe blades – in those cases it may be necessary to import larger nodules from outside (cf. Strahl 1990, 238-263).

North of what has been termed the 'flint line', in Scandinavia and on the North European plain, glaciations transported and scattered the flint over long distances. And rivers and glaciers also transported material in the Alpine and Carpathian forelands, and in the Central European low mountain zone. Sourcing of material found in secondary deposits sometimes allows reconstructing the agency of flowing or frozen water rather than that of humans. Generally speaking archaeologists are less interested in the exact place of origin of flint than in the place of production, but the two are obviously linked.

The term 'ground stone' is not found in the earth sciences but in archaeological literature (e.g. Adams 2002). It is widely applied to all possible varieties of non-flint stones of some toughness regardless of mineral or fossil content, origin or genesis. Most ground stone varieties in use are magmatic or, at least partly, metamorphic rocks. Some sedimentary and volcanic stones are of importance for grinding-, rubbing- and whetstones.

Ground stones are found all over the continent, but with some exceptions, e.g. the loess or marsh landscapes. In theory, as they originate mostly from older geological systems, they are especially abundant where flint is generally not available, and vice versa. In practice, ground stones were transported by ice and water all over Europe, with a few exceptions in mountainous limestone regions.

The toughness of some ground stone varieties allows them to absorb more impact energy whereas flint splits – this may be one reason why mace and battle axe heads, axe and adze blades were often made from ground stones. Most ground stones show a certain granularity which is detectable by the eye or the tactile senses. Such roughness is an important technical attribute necessary for the abrasive tasks done using grindstones and grinding stones, mortars, arrow-shaft smoothers, pigment grinders, etc.

Ground stones from primary as well as secondary deposits tend to be larger than flint nodules. In those parts of Europe where no primary flint sources are accessible it is often impossible to find axe blade sized pieces of flint.

The working of ground stone is not restricted to the Neolithic. However, the frequent use of sawing, drilling and polishing of ground stone artefacts reached a new level in terms of quality (in terms of hours invested per item) as well as quantity (in terms of number of items per capita). Drilled adze and axe blades are amongst the first Neolithic elements in Mesolithic contexts north of the flint line (Klassen 2004).

Networks? What networks?

Here we focus on the networks of lithic raw material exchange. Certain aspects of technology are of interest because they give substantial hints to the modalities of these contacts. This approach is especially useful in cases where different stages of production took place at different sites: where phases of a sequence of mining, testing, first reduction, and further modification can be largely differentiated spatially (Bostyn in this volume). The aim here is to follow the operational chain as material is transported, processed and again transported between sites which acquire and receive materials, and give raw and processed materials, respectively. The dialectics of those activities which are at the same time integrating and recreating the mode of production and the sphere of exchange, have long been in focus e.g. in Central European Early and Middle Neolithic research (de Grooth 1994; van de Velde 1979), where the emphasis was put on spatial aspects and issues of scale (Gehlen and Zimmermann 2013, Bostyn, Allard and Denis, Nowak this volume).

Repeated exchange between more than two exchange partners, be they individuals or groups, constitutes an exchange network. Such networks are reproduced by single transactions (Kerig 2008, 117-147). The exchange may follow established routes and rules, and it may be part of a tradition, but of special significance is the next transaction following an actual deal: the connection between the exchange partners becomes part of what can be seen as a price-finding procedure where it makes a difference if you are exchanging goods with close kin, an established trading partner, or a stranger you will never see again (cf. Sahlins 1972 and see below).

Such systems may be described formally by network studies (e.g. Social Network Analysis: Wasserman and Faust 1994; cf. Knappett 2013), but the state of the art in this field does not yet allow such an enterprise. Currently there is no unified terminology of the raw materials (cf. Mateiciucová and Trnka, Brandl et al. in this volume). Sourcing, as well as standardised methods of probabilistic treatment of ambiguities in raw material classification, remain unsolved problems of unification. But even with all these problems solved, the incompleteness of evidence, due to the differences in the geological conditions mentioned above, will form an obstacle for the future modelling of social networks. A hoard of nodules from different sources reflects contact between groups, but what exactly is the relation between the hoard and the raw material sources? Does it witness direct or indirect contact? Who were the agents? What kind of transaction is reified? The combination of properly sourced raw materials in a hoard is unquestionably hinting at directional relationships, but these relationships are not unambiguous in meaning. Nevertheless, raw material data allows the description and analysis of certain attributes of social and exchange networks, e.g. absolute as well as relative frequencies of occurrences, or the expansion of a network over time and space.

Marshall Sahlins' (1972) work on Stone Age Economics, and especially his typology of reciprocity, is still of undiminished influence in flint exchange studies (Nowak in this volume; Roth 2008): According to Sahlins, in non-state societies, social relationships constrain non-market exchange. Thus, generalised reciprocity or positive reciprocity takes place among close kin. This may be characterised as generosity and a direct gift in return is not expected. Balanced or symmetrical reciprocity is the norm between peers in a definite social context where both seek their individual profit in a framework of mutual social control. Negative reciprocity is found between agents at greater social distances, often between strangers attempting to immediately obtain the largest possible benefit. The supposed transition from these systems of back-and-forth exchange to redistributive systems is not clear-cut but redistribution obviously requires institutions organising 1) collection, 2) sometimes storage, 3) processing and 4) final redistribution. In any case, if exchange is determined by social relationships, studies of exchange practices should enable archaeologists to study the social structure. This is the basis of what became the standard approach to distributional analyses of sourced materials: Colin Renfrew's (e.g. 1975) classic writings on exchange patterns, introducing quantitative spatial analysis to economic archaeology. A source of goods (it may be the actual production site or any other centre of distribution or redistribution) is expected to show a relative abundance of the good while with distance from the source the abundance should diminish. Putative mismatches between this general model and the actual data can be explained – after source criticism – by a set of clearly defined slightly different models of exchange patterns. For example, there might be a secondary distributional centre causing a second peak of abundance at a distance from the source area (for a short review of Renfrew see Brandl et al. in this volume).

Apart from the problem of model selection (different processes may produce similar fall-off curves) there are two other possible major problems with this approach. The first is an archaeological one: the consumption of a raw material is not necessarily connected to a certain survival rate of items preserved. A fall-off pattern may arise from an even distribution of items over an area due to an uneven survival rate arising from depositional processes. This becomes obvious in the various attempts to source early metal, where consumption of the material in the source area itself is thought to have destroyed most of the evidence. The chance of getting access to the resource was higher nearer to the centre of its known distribution, and this may cause an exceptional demand focused on the source area, not to mention the possibility of recycling. In these cases the fall-off pattern may even become reversed. While these reverse distributions cause severe problems in the search for the source areas of earliest European metal (cf. Klassen 2000; Strahm and Hauptmann 2010) similar processes have never been observed for lithics. The life cycle of stone artefacts as well as the sheer number of items prevents these from being recycled totally. The enormous archaeological value of small pieces of worn-out flint is also caused by their low value for prehistoric flint users.

A second problem is connected to economic decision-making. Archaeological fall-off analyses are applied to a single good while at most sites a whole range of raw materials was in use. The choice between different goods can be a very complex decision, especially when taking into account technical needs, incomplete information regarding the exchange situation, the personal relationship between exchange partners and so on. In micro-economics this is described by a so-called indifference curve that shows how different bundles of commodities – in archaeological terms assemblages – have the same utility. In other words: a raw material may be replaced by a combination of others equally valued; common lithic raw materials are not irreplaceable. The case may be different for special purpose or high status substances like the stones used for EN adze blades (Přichystal in this volume), or the 'Jade' from high alpine regions (Pétrequin et al. in this volume), but the vast majority of lithics seems to have been of equally low value. Leaving aside daggers and arrowheads, if seen from the consumer side, the difference between high quality flint and flint of rather mediocre quality is very small for most of the simpler artefacts. Most individual pieces of common artefact types require only a few minutes, even seconds, to be produced. From the initial producers' point of view mining and mass production has a lot of advantages, but from the consumer's side it may be much more costly to obtain better raw material than to use a mediocre one, given the risk of a failure and having to start anew. It makes sense to mine and to process high quality flint, and not only for high quality artefacts, but it makes less sense to use relatively costly high quality materials for common tasks where simple materials and a few minutes of additional work per year fulfil the same need. Besides this, most settlements show a clear main source, or a very restricted range of sources, for most of the raw material. It is therefore very likely that raw material procurement reflects contact between individuals rather than economic choices. Most authors do not focus on individual choices in flint procurement but rather on the use of raw materials in different parts of landscapes. The distribution of raw materials is conceptualised as the outcome of summed individual choices per settlement. In this context raw material exchange networks are suitable as proxies for social networks.

A demographic approach to evolving networks

Initially, and for purely pragmatic purposes, two ideal types of networks can be distinguished in the temperate European Neolithic as covered by this volume. A network of type I is characterised by large numbers of small items of relatively low individual utility. The single piece is sought after as a little something that makes a task or an artefact just a bit more convenient or beautiful. The flow of exchanged items mainly follows established routes of contact rather than being itself a reason for contacting others. A classic example of a type I network is the distribution of most of the local flints e.g. of Rijckholt type.

Type II networks are defined by the exchange of rare, exotic and exceptional materials or objects that are obviously highly valued in themselves. The items may be of no practical value but their utility can be expected to be enormous, for example as showing the existence of contacts on a continental scale. The Jade project (Petrequin et al. in this volume) focuses on such a type II network.

It is self-evident that all exchanged materials were part of a continuum of utility and quantity, on which the two types of networks can be seen as having opposed trajectories: type I networks show rising utility (the practical value) with increasing amounts up to a certain point, while type II networks are characterised by decreasing utility (the prestige value) as quantities increase. Both types were already present in the Early Neolithic of Central Europe: LBK flint distributions (at least in the West) follow a pattern expected for type I exchange from hand-to-hand (Zimmermann 1995), while most of the EN adze blades appear to stem from the same single source area, at some distance from all settled zones (Přichystal this volume).

On this basis one can now begin to understand when and how Neolithic exchange networks changed, but there is still a lack of explanation for those dynamics. A simple but powerful explanation connects exchange to demographic processes, addressing exchange not as a simple function of population density but with population density as a necessary condition for it (Kerig et al. in this volume, building on Shennan et al. 2013).

The far reaching exchange networks of the Early Neolithic LBK (Burnez-Lanotte 2003; Hauzeur in this volume) were connected to relatively low global population densities in Central Europe (Kerig et al. in this volume Fig. 2). The exchange may follow the lineage: LBK households often procured the majority of larger distance flints from areas where, according to the similarities in ceramic style, their ancestors may have come from. This changes later as the involvement of exchange partners in 25 to 50 km distance increased, but for centuries some links were maintained between lineage members as settlements fissioned and households spread (Kerig 2008).

The smaller cultural groups (in terms of the number of people per pottery style) of the Danubian Middle Neolithic of Central Europe, follow the LBK tradition but do not maintain the same far reaching exchanges; raw material supply seems to have been much more direct, involving fewer agents (Mateiciucová and Trnka, Nowak in this volume; Scharl 2010). After the Middle Neolithic Danubian cultures, small cultural groups are associated with a period of slightly higher population density (Kerig et al. in this volume Fig. 2) but they depend even more on local and regional materials than the Middle Neolithic groups did earlier (e.g. Brandl et al. in this volume). The distribution of Danubian axe and adze blades follows a similar pattern (Přichystal in this volume) of contracting networks after the LBK. Over the next thousand years (up to 3300 cal.BC) the population increased again (Kerig et al. in this volume Fig. 2), and, as a rule of thumb, the locally available raw material spectra again included a relatively higher proportion of pieces, witnessing more distant contacts. Areas with a previously predominantly local supply are now participating in regional exchange, while sites in more central positions with a previously regional supply now take part in inter-regional exchange (cf. Kieselbach 2008). Population growth and settlement expansion must once again have caused higher mobility and higher personal contact rates, visible in the far reaching exchange patterns.

Connecting the networks of knowledge

There is more than one approach to the field of NW and Central European Neolithic lithic raw material studies and the current volume seeks to gather some of the most important perspectives developed in different but highly interconnected research traditions.

Earth sciences provide the foundation of what can be called an archaeological lithology: the macroscopic description and classification of lithic samples of archaeological interest. Added to this, the application of petrographic, petrochemical and micro-paleontological methods have an enormous potential to provoke and to change archaeological interpretations, especially on regional and interregional scales. The works and contributions to the volume by Antonín Přichystal, Michael Brandl, Daniel Modl, María M. Martínez, Estella Weiss-Krejci, Inna Mateiciucová and Gerhard Trnka represent a vital Central and Eastern Central European tradition of lithic raw material studies, always in closest contact to the earth sciences. Over the next years, one may expect growing quantitative data from scientific analyses of more and more lithic assemblages which will be made accessible for spatial inquiries in archaeology.

The sourcing of raw materials has a history of more than a century in itself. Combined with methods and theory of the processual archaeology's distribution studies mentioned above, coherent research has emerged over the last 40 years. The processual theory behind some of their earlier works together with the contributions to the current volume by Marjorie de Grooth, Anne Hauzeur, Kathrin Nowak, Michael Brandl, Daniel Modl, María M. Martínez and Estella Weiss-Krejci, became the paradigm in NW and Central European raw material studies focusing on economic aspects.

The technological data from a growing number of lithic assemblages is collected within the framework of attribute-analytical studies, and the chaîne opératoire approach. In the context of the current volume the spatial aspects of the different links of the chain are important. They show true technological, economic, and social differentiations of some kind, requiring explanation. This tradition is widely recognised as a distinct continental Western European tradition – in fact also alive in the Low Lands, Germany and Poland – which is represented in the current volume by Pierre Allard, Solène Denis, Françoise Bostyn, Anne Hauzeur, Marjorie de Grooth, Kathrin Nowak, Pierre Pétrequin, Serge Cassen, Michel Errera, Estelle Gauthier, Lutz Klassen and Alison Sheridan. Attribute-analytical studies make use of larger data sets and they allow the description of a specific material on the background of the wider picture. The chaîne opératoire approach connects description to practice, technology to praxis. To describe the different processes of transmission over space, time, and social spheres seems to be the next logical step.

Transmission is central to evolutionary archaeology: it is here that Stephen Shennan, Tim Kerig, Kevan Edinborough and Sean Downey make the link to population density, and in the future to population structure. They seek to explain the changes in lithic networks by changes in their preconditions and in the constraints of contact between groups of agents.

Another new perspective started from single object biographies and is now integrating sourcing, aspects from distributional studies, from the chaîne opératoire methodology, and from use-wear studies. This approach is represented by the recent work of Annelou van Gijn, Marjorie de Grooth, Pierre Pétrequin, Serge Cassen, Michel Errera, Estelle Gauthier, Lutz Klassen and Alison Sheridan. Their work may be characterised as contextual, inclusive and holistic. It is based on scientific analysis, experimental and ethno-archaeological preliminary studies, and on archaeological source-criticism, but its extraordinary strength certainly comes from well-informed and well-built master narratives.

Each of the archaeological research traditions mentioned above has something to offer in understanding the evolution of early European societies by tracing the routes of lithic exchange. Contradictions remain between contrasting positions but every approach reached some conclusions that can be integrated without inconsistencies by all the authors of the current volume. There are good reasons to believe that those statements are of constant value.

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