*Archaeometry* **47**, 2 (2005) 221–234. Printed in Great Britain

# LITHIC RESOURCES IN THE EARLY PREHISTORY OF THE ALPS*

PH. DELLA CASA

*Department of Pre- and Protohistory, University of Zurich, Karl-Schmid-Str. 4, CH-8006 Zurich, Switzerland*

*Rocks, which are ubiquitous in archaeological sites as chipped or polished tools, were important factors in the prehistoric Alpine economic system. Archaeometric characterization and identification of source areas open the path to a more detailed understanding of the production and diffusion mechanisms behind Alpine lithic industries. An overview of the situation from the eastern to the western Alps in the Mesolithic, the Neolithic and the Copper Age illustrates current debates and issues.*

*KEYWORDS:* ALPS, PREHISTORY, RESOURCES, LITHIC INDUSTRIES, SILEX, METAMORPHIC GREEN ROCKS, LIMESTONES, PROVENANCE ANALYSIS, PRODUCTION, DIFFUSION

## INTRODUCTION

In the Alpine regions, with their specific situation of important and sometimes abundant natural resources, raw materials—above all, ores and minerals—are often considered to be the 'prime movers' of the prehistoric colonization (Primas 1999). Although this view should not be generalized, and needs detailed discussion in any particular case, raw materials indeed appear to be important factors in the settlement dynamic of the Alps under specific conditions. If there is no doubt that an agro-pastoral economy is the basis of prehistoric settlement in almost all mountain areas (Della Casa 2002), metallic and lithic resources could become considerable factors of economic intensification and expansion. Lithic raw materials already played a role in the late Palaeolithic and Mesolithic prelude to the long-lasting colonization of the Alps, and remained attractive in certain regions until the Middle or Late Bronze Age, and sometimes even later. However, the Neolithic and the Copper Age were the main periods of lithic resource exploitation.

The categories of lithic raw materials considered for this contribution are non-metalliferous rocks, including in particular siliceous rocks (generally termed 'silex') such as flint, chert and radiolarite (biogene rocks) and quartz or rock crystal (quartz–opal group; Binsteiner 1993, tab. 1), along with various metamorphic 'green rocks' such as eclogites and serpentinites, as well as schists, sandstones and limestones.

We will not discuss steatite (soapstone) and precious rocks—which did not come into wider use before Roman times—nor specific secondary uses of rocks; for example, as temper in the production of pottery.

* Accepted 11 October 2004.

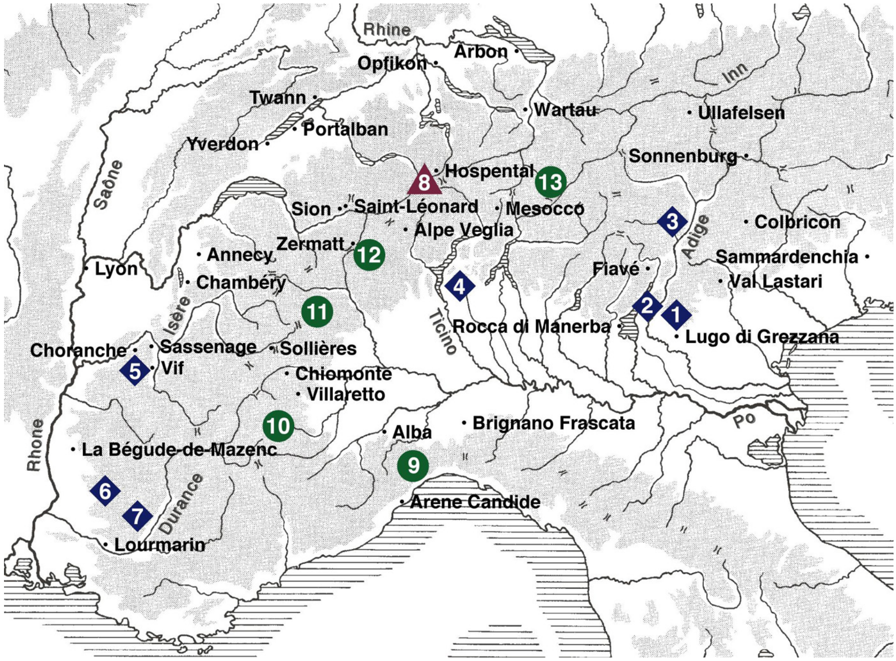


Figure 1 *A map of the major sources of silex (lozenges), rock crystal (triangles) and green rocks (dots) in the southern, central and western Alps: 1, Monti Lessini, Veronese, I (Italy); 2, Monte Baldo, Trentino, I; 3, Val di Non, Trentino, I; 4, Varese, Lombardia, I; 5, Vercors, Rhône-Alpes, F (France); 6, Mont-Ventoux, Provence, F; 7, Forcalquier, Provence, F; 8, Gotthard Massif, CH (Switzerland); 9, Voltri, Liguria, I; 10, Mont-Viso, Piemont, I/F; 11, Gran Paradiso–Aosta Valley, I; 12, Monte Rosa, Valais, CH; 13, Piz Platta, Grisons, CH. Sites marked in bold are cited in the text.*

## SILICEOUS ROCKS

### *Characterization and identification of sources*

Together with calcites and quartzites, silex is among the earliest lithic resources used for the production of tools, and it appears in all late Palaeolithic and Mesolithic contexts in the Alps. Good-quality flints and radiolarites are particularly widespread in the southeastern (Trentino, Veronese), south-central (Varese), western (Vercors) and southwestern (Mont Ventoux) Alps (Fig. 1). In general, local or regional sources predominate within the assemblages, but we do also have evidence of long-distance transport, in particular into zones lacking good-quality lithic resources. South Alpine flint crossed the Alpine watershed to the northern Tyrol in the Mesolithic (Ullafelsen, Fotschertal, A; Schäfer 1998), and was prized in the north Alpine valleys, the Swiss Plateau and Bavaria in the Late Neolithic and the Copper Age (Della Casa 2004). Rock crystal sometimes served as a substitute, and in certain zones of the central Alps reached percentages up to 100% in lithic assemblages; for example, in Alpe Veglia (Alpi Lepontine, I; Fontana *et al.* 2000).

Various types of silex deposits are known. Flint and radiolarite are most common in Cretaceous and Jurassic sediments of the calcareous Alps, and form as nodules, plates or bands in primary deposits (Fig. 2) such as the strata of Rosso ammonitico, Biancone and Scaglia rossa in the Veronese and Trentino regions of Italy (Monti Lessini, Monte Baldo and Val di Non) or the

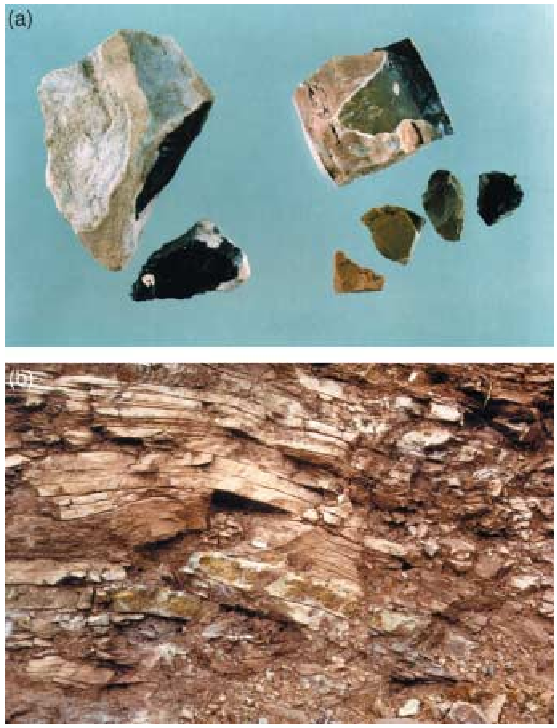


Figure 2 *(a) Radiolarite in plates and band fragments from the Val di Non (Trentino, I). (b) Silex bands in Cretaceous/Jurassic Biancone formations near Priò (Val di Non).*

calcaires Urgoniens of the Mont Ventoux and Vercors in France. Secondary deposits occur in colluviums (e.g., regoliths), moraines and river beds. Flint nodules and blocks from secondary deposits are more often deeply fractured or fissured, and are not suitable for chipping (Peresani 1992); however, they remain easily accessible as opposed to primary deposits. Little is known about early flint mining in the Alpine zone, but it is assumed that exploitation was on-surface or immediately subsurface (Binsteiner 1994, 1996), with no need for deep mining as in other areas of Europe (e.g., Belgium, The Netherlands and Poland) (Weisgerber 1999). Copper and Bronze Age flint mining zones with nearby workshop areas have been documented in the Biancone flint deposits and regoliths at Ceredo and Ponte di Veia, Verona, Italy (Barfield 1995; Binsteiner 1996).

Rock crystal, on the other hand, is a tertiary mineral that is typical of Alpine fissures and fractures. Its occurrence is limited to the crystalline parts of the Alps (Mullis 1995). Rock crystal can be traced to zones of origin by microscope analysis of fluid gas inclusions. These vary according to the geological–tectonic conditions of the fissure formation and are remnants of the fluid from which fissure minerals precipitated. Four different fluid zones can be differentiated across the Swiss Central Alps (Mullis 1995). In the Mesolithic assemblage of Mesocco (Val Mesolcina, CH)—where rock crystal makes up 43% of the lithic industry—raw materials from at least two different fluid zones south and north of the San Bernardino watershed (with dominant $CO_2$ and $H_2O$ fluid inclusions, respectively) could be identified (Della Casa 2000, 126).

Separation of silex varieties is possible by means of macro- and microscopic analysis. Flint can be traced to specific sources through the observation of colour, texture and patterning (Barfield 1999). Petrographic microfacies analysis—that is, the microscopic characterization of texture and fossil inclusions—gives precise information on the nature and age of a flint deposit, and bears the potential for high-resolution location of flint provenance, if accurate sampling of primary deposits is carried out (Binsteiner 1996; Affolter 1999). Products from a number of known silex sources of the southern (Veronese, Trentino) and western Alps (Vercors, Mont Ventoux) have been recognized by this method in Mesolithic, Neolithic and Copper Age assemblages of the Swiss Plateau, the Valais and again in Mesocco (CH), where radiolarite and flysch of the Varese region predominates (Affolter 1999; Della Casa 2000, 125).

There have been attempts to trace flint provenances by chemical methods of analysis (AAS, XRD, ICP–MS and ICP–AES), so far with limited results (Benedetti *et al.* 1992; Bressy *et al.* 1999). As opposed to microfacies analysis, which investigates only the surface of artefacts and is thus totally non-destructive and easy to apply, geochemical analysis as a rule is destructive and needs substantial laboratory equipment. In general, much more analytical coverage of known and potential flint mining zones is needed in order to improve our knowledge of flint mining and distribution throughout the Alps.

### *Production and diffusion*

Strategies of flint provisioning in the late Pleistocene and early Holocene have been investigated in the southeastern Alps and Prealps. At the Epigravettian open site of Val Lastari (Asiago, I), the flint working areas yielded considerable amounts of nodules, blocks and pre-cores, as well as products of *in-situ* flaking. The main raw material sources were very local in the residual Biancone detritus of the valley bottom and slopes (Peresani 1992). The Epigravettian and Mesolithic sites of the Lagorai mountain range (Pian dei Laghetti, Colbricon) are situated far from geological flint zones. Flint provisioning occurred at a distance of 20–30 km to the south of the Valsugana line in Cretaceous deposits, possibly during seasonal movements of hunter–gatherer groups (Benedetti *et al.* 1992, fig. 7).

A similar system of territorial mobility in the procurement of lithic raw materials has been postulated for the already mentioned Mesolithic site of Mesocco in the southern Swiss Alps, with the difference that locally available quartz and rock crystal was also used intensively (Della Casa 2000, fig. 5.20). Flint was exchanged, or rather procured (fragments of plates and nodules are present at the site), from deposits around the lake of Varese at a distance of around 80 km.

In the Monti Lessini, one of the most important source locations for high-quality flint in the southern Alps, the systematic exploitation of the deposits and the serial production of flint artefacts started with the Early Neolithic Fiorano group. A specific settlement activity related to flint production has been localized at Lugo di Grezzana, immediately north of Verona. The site, situated in close vicinity to known flint outcrops, was fortified by a wooden palisade and yielded a number of flint workshops with abundant blade industries typical of the later sixth and early fifth millennia BC in northern Italy (Cavulli and Pedrotti 2001; Cavulli 2002). It is believed that Lugo di Grezzana was one of the supply centres for flint and flint products in the supra-regional exchange network of the Po Plain in the Early Neolithic, in which the Fiorano group played a leading role (Barfield 2000; Pedrotti 2002). In fact, Monti Lessini and related flint qualities dominate the assemblages of the entire Po Plain and northeastern Italy (Ferrari and Mazzieri 1998; Pessina 1998), and tend to supersede local flint sources used in the preceding periods.

Exactly how the diffusion and trade of the flint occurred is as yet unknown. There is evidence of raw plates and blocks or just primarily worked nuclei at several sites on the Po Plain, but prefabricates such as large blades also seem to have been transported over distances that reach 100 km or more. Also, flint was by no means the only lithic raw material with a wide distribution within Early Neolithic northern Italy. Green rocks (e.g., jadeitites and eclogites) from the Piemontese Alps spread eastwards right across the Po Plain as far as Sammardenchia in Friuli, where 60% of the polished lithic industry is based on south-west Alpine metamorphic green rocks (D'Amico 1998). These materials were used for the production of polished axes, and also for ornaments such as pendants or the paragonite bracelets distributed right across northern Italy and beyond (Pessina 1998). Here, the Vhò group of the western Po Plain might have been the driving force behind the system of production and exchange. It must be noted that even obsidian from Lipari and Sardinia entered the Neolithic exchange network of northern Italy (Pessina 1998), although not before the fifth millennium in larger quantities.

During the VBQ and later phases of the Neolithic, the Veronese Prealps remained the most important flint production zone, and the Monti Lessini saw accelerated settlement development (Barfield 1990, fig. 1). The area of distribution covers the entire South Alpine ridge and the Po Plain (Barfield 1999, fig. 1), with some long-distance transport too: in the fifth and fourth millennia BC, flint from Monti Lessini and Monte Baldo is ascertained in the Valais at Sion and Saint-Léonard (Affolter 1999, fig. 1).

In the Copper Age, after 3400 BC, the system changed in several aspects. In working techniques, we see a switch from Neolithic blade technology to bifacial technology for arrowheads and daggers, together with an increasing use of flakes for tools, while in the raw material provisioning new and poorer qualities of flint came into use. The phenomenon is widespread and accompanies a noticeable interruption in cultural continuity between the Neolithic and the Copper Age. At Rocca di Manerba on Lake Garda, Biancone flint was imported as tool blanks or ready-made tools for bifacial daggers and arrowheads, but low-quality local Medolo flint was used and reduced on the site for simpler artefacts (Barfield 1999).

Established trans-Alpine contacts and exchanges are noticeable in the Copper Age; in particular, through the distribution of raw materials and specific finished products such as bifacial ('Remedellian') flint daggers. Flint daggers of South Alpine origin are known from several places north of the Alps, in Switzerland and southern Germany, such as Arbon on Lake Constance (Tillmann 1993; Borello and Mottes 2002; de Capitani *et al.* 2002). One fragment is also reported from Wartau in the Swiss Rhine Valley, the most important connection route to the central Alpine passes. This multi-period site was settled during the Copper Age Horgen phase (3300–3000 BC) for specific economic purposes such as the working of silex, serpentinite and deer antler (Della Casa 2004). The silex assemblage has been consistently analysed for provenance. It is made of raw materials from eight different sources that can be clustered into three groups (Fig. 3): 85% of locally available radiolarites and quartzites (radius 30 km), 8% of Alpine rock crystal and 5% of Jura chert or jasper from distances around 100 km, and 2% of Bavarian plate chert as well as Monti Lessini/Monte Baldo flint traded over long distances (300 km). While silex working was abundant on the site, it is evident that South Alpine flint and Bavarian chert was particularly prized and reached Wartau as tool blanks or finished objects.

In the west, 'silex blond' from deposits around Mont Ventoux in Vaucluse, together with 'silex rubané' from Forcalquier (and Grand-Pressigny silex from central France), played a role similar to that of flint from the Veronese/Trentino (Fig. 1). It was largely diffused into the primary areas occupied by the Neolithic Chassey groups—the lower Rhône Valley, and the southwestern and western Alps—but it was also traded over longer distances to Liguria (Arene

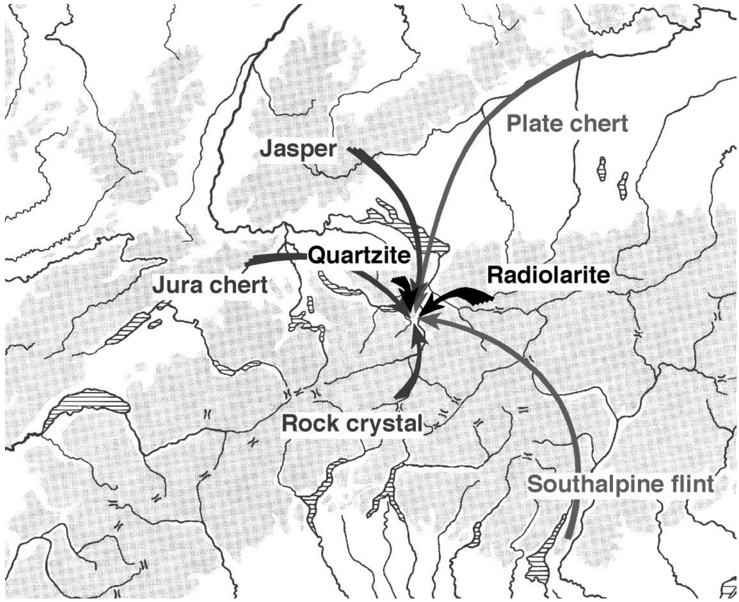


Figure 3 *Silex provisioning at the site of Wartau, Ochsenberg (Rhine Valley, CH). Copper Age, 3300–3000* BC.

Candide) and Piemont (Chiomonte) (Barfield 1999; Riche 1999b). Silex blond is attested early in the Valais (Sion, Saint-Léonard) and on the western Swiss Plateau in Twann or Portalban from the fourth millennium onwards (Affolter 1999, fig. 1).

As in the east, the situation changed in the Late Neolithic and the Copper Age, when new and more localized silex deposits began to be exploited. In the Vercors, the mining zone near Vassieux, which had already been productive during the Mesolithic and Early Neolithic for settlements in the pre-Alpine uplands, the Drôme and the Isère Valleys near Grenoble, such as at Sassenage (Grande Rivoire) or Choranche, boomed with workshops producing Grand-Pressigny style blades. Although the traces of flint working on the Vercors plateau are numerous and impressive, the patterns of distribution of the products, with attested long-distance transport as far as the Jura zone (Yverdon, Lake Neuchâtel—Affolter 1999), remain generally unknown for the time being (Riche 1999a).

The use of flint ceased in prehistoric times in most Alpine areas with the advent of copper alloys in the Bronze Age. Sickle blades are among the few flint items that were still in use during the Early Bronze Age (Della Casa 2004). There are, however, remarkable differences between regions: around Lake Garda and in Fiavé in the Trentino Alps, for example, flint remained widely used until the Late Bronze Age (Perini 1987), possibly due both to the good availability of lithic resources and the scarcity of copper ores. Flint deposits again became economic factors in modern times, in particular for the production of shotgun flintstones in the 18th and 19th centuries, which left its mark on many mining areas in the provinces of Verona and Trentino (Binsteiner 1996). Specific uses in agriculture—for example, for the fitting of wooden harrows—are known until recent times.

As opposed to flint, rock crystal mining and working sites are very rare on the archaeological map. One such site was discovered at Hospental in the crystal-rich zone of the central Gotthard massif, at 2170 m a.s.l. It can be dated to the Late Copper and Early Bronze Age, and it yielded more than 10 kg of rock crystal in different stages of reduction: quartz diamonds, nuclei, flakes and small blades (Primas *et al.* 1992, 310). Rock crystal flakes and tools are particularly common in Neolithic to Copper Age sites of the central Alps, but the raw material remained important into Roman and medieval times for jewellery and glass production.

## METAMORPHIC ALPINE GREEN ROCKS

### *Characterization and identification of sources*

The mining and use of green rocks for polished stone tools and ornaments started in the Early Neolithic and is particularly well attested for the Middle Neolithic and the Alpine Copper Age. 'Green rocks' form a heterogeneous group that includes minerals such as jadeitite or eclogite, orthometamorphic rocks such as amphibolite and serpentinite, or parametamorphic greenschists. The term 'green rocks' is thus not unambiguous, although it is still widely used in the archaeological literature. In any case, it needs to be stated more precisely; alternatively, the terminology 'tough rocks' with an indication of colour (green, dark green, etc.) has been proposed (Thirault *et al.* 1999).

Green rocks are locally available in many regions of the Alps. However, the quality differs considerably and, as with silex, patterns of long-distance distribution of specific-quality products emerge in the Neolithic. As stated above, polished stone tools in Sammardenchia (Friuli, I) were, in the majority, from western origins (D'Amico 1998). The most important source areas for Alpine green rocks are located in the southwestern Alps of Piemont and the Ligurian Apennine (Fig. 1), around Voltri (Liguria) and between Gran Paradiso and Monte Rosa (Val d'Aoste, Valais) for eclogites, and near Mont-Viso (Piemont) for jadeitites and glaucophanites (Ricq-De Bouard 1996; Venturino Gambari 1996).

Metamorphic green rocks occur in primary deposits of the metaophiolitic Piemontese massifs; however, no evidence for prehistoric quarrying or mining activity in these zones has been found so far. More often, secondary deposits in moraines and river alluviums containing fresh and fine-grained pebbles seem to have been exploited (Ricq-De Bouard 1996, 28).

Green rocks can be identified and classified by methods of petrographic, mineralogical or geochemical analysis. Petrographic and mineralogical analysis addresses both the macroscopic structure and the microscopic texture and mineral inclusions of the rocks. It is usually done on thin sections with polarizing microscopy, and is thus partially destructive (Ricq-De Bouard 1996). Alternatively, X-ray diffractometry on entire objects has produced valuable results (Thirault *et al.* 1999), and is sometimes combined with geochemical characterization (D'Amico *et al.* 1995; Chiari *et al.* 1996). The identification of potential sources of provenance requires detailed knowledge of the geological conditions in the Alpine massifs, as well as cross-testing of archaeological objects with samples from geological outcrops and deposits.

### *Production and diffusion*

The hoard of La Bégude-de-Mazenc (Drôme, F), containing ten mostly oversized axe blades, is an excellent marker for the phenomenon of stone tool production in the western Alps, and its different technical, economic and social dimensions. La Bégude blades were made of eclogites and pyroxenites from the Mont-Viso massif, and are known as blanks, finished implements or imitations from a number of sites in the Durance, Buëch and Drôme Valleys. From the area of production, they were distributed as far as the Trentino region, Lake Geneva, Lyon or the Saône

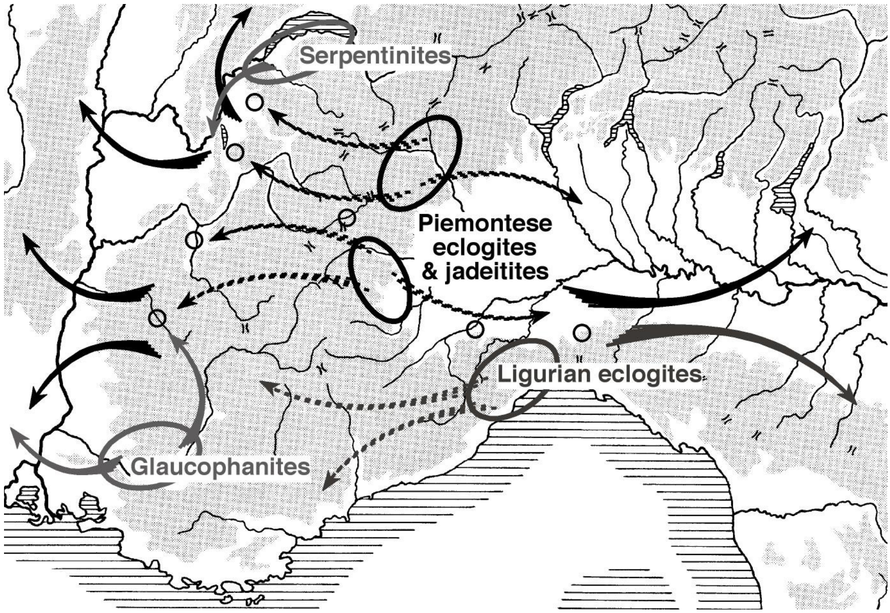


Figure 4 *A model of the Neolithic production and diffusion of green rock blanks and tools in the western and southwestern Alps, the Rhône Valley and the Po Plain (after Ricq-De Bouard, Thirault* et al.*, D'Amico* et al. *and Barfield).*

Valley (Thirault 1999, fig. 8) between the end of the early and the beginning of the Middle Neolithic. The typology, quality of workmanship and raw materials used place these items beyond functional tools; their symbolic value is underlined by the fact that many blades were deposited in grave or hoard contexts.

An oversized (34.3 cm) eclogite blade of La Bégude type, found on the Theodul Pass near Zermatt (Valais, CH) at an altitude of 2400 m a.s.l., is indicative of a possible route of intra-Alpine contacts in the fifth millennium BC (Gallay 1986; Pétrequin *et al.* 1998).

Petrographic analysis of 282 Neolithic objects (regular axe blades, arrowheads, beads and bracelets) from the Rhône-Alpes region revealed, among 22 minerals identified, two major groups of rocks: serpentinites and chloritites on the one hand, and eclogites, omphacites and jadeitites on the other (Thirault *et al.* 1999, fig. 3). Source areas have been localized in Liguria and Piemont for eclogites, omphacites, and to a lesser extent jadeitites, in the southern Leman basin for serpentinites, and in the Durance region for glaucophanites (Fig. 4).

Local availability certainly played a role in the choice of materials, but possibly not as much as mechanical qualities: different rocks were quite selectively used for different purposes; for example, tough and hard rocks for axes, and soft and more easily workable rocks for ornaments. Also, chronological differences can be noted in the patterns of green rock provisioning. During the Neolithic, raw materials seemingly travelled westwards as pre-forms or blanks, while the finishing of tools took place in the specialized workshops of the Alpine valleys—for example, Sollières, Les Balmes—and on the western ridge of the Alpine massifs, such as at Vif, Chambéry and Annecy (Thirault *et al.* 1999, fig. 8). From there, finished products—mostly axe blades—were diffused to southern France, the Rhône Valley and beyond (Fig. 4). To the east, there is evidence of a similar movement towards the Piemontese lowlands (for example, the workshops of Alba and Brignano Frascata) and across the Po Plain (D'Amico *et al.* 1995; Barfield 1996).

Figure 5 *Different stages of serpentinite tool production at the site of Wartau, Ochsenberg (Rhine Valley, CH): pre-forms, axe blanks, refuse (top), axe blades and chisels, and broken and re-used pieces. Copper Age, 3300–3000 BC.*

The Chasséen people, who were originally located in the Rhône Valley, appear to be a driving force behind these economic activities. It has even been argued that the search for control of Alpine green rock resources led to the expansion of Chassey groups into the Alps and eastwards across the Alpine massifs (Barfield 1996; Thirault 1999).

In the later Neolithic and the Copper Age, production of polished stone tools and ornaments switched to a broader variety of local or regional (< 100 km) rocks, such as serpentinites, chloritites and glaucophanites, with a remarkable decrease in the long-distance transport of eclogites and jadeitites (Thirault *et al.* 1999). At the Les Lauzières site of Lourmarin (Vaucluse, F), 80% of the implements were made of local Durance glaucophanites and metabasites (Ricq-De Bouard 1996). This fits the broader picture of emerging local Alpine Copper Age groups with secret identities and economic networks.

The serpentinite industry is also well attested in the central Alps during the Copper Age. At the already mentioned site of Wartau in the Rhine Valley, the entire work process of axe blade and chisel production could be documented (Fig. 5). The selection of raw material is evident: while only hard and tough green rocks were used for large axe blades in Arbon on Lake Constance, the vast majority of the rather small axes and chisels from Wartau are made of the soft and fissile serpentinite. Accordingly, working techniques differ: breaking and pecking in Arbon, and sawing and grinding in Wartau (de Capitani *et al.* 2002; Della Casa 2004). The production of polished stone tools there is tightly linked to the working of deer antler, particularly for blade sockets, and maybe also of wood for axe shafts. Presumably, complete axes from Wartau and similar specialized workshops were circulated in the Rhine Valley and Lake Constance region during the Horgen period (Della Casa 2004).

Serpentinite raw materials from Wartau have not yet been analysed for provenance. Primary deposits of serpentinite have been reported from the ophiolitic zone of Piz Platta in the central Grisons (Primas 1985), while the moraines of the former Rhine glacier all along the Rhine Valley are rich in secondary deposits of Alpine rocks. Serpentinite pebbles can also be collected in the river bed, but their heavy mechanical strain makes them less suitable for tool production (Della Casa 2004).

The use of a number of other specific stone implements goes hand in hand with the production of serpentinite polished objects. Most important and numerous in Wartau are stone saws made of sand schist, for the cutting of pre-forms and blanks. Quartzite, gneiss or granite hammer stones and sandstone grinding pads and grindstones were also commonly utilized (Della Casa 2004).

Polished serpentinite arrowheads are a typical phenomenon of the inner valleys of the western Alps, with diffusion to the west Alpine and Jura lakes (Annecy, Chalain, Clairvaux and Neuchâtel). Workshops have been localized at Villaretto, Balm'Chanto, in Val Chisone (Nisbet and Biagi 1987) and in the Maurienne Valley at Sollières and Bessans (Thirault *et al.* 1999). The raw material used was always local serpentinite, and to a lesser extent amphibolite. A centralized form of production near the primary lithic deposits with controlled distribution has thus been proposed.

Neolithic stone bracelets in the Piemont and French Alps were usually made of serpentinite, as opposed to their counterparts in southern France, which were worked in limestone or marble. Workshops are known on the western Po Plain; for example, at Brignano Frascata (Venturino Gambari 1996).

The specialized production of ornaments—beads and pendants—has been observed at Les Balmes cave in Sollières (Thirault *et al.* 1999). For the serpentinite/chlorite pendants, there is evidence for the complete work process, including flakes, blanks and broken pieces, while the different cylindrical, spherical and winged limestone beads seem to be closely related to products from southern France (Barge 1982). Due to the ubiquity of the raw material, a localization of the production is not possible.

## LIMESTONE BEADS

### *Evidence from the site of Wartau, Ochsenberg (CH)*

Fine-grained soft marbles and limestones were particularly suitable for the production of small items such as buttons, pendants and beads. The raw materials are easily accessible in many Alpine and pre-Alpine regions, and the products are widespread.

The Wartau excavations yielded evidence of the production of flat cylindrical limestone beads in the same silex–serpentinite–antler workshop (Della Casa 2004). Again, all stages of the work process are documented, from the selection of pebbles, the cutting of blanks and their perforation to the finished polished beads (Fig. 6). Other larger beads made of greenschist and limestone winged beads are also represented, but it remains unclear whether they were worked on the site.

The two winged beads deserve special attention: they belong to a type that originated in southern France in the early Copper Age (Barge 1982). The type is also known from the French Jura lakes, and the western and the northeastern Swiss Plateau. However, the northwestern and northeastern series show considerable variations in shape and size (Maréchal *et al.* 1998). The axe shape of the winged beads from Wartau is characteristic of a regional group localized between the Rhine Valley, Lake Constance and central Switzerland (Della Casa 2004), and is indicative of both the long-distance diffusion of ideas and their local adaptation.

## CONCLUSIONS

Returning to our initial question on the role of lithic resources in the colonization process of the Alps, differentiated answers become possible. While silex appears in the socio-ecological

Figure 6 *Limestone bead production at the site of Wartau, Ochsenberg (Rhine Valley, CH): blanks, workpieces and complete cylindrical beads (left), winged beads, bead fragment. Copper Age, 3300–3000* BC.

networks of the late Glacial and early Post-glacial periods as part of embedded procurement systems (Della Casa 2000, 138), specific-quality flint sources such as the Monti Lessini or the Mont Ventoux emerge as centres of supra-regional networks right from the beginnings of the Neolithic. It can be assumed that in these areas, the search for control over production and distribution of prized raw materials triggered the development of settlements (Barfield 2000).

At about the same time, ground stone tools came into use, and although the phenomenon is apparently a generalized one, provenance analysis reveals that the Ligurian and Piemontese deposits played the leading part in the raw material supply from the Rhône Valley to the Po delta during the Neolithic. An explicit Alpine vocation of the Chassey groups, already noticeable in their subsistence economy, emerges from this process (Brochier *et al.* 1999). Knowledge of regional Alpine topography, the quality of the green rock deposits, and specialized workmanship can thus be retained as key factors in the success of the products made from west Alpine green rock.

However, the stories of La Bégude axes and stone bracelets also tell us that beyond aesthetic qualities, symbolic values of prestige and power could be attributed to specific objects through selection and discrete modes of deposition. The Copper Age hoard of Sonnenburg (Castelbadia) in the Pustertal underlines the importance and longevity of these aspects (Lunz 1996).

The patterns of stone tool and ornament distribution may, moreover, serve as indicators of supra-regional and trans-Alpine routes of communication and exchange. Axe blades were traded to remote areas and subsequently reworked (Pétrequin *et al.* 1998), and winged beads were changed and adapted to local needs (Maréchal *et al.* 1998). Obviously, not only prized raw materials and finished objects travelled along the routes, but also ideas and concepts of social structure and behaviour. An illustrative example is given by the 'Remedellian' Copper Age double tomb of Opfikon near Zurich, which contains several bifacial flint arrowheads and an imported leaf-shaped dagger of South Alpine origin (Wyss 1969).

Thanks to analytical archaeometric approaches to raw materials, over the past 10–15 years we have experienced a considerable increase in our knowledge of the procurement, production and distribution of lithic industries within the broader framework of prehistoric Alpine economic and social development. But the picture is still incomplete and fragmentary in terms of material, geographical and chronological coverage. In particular, problems and unanswered questions remain in the characterization of lithic assemblages and sequences, the exact localization of deposits and the identification of prehistoric mining activities.

## ACKNOWLEDGEMENTS

The Wartau (Rhine Valley, CH) excavations were supported by the Swiss National Foundation for Scientific Research and the Archaeological Heritage of St Gallen. Margarita Primas, Biljana Schmid-Sikimic and Martin Schindler are acknowledged for access to the material and documentation. Petrographic analysis of the Wartau silex and stone tools was carried out by Ueli Eberli. Microfacies analysis of the Mesocco silex was performed by Jehanne Affolter, and fluid inclusion analysis of the rock crystal by Josef Mullis. I would like to thank Rüdiger Krause for his interest and comments.

## REFERENCES

Affolter, J., 1999, Caractérisation pétrographique et utilisation préhistorique de quelques matériaux siliceux alpines, in *PAESE '97* (ed. Ph. Della Casa), UPA 55, 253–6, Habelt, Bonn.

Barfield, L. H., 1990, The lithic factor: a study of the relationship between stone sources and human settlement in the Monti Lessini and the Southern Alps, in *The Neolithisation of the Alpine region* (ed. P. Biagi), 147–57, Monografie di Natura Bresciana 13, Vannini, Brescia.

Barfield, L. H., 1995, Catalogue of flint mines: I 27 Ponte di Veia, Monti Lessini, Verona Province, *Archeologia Polona*, **33**, 437–43.

Barfield, L. H., 1996, Le asce in pietra levigata nel Neolitico d'Europa e d'Italia, in *Le vie della pietra verde* (ed. M. Venturino Gambari), 57–65, Omega, Torino.

Barfield, L. H., 1999, Neolithic and Copper Age flint exploitation in northern Italy, in *PAESE '97* (ed. Ph. Della Casa), UPA 55, 245–52, Habelt, Bonn.

Barfield, L. H., 2000, Commercio e scambi nel Neolitico dell'Italia settentrionale, in *La neolitizzazione tra oriente e occidente* (eds. A. Pessina and G. Muscio), 55–66, Museo Friuliano di Storia Naturale, Udine.

Barge, H., 1982, *Les parures du Néolithique ancien au début de l'Age des Métaux en Languedoc*, CNRS, Marseille.

Benedetti, R., Campana, R., D'Amico, C., and Nannetti, M., 1992, Petroarchaeometry of epigravettian and mesolithic flints in the Val Cismòn–Lagorai area (NE Italy). The flint supply question, *Preistoria Alpina*, **28**, 33–49.

Binsteiner, A., 1993, Die Silexlagerstätten des mittleren Alpenbogens: ein Vorbericht, *Archaeologisches Korrespondenzblatt*, **23**, 439–52.

Binsteiner, A., 1994, Ausgewählte Silexlagerstätten und deren Abbau in den Provinzen Trient und Verona, *Archaeologisches Korrespondenzblatt*, **24**, 255–63.

Binsteiner, A., 1996, Alpine Silexlagerstätten, *Bayerische Vorgeschichtsblätter*, **61**, 1–22.

Borello, M. A., and Mottes, E., 2002, La circulation des silex d'origine nord-italienne en Suisse au Néolithique: note préliminaire, in *Internéo 4-2002* (ed. C. Billard), 85–98, Association pour les études interrégionales sur le Néolithique, Paris.

Bressy, C., Bintz, P., and Poupeau, G., 1999, La caractérisation géochimique appliquée aux questions de circulation du silex dans les massifs de Chartreuse et du Vercors (Alpes occidentales, France), in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 141–9, Valence.

Brochier, J. L., Beeching, A., Maamar, H. S., and Vital, J., 1999, Les grottes bergeries des Préalpes et le pastoralisme alpin, durant la fin de la Préhistoire, in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 77–114, Valence.

Cavulli, F., 2002, L'insediamento di Lugo di Grezzana, in *Preistoria Veronese, contributi e aggiornamenti* (ed. A. Aspes), 66–7, Memorie del Museo Civico di Storia Naturale Verona 2a-5.

Cavulli, F., and Pedrotti, A., 2001, L'insediamento del Neolitico antico di Lugo di Grezzana: la palizzata lignea, *Preistoria Alpina*, **37**, 11–24.

Chiari, G., Compagnoni, R., Giustetto, R., and Ricq-De Bouard, M., 1996, Metodi archeometrici per lo studio dei manufatti in pietra levigata, in *Le vie della pietra verde* (ed. M. Venturino Gambari), 35–53, Omega, Torino.

D'Amico, C., 1998, La circolazione delle materie prime nel Neolitico: le pietre verdi, in *Settemila anni fa, il primo pane* (eds. A. Pessina and G. Muscio), 177–83, Museo Friuliano di Storia Naturale, Udine.

D'Amico, C., Campana, R., Felice, G., and Ghedini, M., 1995, Eclogites and jades as prehistoric implements in Europe, a case of petrology applied to cultural heritage, *European Journal of Mineralogy*, **7**, 29–41.

de Capitani, A., Deschler-Erb, S., Leuzinger, U., Marti-Grädel, E., and Schibler, J., 2002, *Die jungsteinzeitliche Seeufersiedlung Arbon Bleiche 3—Funde*, Kanton Thurgau, Frauenfeld.

Della Casa, Ph., 2000, *Mesolcina præhistorica. Mensch und Naturraum in einem Bündner Südalpental vom Mesolithikum bis in römische Zeit*, UPA 67, Habelt, Bonn.

Della Casa, Ph., 2002, *Landschaften, Siedlungen, Ressourcen—Langzeitszenarien menschlicher Aktivität in ausgewählten alpinen Gebieten der Schweiz, Italiens und Frankreichs*, Préhistoires 6, Mergoil, Montagnac.

Della Casa, Ph., 2004, Die ältesten Horizonte, in *Wartau—Ur- und frühgeschichtliche Siedlungen und Brandopferplatz im Alpenrheintal (Kanton St. Gallen, Schweiz), II, Bronzezeit, Kupferzeit, Mesolithikum* (eds. M. Primas, Ph. Della Casa, E. Jochum Zimmermann and R. Huber), UPA 108, Habelt, Bonn.

Ferrari, A., and Mazzieri, P., 1998, Fonti e processi di scambio di rocce silicee scheggiabili, in *Settemila anni fa, il primo pane* (eds. A. Pessina and G. Muscio), 165–9, Museo Friuliano di Storia Naturale, Udine.

Fontana, F., Guerreschi, A., and Vullo, N., 2000, Le site mésolithique de l'Alpe Veglia (Alpi Lepontine, Italia): analyse techno-typologique et spatiale, in *MESO '97* (ed. P. Crotti), CAR 81, 259–65, Lausanne.

Gallay, A., 1986, *Une hache néolithique bretonne sur le chemin du col du Théodule, in Le Valais avant l'histoire, 14 000 av. J.-C.-47 apr. J.-C. (Sion Musées Cantonaux)*, 90–1, Sion.

Lunz, R., 1996, Castelbadia (San Lorenzo di Sebato), loc. Sonnenburg, in *Le vie della pietra verde* (ed. M. Venturino Gambari), 178–9, Omega, Torino.

Maréchal, D., Pétrequin, A.-M., Pétrequin, P., and Arbogast, R.-M., 1998, Les parures du Néolithique final à Chalain et Clairvaux, *Gallia Préhistoire*, **40**, 141–203.

Mullis, J., 1995, Genesis of Alpine fissure minerals, *Scientific and Technical Information*, **11**(2), 54–64.

Nisbet, R., and Biagi, P., 1987, *Balm'Chanto: un riparo sottoroccia dell'età del Rame nelle Alpi Cozie*, Archeologia dell'Italia settentrionale 4, New Press, Como.

Pedrotti, A., 2002, Neolitico antico, in *Preistoria Veronese, contributi e aggiornamenti* (ed. A. Aspes), Mem. Museo Civico Storia Naturale Verona 2a-5, 59–65.

Peresani, M., 1992, Flint exploitation at Epigravettien sites in the Asiago Plateau (Venetian Prealps), *Preistoria Alpina*, **28**, 193–205.

Perini, R., 1987, *Scavi archeologici nella zona palafitticola di Fiavé-Carera. II: resti della cultura materiale, metallo—osso—litica—legno*, Patrimonio storico e artistico del Trentino 9, Servizio beni culturali, Trento.

Pessina, A., 1998, Aspetti culturali e problematiche del Primo Neolitico dell'Italia settentrionale, in *Settemila anni fa, il primo pane* (eds. A. Pessina and G. Muscio), 95–105, Museo Friuliano di Storia Naturale, Udine.

Pétrequin, P., Croutsch, C., and Cassen, S., 1998, A propos du dépôt de La Bégude: haches alpines et haches carnacéennes pendant le 5e millénaire, *Bulletin de la Société Préhistorique Française*, **95**, 239–54.

Primas, M., 1985, *Cazis-Petrushügel in Graubünden: Neolithikum, Bronzezeit, Spätmittelalter*, Zürcher Stud. Arch., Juris, Zürich.

Primas, M., 1999, From fiction to facts. Current research on prehistoric human activity in the Alps, in *PAESE '97* (ed. Ph. Della Casa), UPA 55, 1–10, Habelt, Bonn.

Primas, M., Della Casa, Ph., and Schmid-Sikimic, B., 1992, *Archäologie zwischen Vierwaldstättersee und Gotthard*, UPA 12, Habelt, Bonn.

Riche, C., 1999a, Les ateliers de taille de Vassieux-en-Vercors: exploitation des gîtes et diffusion des produits, in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 155–74, Valence.

Riche, C., 1999b, La diffusion des silex dits 'blonds', du Grand-Pressigny et des silex rubanés: inventaire dans les séries archéologiques de la vallée du Rhône, du Vercors et de Savoie, in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 175–81, Valence.

Ricq-De Bouard, M., 1996, *Pétrographie et sociétés néolithiques en France méditerranéenne*, CNRS, Paris.

Schäfer, D., 1998, Zum Untersuchungsstand auf dem altmesolithischen Fundplatz vom Ullafelsen im Fotschertal (Stubaier Alpen, Tirol), *Germania*, **76**(2), 439–96.

Thirault, E., 1999, La Bégude-de-Mazenc quartier Gros-Jean (Drôme): un dépôt de longues lames de hache polies, in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 297–313, Valence.

Thirault, E., Santallier, D., and Véra, R., 1999, Les matériaux lithiques polis du Néolithique rhône-alpin: de la caractérisation à l'interprétation archéologique, in *Circulations et identités culturelles alpines à la fin de la préhistoire* (ed. A. Beeching), CIRCALP 1997/98, 259–96, Valence.

Tillmann, A., 1993, Gastgeschenke aus dem Süden? Zur Frage einer Süd-Nord-Verbindung zwischen Südbayern und Oberitalien im späten Jungneolithikum, *Archaeologisches Korrespondenzblatt*, **23**, 453–60.

Venturino Gambari, M., 1996, La lavorazione della pietra verde nel Piemonte preistorico, in *Le vie della pietra verde* (ed. M. Venturino Gambari), 66–73, Omega, Torino.

Weisgerber, G., 1999, *5000 Jahre Feuersteinbergbau*, 3rd rev. edn, Bergbau-Museum, Bochum.

Wyss, R., 1969, Die Gräber und weitere Belege zur geistigen Kultur, in *Ur- und frühgeschichtliche Archäologie der Scheiz (SGUF)*, II, 139–56, Basel.