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Polished stone between the Neolithic and Bronze Ages in Northern Italy

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ABSTRACT - The neolithic polished stone in Northern Italy is dominanted by a few lithologies, in particular eclogites and jades and some other minor HP metaophiolites, provenancing from the Western Alps, or from perialpine tertiary conglomerates and quaternary alluvial deposits. These lithologies represent 70-90% of the Neolithic findings. In some cases the use of different lithologies of local origin was relevant. A problematic group is represented by the serpentinites, possibly originating from various sources. The ornaments were selected from soft rocks such as chlorite schists, mica schists and serpentinites. In one case a lithological drastic change, with use of basic magmatites for chalcolithic hammer axes, is noted.

Key words: Polished stone, Neolithic, Copper Age, Jade Axes, Ornaments
Parole chiave: Pietra levigata, Neolitico, Calcolitico, Asce di giada, Ornamenti

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1. INTRODUCTION

This contribution is part of a study project on polished stone in Northern Italy, in the framework of the CNR specific "Beni Culturali" Project. Numerous prehistoric archeologists are involved in the project, some of whom have contributed directly to the information contained herein and are listed below in the acknowledgments. The aim of the project is to achieve a widespread knowledge of the lithology of polished stone in Northern Italy, with the systematic study of a good number of sites that are significant in terms of geographical position, time placing and wealth of findings; and through the comparison with other Italian sites and with sample collections of axes of Italian origin in European prehistoric collections (e.g. D'AMICO *et al*, 1998).

The interpretative aim is to obtain the elements from which a picture of the spatial distribution and a diachronic picture of the lithological and typological variations can be built up. These will provide suggestions and/or verifications regarding the supply/exchange/gift/use flows and the medium and long-distance regional contacts, in addition to what is suggested by the archeological context.

2. THE LITHOLOGICAL PICTURE

Tab.1 shows a summary of the dominant lithologies in North Italian polished stone which, thanks to this lithological prevalence, merits the traditional name of "green stone". This picture is the result of a series of studies in progress and at present only partly published (D'AMICO, 1993, 1995; D'AMICO *et al.* 1991, 1992, 1995, 1996a,b,c,d, 1997; D'AMICO & GHEDINI, 1996).

Two geologically linked lithologies are dominant, accounting for almost 60% of the findings, named eclogites and jades. A smaller heterogeneous group of lithotypes, linked genetically to each other and to the previous ones, is collectively defined as other high pressure metaophiolites (HP in petrological terms), obviously indicating that all the above lithologies contribute to form an HP metaophiolite supergroup, with a common geological genesis, region of discovery and consequently origin of the raw material and/or artefacts. This group makes up 65% of the polished stone in this sample.

A brief petrographical note is given here to clarify the character of these lithologies. Data and methods are dealt with in greater detail in D'AMICO *et al.*,

1991, 1995, 1997; COMPAGNONI *et al.*, 1995; CHIARI *et al.*, 1996.

Eclogites are rocks consisting of Na-pyroxenes (Na-Px, mainly but not only omphacite, a range of compositions quite rich in Ca and Mg and/or Fe) and of garnets (Grt), usually with Na-Px > Grt and with a lower and variable presence of several other minerals. There is a notable variety of eclogites, in terms of composition (Mg-eclogite vs Fe-eclogite subgroups) and of various structural characteristics.

The eclogites of the artefacts considered here are all of the alpine type, i.e. metamorphism products which need a high pressure, corresponding to at least twenty five km depth, and a medium-low temperature of around 400-500°C in order to be generated. Eclogites are rocks only rarely found in surface outcrops, since the possibility of a geological mass, carried down to the great depth necessary to generate HP minerals such as in the eclogites, coming back up to the surface, is rare. These rare geological cases include the geological units of the Western Alps (between the Voltri Group, Genoa and the Aosta valley, almost exclusively on the Italian side) which contain eclogites similar to those of the neolithic artefacts (cfr. COMPAGNONI *et al.*, 1995; RICQ-DE-BOUARD *et al.*, 1990, 1996).

There is agreement, between all the authors working on this subject, on the provenance of the eclogite and jade artefacts from the Western Alpine area and its foothills.

The jades are Na-pyroxenites, made up by about 90% (85->95%) of Na-pyroxenes. Since these minerals have strongly variable compositions (cfr. Fig.1), defined by two different names (jadeite and omphacites, sometimes specified by the prefix Fe-), some subgroups such as jadeitites and Fe-jadeitites (which contain only or mainly extreme Na-pyroxenes, poor in Ca and Mg) can be distinguished from omphacitites (containing only or mainly Na-pyroxenes rich in Ca and Mg) and from mixed jades (with an important presence of Na-pyroxenes of various types). The terms rich in iron (e.g. Fe-jadeitites or Fe-omphacitites) differ from the terms poor in Fe (e.g. jadeitites or Mg-omphacitites), the first being dark green and the second light or medium green. It should be taken into account that the various terms may vary in shade and that a clear distintion is not always easy or possible.

The subgroups of the jades are almost all present in each of the collections of artefacts so far examined. The jades are geologically much rarer than the eclogites, in the masses of which they are contained as veins, spots and lenses. Jades connected to serpentinites are however also known.

The "other HP metaophiolites" in Tab.1 are a miscellany of little represented lithotypes, such as omphacite schists, glaucophane schists, green schists, metabasalts, zoisitic rocks, etc., discussed in some detail in D'AMICO & GHEDINI (1996) and D'AMICO *et al.* (1997).

A lithic group that merits more reflection than usually is the case for polished stone is the group of serpentinites, all formed mainly from antigorites, within which distinctions can be made on the basis of the presence and quantity of any chlorites, amphiboles and pyroxene relics. This lithology falls in fact among the metaophiolites, but has much less strict geological constraints than eclogites and jades, because of its greater abundance and geological diffusion. It is therefore possible that a part, probably quite large, of the serpentinites is linked to the eclogites and jades described above, and originates from the same Western Alpine regions. Another part of them, however, may have a different origin as shown in Chapter 4 for two cases (PESSINA & D'AMICO, 1999; D'AMICO *et al.*, in preparation).

With the partial but important provenence of serpentinites from the Western Alps, we can confidently consider that the supergroup of the HP metaophiolites (eclogites+jades+other metaophiolites + serpentinites in part) amounts to around 70% of the polished stone considered. It will be seen later (Chapter 3 and Tab.2) that in many sites this percentage can reach 90% (cfr. also RICQ-DE-BOUARD *et al.*, 1990; CABELLA *et al.*, 1994, 1995; D'AMICO, 1995; D'AMICO & GHEDINI, 1996; some articles in VENTURINO GAMBARI (ed), 1996).

The "Other" group in Tab.1 is a miscellany of lithologies, often of casual and erratic significance if in small amounts, but of great significance, though variable from site to site, if in large quantities, as will be seen for the findings at S.Lazzaro di Savena and Sammardenchia (Paragraph 3.2).

3. ARTICULATION OF THE LITHOLOGICAL PICTURE

3.1. *Articulation by site*

The general and summary picture in Tab.1 can be articulated by following the distribution at the individual sites studied so far, as in Tab.2. The following sites are considered: Alba (D'AMICO & GHEDINI, 1966; VENTURINO GAMBARI & ZAMAGNI, 1966), Brignano Frascata (D'AMICO & STARNINI, 1996; D'AMICO *et al.*, 2000; ZAMAGNI, 1996), Vho and Ostiano (D'AMICO, 1995; VIROLI, 1995), Gaione (BERNABÒ BREA *et al.*, 1996; ANDÒ, 1998), S.Lazzaro di Savena (FABRIS, 1996; CASADEI, 1997), Trentino (D'AMICO *et al.*, in preparation, and studies in progress), Sammardenchia (D'AMICO *et al.*, 1992, 1996b, 1997; PESSINA & D'AMICO, 1999).

The lithic population in the various cases differs in content, as can be seen from Tab.2. Alongside collections very rich in findings (Alba, 114 findings selected from 950; Gaione, 258 findings; Sammardenchia, 290) are other poorer Neolithic collections (Brignano Frascata, Vho, Ostiano, S.Lazzaro di Savena 1), a Chalcolithic collection, medium in size but lithologically very homogeneous (S.Lazzaro 2) and a heterogeneous collection from the Trentino (between Neolithic and Bronze Age).

Evaluation of the presence percentages in the various cases in Tab.2 must take into account the statistical weight of each case to obtain a correct reading, this being extremely reliable in the first three sites and for the S.Lazzaro 2 collection, but less representative in the other cases, for which some variation can be expected following the sampling increases. In the case of Brignano Frascata this check can already be carried out, comparing the slightly different data presented by Zamagni (1996) with respect to those of D'Amico & Starnini (1996) and D'Amico *et al.* (2000) reported in Tab.2.

Also in Tab.2 a fairly clear-cut difference can be seen between the first columns, corresponding to western sites (Alba, Brignano Frascata, Vho+Ostiano), where jades tend to prevail over eclogites, and the other columns, corresponding to more eastern or southern sites (Gaione, S.Lazzaro 1, Trentino, Sammardenchia), where eclogites prevail over jades. Further checks will obviously have to be carried out in order to understand whether these differences are significant, and what their sense is. For the moment the strong dominance of eclogites over jades at Gaione and S.Lazzaro di Savena with respect to any other case is particularly impressive. This feature seems almost to suggest an Appenine foothill route of lithic supply different to the other circulation routes, a route that also appears to be confirmed by the relatively common abundance of omphacite schists (6% in both, cfr. Fabris, 1996; Andò, 1998), much greater than in all the other cases. Further examinations of the polished stone in Appenine foothill sites will ascertain whether this feature is widespread or merely contingent.

The miscellaneous "Other" group reveals notably heterogeneous cases. When the specific group of the site is small in quantity, it is mainly residual and casual in nature, linked to finds of little significance, such as pebbles or strikers or similar tools. On the other hand, in the cases where the group is well represented (Sammardenchia, S.Lazzaro 2) it acquires substantial importance, defining the lithic physiognomy of the site. The group "Others" is formed by lithologies that differ from case to case, which provide important information on the lithic supply. For example (as will be seen in Chapter 4) at Sammardenchia important local contributions and more modest importations from the East; at S. Lazzaro di Savena, Chalcolithic, a dominant contribution of Appenninic basic magmatites.

It is interesting, from a methodological point of view, to note how the complex situation of serpentinites group, discussed in Paragraph 3.2. and Chapter 4, is even just suggested through the oscillations in quantity of the lithological data, and even more so through the lithology/typology relationships (Tab.3 and Paragraph 3.2.).

3.2. *Articulation by lithology/typology relationships*

Tab.3 demonstrates how there are links between lithology and typology in the artefacts. In this table, the "Others" group of Tab.2 has been broken down, distinguishing the main local groups. In particular, basic magmatic rocks at S.Lazzaro 2 (Casadei, 1997), ashstones/tuffites, chlorite schists and most of the paragonite mica schists at Sammardenchia (D'Amico *et al.*, 1997).

The groups of eclogites, jades and other metaophiolites, which can be arranged in the HP Metaophiolite supergroup, are homogeneous in their distribution and provide most of the axes, adzes, hatchets and chisels. It is unclear whether the greater proportion of jades with respect to eclogites in valuable artefacts such as large axes, hatchets and chisels with respect to axes/adzes indicates an intentional selection. This will be verified with an increase in sampling of the sites and of the findings.

The ashstones/tuffites (referring to the Ladinian "green stone" of the Alps), present only at Sammardenchia (except for two Trentino findings), and local in origin (D'Amico *et al.*, 1997; Pessina & D'Amico, 1999), resemble the HP metaophiolites as regards proportion between typology and lithology, almost as if the local production, which in this case includes some rough-outs, copied the main typologies imported from the west, made from more valuable stones as eclogites and jades.

The serpentinites, on the other hand, show a clear difference with respect to the other lithologies in the typology/lithology relationships, parallel to their difference in general distribution discussed in Paragraph 3.1. In particular there is an important presence of hammer axes and chisel axes, absent in the other lithologies. Among the sites considered here, these typologies made from serpentinite are only present at Sammardenchia and suggest an importation from the East (D'Amico *et al.*, 1997; Pessina & D'Amico, 1999; see Chapter 4.).

The Rings category reveals a strict selection of the lithotypes used. Soft lithotypes were chosen above all to make the rings, such as serpentinites, chlorite schists and paragonite mica schists, while the HP metaophiolites are rarer. Among the cases considered, the

only two jades used for rings were found at Alba (D'AMICO & GHEDINI, 1996; TRAVERSONE, 1996), plus a jadeitite ring in the Bologna area (D'AMICO *et al.*, 1996a) and an eclogite one at Brignano Frascata (ZAMAGNI, 1966). The rings made from ashstones/tuffites at Sammardenchia, and from hornblende metagabbro (among the "basic rocks" in Tab.3) at Gaione can be considered local specialities. The rings made from chlorite schists at Sammardenchia are also for the moment a unique case, and their origin has not yet been identified.

On the other hand, the use of paragonite mica schists, found at Alba (D'AMICO & GHEDINI, 1996), at Sammardenchia (D'AMICO *et al.*, 1997) and in other places (TRAVERSONE, 1996), and above all of serpentinites, found at Sammardenchia (D'AMICO *et al.*, 1997), at Brignano Frascata (ZAMAGNI, 1996; D'AMICO *et al.*, 2000) and in various other places (FASANI *et al.*, 1994; TRAVERSONE, 1996; PERINI *et al.*, This volume), seems to be more widespread in the Neolithic society for making rings.

Finally, the group of "Basic rocks" in Tab.3 is almost entirely from the S.Lazzaro di Savena collection (S.Lazzaro 2; "Others" in Tab.2), except for the Gaione ring. The lithology/typology relationship of the S.Lazzaro collection of findings in basic magmatites is in general completely different and unrelated to the other groups, containing in particular a large quantity of hammer axes, which thus tends to attribute it to the Chalcolithic period.

4. PROVENANCE AND CONCLUSIONS

For the HP metaophiolite supergroup the general provenance from the Western Alps is accepted by all authors (RICQ-DE-BOUARD *et al.*, 1990; RICQ-DE-BOUARD & FEDELE, 1993; RICQ-DE-BOUARD, 1996; D'AMICO *et al.*, 1995, 1998; COMPAGNONI *et al.*, 1995; cfr. also Chapter 2.). It appears probable to the same authors that the collection of the lithic materials mainly occurred not from the primary outcrops of the Western Alps, but from secondary clastic deposits, both along the current watercourses and from peralpine oligocenic conglomerates, in turn supplying the pebbles of the current watercourses.

This opinion is supported by the fact that the known main atelier sites are far from the primary outcrops and are instead geologically connected to fluvial supply by oligocenic conglomerates upstream from the sites. This is the case of Alba (VENTURINO GAMBARI & ZAMAGNI, 1996), Brignano Frascata (ZAMAGNI, 1996; D'AMICO & STARNINI, 1996; D'AMICO *et al.*, 2000) and Rivanazzano (MANNONI & STARNINI, 1994; MANNONI *et al.*,1996). The stone collection from secondary sources greatly increases the potential lithic gathering area to all the basins supplied by both the primary sources and the secondary oligocenic conglomerats, as pointed out by D'AMICO *et al.* (1998) and as is indicated in Fig.2. This figure proposes a further hypothetical expansion of the possible lithic collection areas, as the Gaione lithic data (study in progress; cfr. ANDÒ, 1998) seem to indicate, still awaiting geological verification however.

The serpentinites represent an archeometrically interesting lithology, due to the open question of their provenances, also shown by the different distributions with respect to the other lithologies in Tab.2 and 3. Since serpentinites outcrop in the same Western Alpine regions, from which the dominant eclogites and jades derive, and from there they follow the destination of erosion and deposit in the tertiary conglomerates and in the current alluvial sediments, it is inevitable to take a certain additional contribution of serpentinites for granted, which is in fact often found in the findings together with jades and eclogites (e.g. RICQ-DE-BOUARD, 1996; various studies in VENTURINO GAMBARI (ed), 1996).

This conclusion cannot, however, be generalized. A second certain lithic source of serpentinites of the Neolithic artefacts is identified in the alluvial deposits of the Adige (DI BRAIDA, 1991) and presumably in general in the alluvial (+ morenic) deposits of the Isarco-Adige axis between South Tyrol and Trentino, with geological provenance of the materials from the Pennidic Units between the Brenner Pass and Val Aurina (D'AMICO *et al.*, in preparation). At least a third source is suggested by the typological particularities of the hammer axes in serpentinite at Sammardenchia (Tab.3; cfr. also D'AMICO *et al.*, 1996b; PESSINA & D'AMICO, 1999), one of which, found during digging, is without any doubt neolithic, and which are absent in all the other collections considered here. A systematic study of the serpentinites has not however been made yet, from which definite conclusions can be drawn. Such a study will be worthy of particular attention also with reference to the abundant serpentinites of Chalcolithic axes in Venezia Giulia (D'AMICO *et al.*, 1996c) and in particular in the Ljubljana marsh (study in progress), where this lithology dominates in 50% of the findings.

The theoretical basis of the attention to be paid to the serpentinites lies in the fact that these lithologies have much less strict geological constraints than eclogites and jades, because they are less linked to extreme pressures of genesis, and thus geologically more widespread and with various possible alpine and extra-alpine provenances.

The provenance of the individual sub-groups gathered together in the miscellaneous "Others" group in Tab.2-3 may be merely local, scarce and mostly ca-

sual and without a significance worthy of attention (Alba, Brignano Frascata, Vho-Ostiano, Gaione) or may instead be highly significant and characterizing the lithic physiognomy of the site, rich in information on the provenance and use of the raw material. Among these cases the group of ashstones/tuffites of Sammardenchia (Tab.4) deserves attention and, with other minor lithic presences, represents 22% of the polished stone of the area. These derive from pebbles of the local plain (D'Amico *et al.*, 1992, 1997) and represent a clear selection from the pebbles of the lithologies which, in colour, fine grain, cohesion and hardness, more closely resembled the valuable eclogites and jades imported from the West. In fact the ashstones/tuffites in the pebbles are not so predominant in respect to sandstones and basalts (cfr. Tab.4), which are much less selected among the artefacts. Some rough-outs are evidence of local processing (Pessina & D'Amico, 1999), unlike all the other lithologies.

Among the "Others" of Sammardenchia, Tab.4 identifies around 5% of materials interpreted as having a Danubian provenance, with a very high probability for two silexites and one vitric tuff and to be verified further for some dacites (D'Amico *et al.*, 1997; Pessina & D'Amico, 1999). The use of these local and eastern stones attributes a specific lithic physiognomy to Sammardenchia, unique in Northern Italy.

One absolutely remarkable case of the "Others" category in Tab.1-2 can be seen at S.Lazzaro di Savena, where implements are made of basic magmatic rocks, with a prevalence of dolerites and diabases, all with the characteristics of Appenine ophiolites[1]. These characteristics suggest a provenance either from Eastern Liguria or from Tyrrhenian Tuscany (Casadei, 1997; studies in progress). Nearly half the findings consist of hammer axes, typically Chalcolithic, while chisels and hatchets are rare. Although surface collections like this one advise caution, it seems reasonable to hypothesise that, at least in this area, the use and provenance of polished stone changed drastically in the Chalcolithic period. This case, held in little consideration so far, merits careful consideration.

Some mention should be made of the remaining lithotypes. The few paragonite mica schists, found only in the rings, are also rare rocks referring to HP metamorphic conditions like eclogites and jades, and thus also originating from HP Western Alpine metamorphic units. Consistent with a Western Alpine provenance, many Neolithic ornamental objects in paragonite mica schist are known in Piedmont, near the Western Alps (Traversone, 1996), while the data cited here also show their extensive exportation.

The provenance of the chlorite schists (Tab.3-4), also practically only found in ornaments and for the moment present only at Sammardenchia, has not yet been identified. A provenance from the masses of "pietra ollare" (essentially chloritoschists) of the Aosta area and the Lanzo valleys, which, in the context of western provenances, would logically seem to be the first to take into consideration, can be excluded. In fact, a petrographical comparison (Mugnaini, 1995) showed strong petrographical differences between the chlorite schists of the rings and the "pietra ollare".

The same problem applies to the few nephrites, not distinguished in Tab.1-3. The use of nephrites is widely known in Swiss Neolithic artefacts (cfr. Mutschlechner, 1948; Giess, 1994). A similar provenance can be hypothesized for the sites considered here. The casuality and the rarity of findings made from nephrite probably indicate that they were occasional gifts. This makes archeometrically difficult tracing their origin with certainty.

NOTES

1 - The Appenine ophiolites are oceanic bottom magmatic masses inserted in the surface crust by the orogenic alpine events, which, thanks to the fact that they always stayed at low depths, did not undergo subduction and HP metamorphism, as instead occurred to the corresponding masses which, other parts of the orogenic belt being implicated in the alpine subduction, were transformed over time into HP metaophiolites, like eclogites and jades.

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SUMMARY - The data obtained to date (1997) in the study on Neolithic and post-Neolithic polished stone in Northern Italy, considering eight different sites or areas, are reported and commented on. Some lithologies appear to be dominant, particularly as axes. These are made from eclogites, jades and minor lithotypes connected to them, which can be grouped into a supergroup of high pressure (HP) metaophiolites. The geological constraint of these lithologies is very narrow and implies a provenance from formations of the Western Alps, or from perialpine tertiary conglomerates and quaternary alluvial deposits, deriving from the erosion of these formations. The HP metaophiolitic lithologies represent 90% of the Neolithic findings in the most western areas, while they are accompanied by other lithologies in the eastern areas. In these, exemplified here by the large site at Sammardenchia, Friuli, there is also use of local stone, collected from alluvial pebbles, with a particular selection of triassic cinerites/tuffites, as well as a lesser use of Danubian lithologies and typologies. A problematic group is represented by the serpentinites, which may originate from the Western Alps like the other HP metaophiolites, or from the Isarco-Adige valleys and/or Eastern Alpine areas. The ornaments were selected from soft rocks such as chloriteschists, paragonite micaschists and serpentinites, some of western provenance, some local, some uncertain. A lithological drastic diachronic change is very evident in the S. Lazzaro di Savena area, where the Chalcolithic hammer axes (together with other artefacts) are all made from appenine basic magmatites, possibly coming from East Liguria or the coastal part of Tuscany.

RIASSUNTO - Sono esposti e commentati i dati finora (al 1997) ottenuti nello studio della pietra levigata neolitica e post-neolitica in Italia settentrionale, considerando otto diversi siti o aree. Alcune litologie appaiono dominanti, in particolare nelle asce s.l. Si tratta di eclogiti e giade e di minori litotipi ad esse collegati, raggruppabili in un supergruppo di metaofioliti di alta pressione (HP). Il vincolo geologico di queste litologie è molto stretto e implica una provenienza da formazioni delle Alpi occidentali, o dai depositi conglomeratici terziari e alluvionali quaternari perialpini, derivanti dall'erosione di quelle formazioni. Le litologie metaofiolitiche HP rappresentano 90% dei reperti neolitici nella aree più occidentali, mentre sono accompagnati da altre litologie nelle zone orientali. In queste, esemplificate qui soprattutto dal grande sito di Sammardenchia, Friuli, vi è anche uso di pietre locali, raccolte dai ciottoli alluvionali, con particolare selezione di cineriti/tufiti triassiche, oltre a un minore utilizzo di litologie e tipologie danubiane. Un gruppo problematico è dato dalle serpentiniti, che possono avere provenienza dalle Alpi occidentali come le altre metaofioliti HP, o avere origine dalle valli Isarco-Adige, e/o una provenienza orientale. Gli ornamenti sono stati selezionati da rocce tenere come cloritoscisti, micascisti paragonitici, serpentiniti, ora di provenienza occidentale, ora locale, ora incerta. Molto vistoso il cambio litologico nell'area di S.Lazzaro di Savena, ove tutte le asce- martello eneolitiche (accanto ad altri manufatti) sono fatte di magmatiti basiche appenniniche, provenienti presumibilmente da Liguria est o Toscana tirrenica, e attestanti un drastico cambiamento litico.

REFERENCES

ANDO' M.C., 1998 - *La Pietra Levigata Neolitica di Gaione (PR); Studio Petroarcheometrico dei Litotipi.* Tesi di Laurea, Sci. Geol., Univ. Bologna, A.A. 1996-97

BERNABO' BREA M., D'AMICO C., GHEDINI M., GHIRETTI A. & OCCHI S., 1996 - Gaione, loc. Case Catena. In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.122-136. Omega Edizioni, Torino

CABELLA R., CORTESOGNO L., GAGGERO L., ISETTI E. & ROSSI G., 1994 - Dati preliminari sui manufatti neolitici in pietra levigata delle Alpi liguri. In: C.D'Amico & R.Campana (eds), Le Scienze della Terra e l'Archeometria, p.15-17. Bologna

CABELLA R., CORTESOGNO L., GAGGERO L., FIRPO M., GARIBALDI P., ISETTI E., RAMELLA A. & ROSSI G., 1995 - Industria in pietra levigata dalle vallate savonesi a sud dello spartiacque padano-tirrenico: petrografia, distribuzione e possibile provenienza. In: 2a giornata "Le Scienze della Terra e l'Archeometria", 7-8 aprile 1995, p.99-102. Rovereto, Museo Civico

CASADEI S., 1997 - *Ricerche Petrografiche e Archeometriche sulla Pietra Levigata Eneolitica in Materiale Basaltico del Museo di S.Lazzaro di Savena (BO).* Tesi di Laurea, Sci. Geol. Univ. Bologna, A.A. 1995-96

CHIARI G., COMPAGNONI R., GIUSTETTO R. & RISQ-DE-BOUARD M., 1996 - Metodi archeometrici per lo studio dei manufatti in pietra levigata. In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.35-53. Omega Edizioni, Torino

COMPAGNONI R. & RICQ-DE-BOUARD M., 1993 - French neolithic stone axes in "jade": petrological variability and origin. *Terra Nova* (Abstracts) 5, suppl. 4:5-6

COMPAGNONI R., RICQ DE BOUARD M., GIUSTETTO R. & COLOMBO F., 1995 - Eclogite and Na-pyroxenite stone axes of southwestern Europe: a preliminary petrologic survey. *Boll. Museo Regionale Scienze Naturali* 13, suppl. 2, p.:329-359. Torino

D'AMICO C., 1993 - Eclogites and jades as prehistoric implements in Europe *Terra Nova* (Abstracts) 5, suppl. 4:7-8.

D'AMICO C., 1995 - Petroarcheometria dei reperti in pietra levigata. *Monografie di Natura Bresciana* 22:92-96

D'AMICO C. & FELICE G., 1994 - Petroarcheometria di reperti neolitici di Sammardenchia (Udine): notizie preliminari. Atti XXIX Riun. Scient. Ist Ital. Preistoria e Protostoria, p.159-165. Firenze

D'AMICO C. & GHEDINI M., 1996 - La pietra levigata della collezione "Traverso" di Alba, nel Museo etnografico

"L. Pigorini" di Roma. *Museologia Scientifica* 13, suppl. 1-2:293-312

D'Amico C. & Starnini E., 1996 - Brignano frascata (Scavi Tinè). In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.74-79. Omega Edizioni, Torino

D'Amico C., Bargossi G., Felice G. & Mazzeo M., 1991 - Giade ed eclogiti in pietra levigata: studio petroarcheometrico. *Miner. Petrogr. Acta* 34:257-283

D'Amico C., Felice G. & Ghedini M., 1992 - Lithic supplies in the Early Neolithic to Sammardenchia (Friuli), Northern Italy. *Science and Tecnology for Cultural Heritage* 1:159-176

D'Amico C., Campana R., Felice G. & Ghedini M., 1995 - Eclogites and jades as prehistoric implements in Europe: a case of petrology applied to cultural heritage. *Eur. J. Mineral* 7:29-41

D'Amico C., Ghedini M. & Morico G., 1996a - Museo Aldrovandiano, Bologna In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.27-28. Omega Edizioni, Torino

D'Amico C., Ferrari A., Ghedini M. & Pessina A., 1996b - Sammardenchia (Pozzuolo del Friuli). In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.84-91. Omega Edizioni, Torino

D'Amico C., Ghedini M., Micheli R. & Montagnari Kokelj E., 1996c - Le asce forate del Friuli-Venezia Giulia. In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.229-238. Omega Edizioni, Torino

D'Amico C., Felice G. & Ghedini M., 1998 - Neolithic to Bronze polished stone in Northern Italy. XIII Congr. Intern. UISSP, Forlì 1996, vol.3,9:389-399

D'Amico C., Felice G., Gasparotto G., Ghedini M., Nannetti M.C. & Trentini P., 1997 - La pietra levigata neolitica di Sammardenchia (Friuli): catalogo petrografico. *Miner. Petrogr. Acta* 40:385-426

D'Amico C., Starnini E. & Voytek B., 2000 - L'industria litica di Brignano Frascata (AL): dati paleoeconomici di un insediamento del Neolitico antico padano attraverso l'analisi tipologica funzionale e lo studio della provenienza delle materie prime. *Preistoria Alpina* 31:91-124

D'Amico C., Jacobs R., Le Brun-Ricalens F. & Loehr H., 1998 - Steinbeilklingen aus "Jade" im Grossherzogtum Luxemburg. *Bull. Soc. Préhist. Luxembourgeoise* 17:157-212

D'Amico C., Felice G. & Pedrotti A.L., in preparation - La pietra levigata neolitica di Isera (TN)

Di Braida A., 1991 - *Petroarcheometria di Manufatti in Pietra Levigata di Siti Trentini; Tipologie, Casistica e Approvvigionamenti del Materiale nel Neolitico e nell'Età del Bronzo.* Tesi di Laurea, Sci. Geol., Univ. Bologna, A.A. 1990-91

Fabris S., 1996 - *Ricerche Petrografiche e Archeometriche sulla Pietra Levigata Neolitica dell'Area di S.Lazzaro di Savena (BO).* Tesi di Laurea, Sci. Geol. Univ. Bologna, A.A. 1995-96

Fasani L., Biagi P., D'Amico C., Starnini E. & Voytek B., 1994 - Stazione neolitica a Valer (Azzano Decimo-Pordenone): rapporto preliminare degli scavi 1990-1991. *Atti Soc. Preist. Protost. Friuli V.G.* 8:97-113

Giess H., 1994 - Jade in Switzerland. *The Bulletin of the Friends of Jade* 8:1-46. S. Diego, Ca.

Mannoni T. & Starnini E., 1994 - Il contributo delle analisi petrografiche nello studio dell'officina di Rivanazzano (PV). In: C.D'Amico & R.Campana (eds), Le Scienze della Terra e l'Archeometria. Bologna

Mannoni T., Starnini E. & Simone Zopfi L., 1996 - Rivanazzano. In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.119- 122. Omega Edizioni, Torino

Mugnaini D., 1995 - *Studio Petroarcheometrico dei Manufatti Strumentali e Ornamentali in Serpentinite e Cloritoscisto di Siti Neolitici Friulani e Trentini.* Tesi di Laurea, Sci. Nat., Univ. Bologna, A.A. 1994/95

Mutschlechner G., 1948 - Vorkommen der Steinzeitlichen Werkstaffe Nephrit und Jadeit in Unseren Alpen. *Der Schlern*: 107-109

Perini M., Starnini E., D'Amico C. & Omomano C., This volume - A new settlement of the Vhò Group at Isorella (BS): preliminary results in the 1997 research.

Pessina A. & D'Amico C., 1999 – L'industria levigata del sito neolitico di Sammardenchia (Pozzuolo del Friuli, Udine); aspetti archeologici e petroarcheometrici. In: "Sammardenchia", pubbl.41:23-92. Museo Friulano di Storia Naturale, Udine

Ricq-De-Bouard M., 1996 - Petrographie et sociétés neolithiques en France méditerranéenne: l'outilage en pierre polie. *Monographie* 16. 272pp, CNRS éd., Paris

Ricq-de-Bouard M., Compagnoni R., Desmons J. & Fedele F., 1990 - Les roches alpines dans l'outillage poli néolithiqhe de la France Méditerranéenne: classification, origine, circulation. *Gallia Préhistoire* 32:125-149

Ricq-de-Bouard M. & Fedele G.F., 1993 - Neolithic rock resources across the Western Alps: circulation data and models. *Geoacheology* 8,1:1-22

Ricq-De-Bouard M., Compagnoni R., Colombo F. & Deiss W., 1996 - Le materiel des Musées de Provence et du Dauphinè: contribue à la connaissance des courants de circulation transalpins, au Neolithique. *Museologia Scientifica* 13, suppl.1-2:313-328

Starnini E., D'Amico C., Ottomano C. & Perini M., (this volume) - Un nuovo insediamento del gruppo Vho a Isorella (BS): primi dati delle ricerche del 1997.

Traversone B., 1996 - Oggetti ornamentali In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.197-202. Omega Edizioni, Torino

Venturino Gambari M. (ed), 1996 - Le Vie della Pietra Verde: l'Industria Litica Levigata nella Preistortia dell'Italia Settentrionale. 302 pp, Omega edizioni, Torino

Venturino Gambari M. & Zamagni B., 1996 - Alba. In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.92-98. Omega Edizioni, Torino

Viroli S., 1995 - *Studio Petroarcheometrico delle Pietre Levigate Neolitiche di Vho-Ostiano (CR).* Tesi di Laurea, Sci. Geol., Univ. Bologna, A.A. 1994-95

Zamagni B., 1996 - Brignano Frascata In: M.Venturino Gambari (ed), Le Vie della Pietra Verde, p.92-98. Omega Edizioni, Torino.

Table 1
Summary of polished stone lithology in Northern Italy
(786 studied finds)

ECLOGITES	281	35.8%
JADES (Na-pyroxenites)	183	23.3 %
Other HP METAOPHIOLITES	50	6.4%
SERPENTINITES	68	8.5%
OTHER STONES	204	26.0%

Table 2
Lithology in single sites

		Alba *114*	BriF *32*	Vho-Ost *25*	Gaione *258*	S. Laz.1° *35*	S. Laz.2° *62*	Trent *70*	Samm. *290*
Eclogites	%	36	22	36	49	66	-	27	36
Jades	%	38	34	56	23	13	-	19	22.5
O. M.O.	%	10	6	-	16	9	-	-	2
Serpent.	%	7	22	4	5.5	3	-	33	7
Other St.	%	8	16	4	6.5	-	100	21	32.5

Alba, Brignano Frascata, Vho e Ostiano, Gaione, S. Lazzaro di Savena, Trentino (vari), Sammardenchia.

Table 3
Typology / Lithology relationships
(numbers of finds)

	Axes l.s.	Large Axes	Hachettes	Hammer-Axes	Chisels	Chisel-Axes	Rings	Fragm. Undef.
Eclogites	177	10	39	-	10	2	-	43
Jades	92	8	35	-	11	-	2	28
Other M.O.	26	2	3	-	3	-	-	17
Serpentinites	9	1	6	6	2	4	7	33
Cloriteschists	-	-	-	-	-	-	7	2
Micaschists	-	-	-	-	-	-	5	-
Basic rocks	20	-	1	28	1	-	-	13
Cinerite/Tuffites	20	1	4	-	3	1	2	21

Table 4
The case of Sammardenchia
(from D'Amico *et al.*, 1997)

Archaeometric Supergroups		*Lithologic Groups*	
Volcanites and sedimentary rocks of local provenance	**22.5%**	Cinerites/tuffites Sandstones Slates Basalts	**18.5%** **1.5%** **1.5%** **1.0%**
HP Metaophiolites of western importation ..... + *micaschists*	**62%**	Eclogites Jades Omphacite Schists Glaucophane Schists Zoisitites ..... Micaschists	**36.0%** **22.5%** **<1.0%** **<1.0%** **<1.0%** **1.5%**
Metaultramafites of uncertain, various provenances	**10.5%**	Serpentinites Cloriteschists Nephrites	**7.0%** **3.0%** **<1.0%**
Volcanites/Volcanoclastites of probable eastern provenance	**5.0%**	Dacites (andesites) Silexites Vitric Cinerite	**4.0%** **<1.0%** **<0.5%**

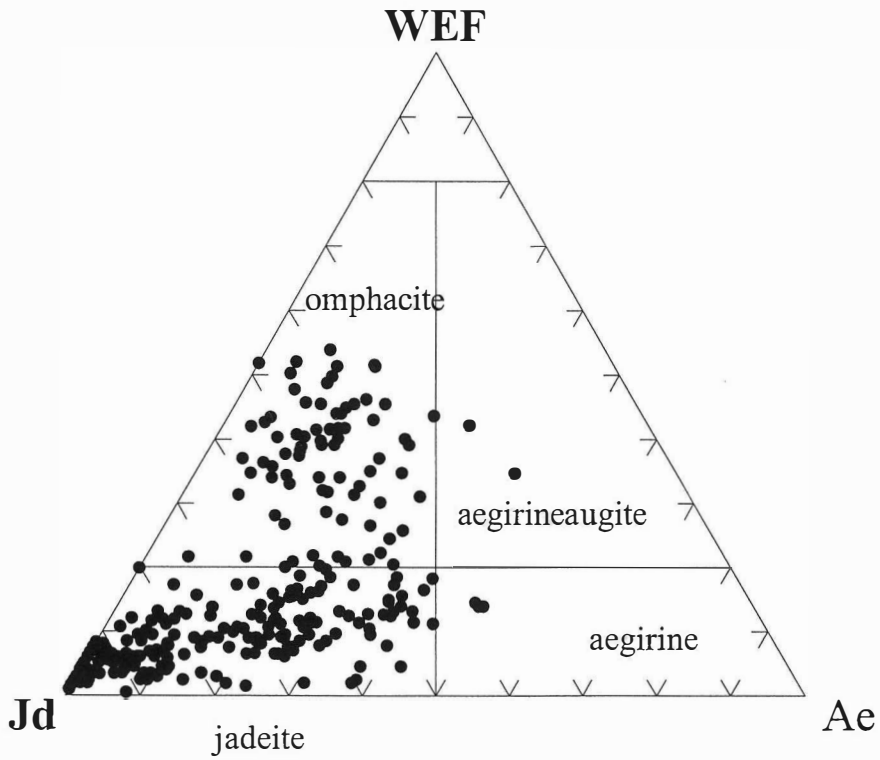
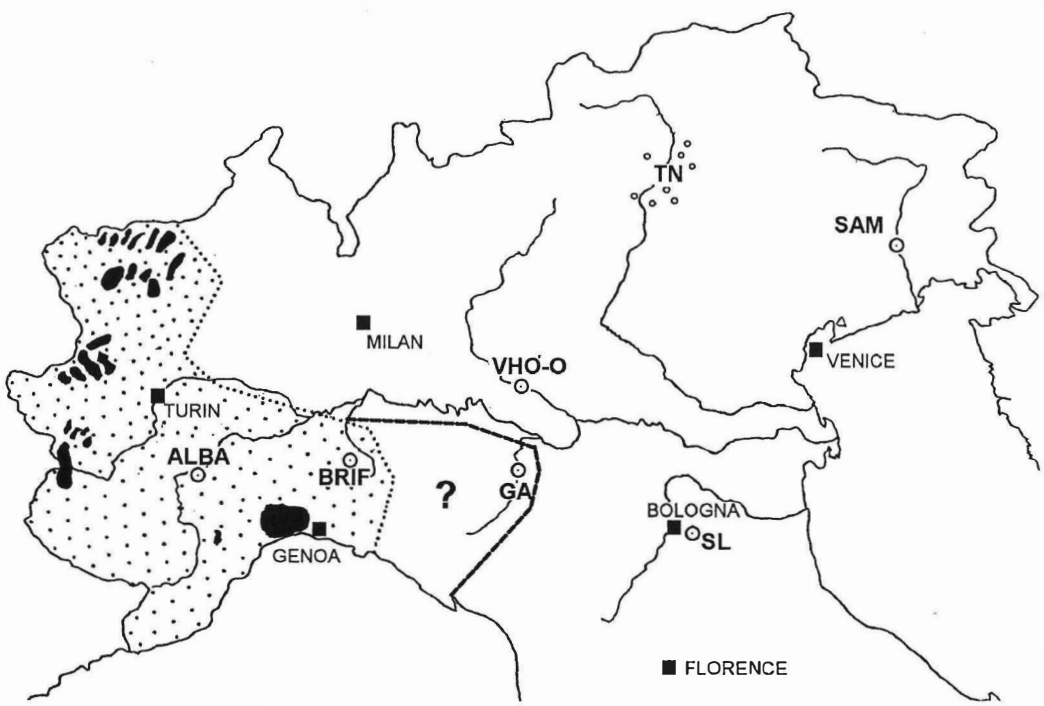


Fig. 1 – Composition of the jades at Sammardenchia (from D'Amico *et al.*, 1997). The Na-pyroxenes of the jades have an extremely variable composition, occupying the jadeite and most of the omphacite range. Different compositions within the range very often coexist in the same jade, particularly in the mixed jades. The Fe-jadeites and the Fe-omphacites occupy the right side of the point distribution, grading without a hiatus to the less ferriferous terms.



O Neolithic sites

ALBA, BRIF = Brignano Frascata, VHO-O = Vho e Ostiano, GA = Gaione
SL = San Lazzaro di Savena, TN = Trentino, SAM = Sammardenchia

Fig. 2 – Areas of potential neolithic collection of eclogites, jades and connected HP metaophiolites (cfr. D'Amico *et al.*, 1998). The primary outcrop areas are shown in black. The areas of oligocenic conglomerates with HP metaophiolitic elements, and the areas bearing alluvial pebbles deriving from the primary and secondary outcrops, are dotted. The extension of this area towards the east is proposed by a question mark, and awaits geological verification, since some characteristics of the Gaione collection suggest a close provenance, rather than importation, of eclogites and jades.