CIRCULATION OF RAW MATERIALS, FINAL PRODUCTS OR IDEAS IN THE NEOLITHIC COMMUNITIES OF SOUTHERN ITALY: THE CONTRIBUTION OF ARCHAEOMETRIC ANALYSES TO THE STUDY OF POTTERY, FLINT AND OBSIDIAN.

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Abstract: This paper offers a brief overview of Neolithic exchange in southern Italy during the Early to Late Neolithic (from 6200 to 4000 BC). There have been a number of archaeometric studies which have focussed on certain 'core' materials: pottery, flint and obsidian. Different materials traded by the same communities seem to follow various circulation model(s) for raw materials, final products or ideas. Some positive insights can therefore be gained into the inter- and intra-group organization of the many Neolithic communities, who shared so many other common behavioural features.

Keywords: Southern Italy, pottery, obsidian, flint, archaeometry.

Riassunto: *Si presenta una breve panoramica sulla circolazione nel Neolitico dell'Italia meridionale dalle sue fasi iniziali a quelle finali (da ca. 6.200 a 4.000 BC). In questi anni numerosi studi archeometrici si sono concentrati su alcune classi di materiali (ceramica, selce ed ossidiana) per determinarne la provenienza. Materiali differenti scambiati dalle stesse comunità sembrano seguire distinti modelli di circolazione di materie prime, prodotti finiti o idee. Il confronto tra questi diversi aspetti sembra suggerire diverse modalità di organizzazione intra e inter gruppo delle comunità del Neolitico.*

Parole chiave: *Italia meridionale, ceramica, ossidiana, selce, archeometria.*

Introduction

Between the end of the 7th and the beginning of the 4th millennium BC, different areas of southern Italy were densely populated by agricultural and herding communities who exploited the favourable climate and fertile soil, and lived in open air settlements, sometimes with ditched or dry-stone wall enclosures. Sites are spread over a range of locations (inland plains and hillsides, river terraces and coastal areas) and date from Early to Late phases of the Neolithic. Natural shelters and karstic caves were often also used and artificially modified for domestic purposes or display evidence of funerary or cult practices.

Pioneer Neolithic colonisation – probably maritime – reached the south-eastern regions of the Italian peninsula (Apulia, Basilicata and Calabria) by 7100 BP and then spread upwards along inland and coastal routes, reaching central and northern Italy by 6800 BP (Müller 1994; Forenbaher and Miracle 2005). However, the way in which Neolithic communities became economically productive is still largely unknown: their presumable interaction with local Mesolithic cultures and the trans-Adriatic contribution from central/eastern Mediterranean regions are still unknown. The bulk of agricultural domesticates and related technological baggage (pottery and lithic industries) that accompanied the Italian Neolithic are more or less chronologically and culturally related – depending on different conceptual approaches (migration vs. acculturation) – to the eastern Adriatic coast, the Greek Ionian Islands and further east to the southern Balkans.

Early to Late Neolithic phases are culturally marked by a rapid diversification of wares, shapes and decorative styles, some of which also seem to be exclusive to specific areas. The degree to which the range of Neolithic ceramic decorative styles fit in a rigid typological and chronological classification is very complex and difficult to define. Impressed/Cardial Wares are among the earliest types of pottery to appear in southern Italy. The fact that many dates, mainly in Early Neolithic phases of the first half of the 6th

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millennium BC, seem to be very close to each other, regardless of the stylistic characteristics of the ceramic classes (with a rapid development of "evolved" impressed, painted and scratched wares), is also of particular significance. Typologically the development of the Mid Neolithic in southern Italy is fairly clearly marked by the spread of red- and brown-painted fine wares, known also as *figulina*.

Aims

This paper aims to offer a brief overview of Neolithic exchange in southern Italy. The examination of circulation during the Early to Late Neolithic is not new in this area (Skeates 1993): long-distance trade as well as complex social organization are among the many practices labelled as Neolithic innovations. However, data is continuously being generated by ongoing excavation and developments in different fields of scientific analyses, calling for constant re-evaluation of current interpretations, which will hopefully gradually reveal the dynamics of Neolithic exchange. In particular, there have been a number of archaeometric studies which have focussed on certain 'core' materials which offer new insights not only into exchange, but also into Neolithic societies. With regard to the several key artefact types which could be considered when examining circulation, this paper will focus mainly on pottery, flint and obsidian. Polished stone artefacts ("greenstone" as well as steatite), which form another typical Neolithic long-distance exchange network, have not been systematically analysed in southern Italian Neolithic sites until recently (O'Hare 1990; Leighton and Dixon 1992).

An archaeometric approach does not cover all the relevant issues. There are many other factors which should be borne in mind that have been touched upon in past studies (Dillian and White 2010). From a substantivist perspective (and partially shared by the "*new archaeology*"), the emergence of progressively more complex socio-political entities led to a symmetrical decrease in the social and ideological embedment of economic factors. In ancient societies reciprocity or wealth redistribution played a greater role. The new emphasis in the 1990s on contextual and post-processual archaeology and data analysis provided deeper insights into the economy of individual communities, as well as wider socio-cultural entities. Material culture also assumed symbolic values and greater attention has been paid to variability factors. From a technological approach, greater importance should be given to the study of the technical behaviour that can be read from archaeological artefacts: technology can embody social dynamics, economic values, historical contingencies and cultural choices.

Pottery

Petrological (optical microscopy), mineralogical (X-ray powder diffraction) and chemical analyses (X-ray fluorescence) have been cross-checked and systematically carried out on Early to Late Neolithic pottery, analysed in the Geomineralogical Department of Bari University (Laviano, Muntoni 2006). Correlated analysis of pelitic and clayey samples was also conducted: only the combined analyses of clay sources and archaeological pottery can provide additional information on which clay sources were used, why and what kinds of problem were encountered by potters in the past when modifying materials. The main patterns of variation in Neolithic pottery production, from the 7th to the 4th millennium BC, are summarized here mainly in relation to provenance of raw materials and/or finished pottery artefacts (fig. 1).

Generally local clays were used. Ceramic production seems quite homogeneous (with regard to raw material supply, grain size variability and firing techniques) in Early Neolithic villages, although high levels of inter-site variation were observed between different neighbouring sites (Muntoni 2009). Some degree of variation in grain size composition of natural non-plastics is also noticeable between different wares. In some cases, exploitation of a range of different local fabrics has been verified in some Early Neolithic settlements and it was related to intra-group choices as a response to social/traditional and/or functional constraints. Few finished pots were actually considered outliers, exchanged at an inter-site scale during the Early Neolithic.

Preparation of raw materials has shown different choices made by ancient potters. Clays are usually refined to a greater or lesser extent and the use of mineral temper such as sand, calcite and grog has been attested[1]. The maximum temperature reached during firing was usually between 600/700°C and 850°C. Generally a small number of multi-functional forms were produced and a low degree of standardization of shape and/or types was verified in the more ancient Early Neolithic sites of southern Italy.

In an advanced phase of the Early Neolithic the selection of raw materials, with specific grain-size and compositional characteristics, seems to be mainly related to the vessels' use and dimensions, and so to better mechanical resistance and stability offered by pastes with larger grain

1 For a stimulating discussion of the dynamics and meaning of the changes in temper usage in a different Neolithic context see Rodot and Martineau 2007.

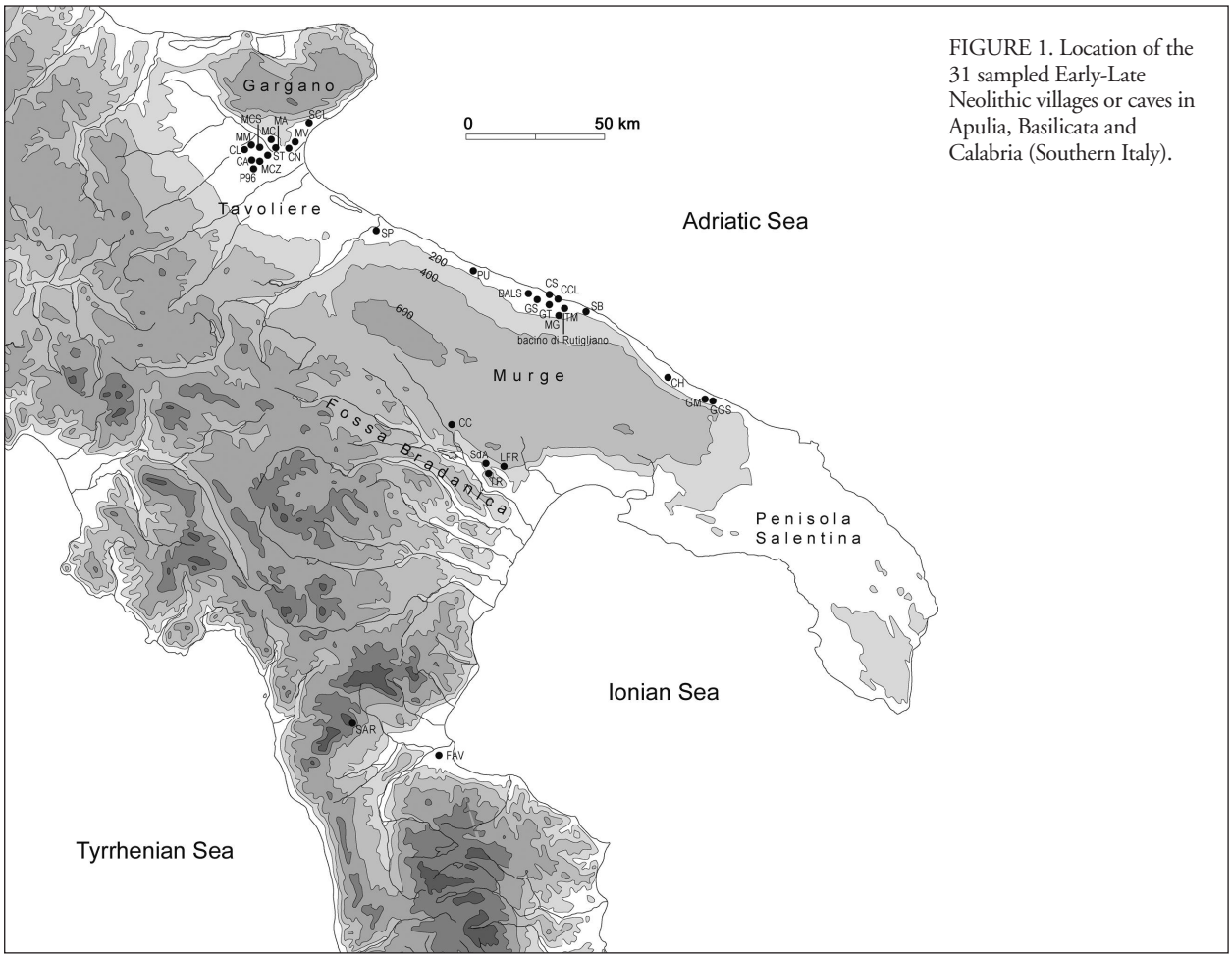


FIGURE 1. Location of the 31 sampled Early-Late Neolithic villages or caves in Apulia, Basilicata and Calabria (Southern Italy).

sizes. An increasing standardisation of paste composition can then be observed and different fabrics may be related to typological groups of shapes or archaeological classes. Increasingly elaborate ceramic production was particularly evident in the final products: a small number of function-oriented forms were in fact produced and an increasing variety of shapes or types can be seen.

While obviously specialization in pottery may not have occurred in the Early Neolithic, a variety of forms of intensification can be recognised in the narrower sense of concentration on particular products and reduction in the variety of raw materials and shapes. Even if forms and surface-finishing techniques remain the major source of variability for Early Neolithic wares, raw materials and technological variations could also indicate appreciable group or individual choices as a response to local functional and/or social constraints. Moreover, groups that stuck to the same taste and behavioural choices were completely autonomous as far as raw material supply and pottery manufacture were concerned. This may suggest a strong pottery tradition, with the emergence of a few significant advances, such as the introduction of different decorative styles and an increasing degree of control exercised by the ceramists over ceramic production. This could also be hypothesized in a domestic production model, characterized by simple technology, equal access to resources and minimal division of labour based on sex and age.

Mid-Late Neolithic *figulina* productions (red-painted bands and 'Serra d'Alto' wares) were widespread in southern Italy in the 5th millennium BC and exhibited homogeneous formal and technical features. The wide distribution of Serra d'Alto wares even in central and northern Italy and its frequent occurrence in funerary/cultual contexts, have led many scholars to emphasize its exchange value. Our extended archaeometric project (Muntoni and Laviano 2008) aimed to verify the hypothesis of the circulation of finished ceramic pots, rather than of production models in different areas of southern Italy. An extensive database of the mineralogical, petrographic and chemical data of this ware was built up using data from many of the excavated Neolithic villages in Apulia, Basilicata and Calabria.

The mineralogical and chemical components of the Apulia and Basilicata samples fit very well with those of the Plio-Pleistocene silty clays of the Bradanic Trough. In some cases, the Plio-Pleistocene silty clay can be found 30 km away from the sites under consideration. The use of specific clay-beds shows a more complex clay supply activity, involving perhaps a whole group of people. Such activity might be distinct from individual and domestic tasks and may suggest that local production was no longer domestic.

Major and trace element concentrations are important for distinguishing different sub-groups of pottery in relation

to their precise geographical setting. The observed differences may account for different exploitation sites within the same geological basin. It can be inferred that Serra d'Alto pottery was produced at more than one site in Apulia and Basilicata and that finished pots were not exchanged between different sites.
Calabrian pottery samples (Muntoni *et al.* 2009) show the exploitation of a local non-Apulian clay source, which can probably be identified with the local Calabrian grey marly or silty clays. The formal analogies between pots found at distant Neolithic sites all over south-eastern Italy does not correspond to an actual exchange of finished pots produced in Apulia or Basilicata. The suggestion that painted fine wares may have been a commodity for long-distance exchange cannot yet be confirmed.
Mid Neolithic coarse wares analysed in many settlements across the Tavoliere Plain, the Murge Plateau and the Bradanic Trough, were produced using eluvial or colluvial deposits in a carbonatic area and were systematically tempered by angular to sub-angular coarse-grained spatic calcite clasts. The spatic calcite seems to be of speleothemic origin (low MgO/CaO ratio). The amount of calcite temper seems to have been quantified according to different recipes. We must consider that karstic caves and dolines are typical forms in the calcareous Murge and Gargano landscape and they were frequently used in the Mid to Late Neolithic period for ritual and/or funerary activity. Our preliminary results suggest that the calcite-tempered Serra d'Alto coarse ware was produced at various sites, using different raw materials with comparable paste-processing. The strong similarities in technological processes at different sites clearly show a broad network of middle-distance exchange of formal and technological production techniques between many Neolithic communities located in different geographical areas of south-eastern Italy, who shared many other common behavioural features.
At Mid Neolithic sites, the deliberate use of different raw materials and paste processes according to the vessel function observed in Serra d'Alto wares (*figulina* and coarse), as well as the compositional differences within the same pottery class (i.e. fine or coarse ware) suggests a polycentric production based on a common technological background. The hypothesis of the circulation of finished ceramic pots was not confirmed, while widespread circulation of technological models probably occurred in different areas of southern Italy. All data confirm a more complex social mode of production that might have evolved from a domestic mode of production to an incipient-specialization stage. High temperatures have also been suggested for these painted fine wares, revealing better firing control (temperature, rate of heating and oxidising atmosphere) and the use of kilns.

Flint

The Neolithic and Copper Age flint mines of the Gargano area are being systematically studied by a team from Siena University under the direction of Attilio Galiberti (Galiberti 2005; Tarantini and Galiberti in press). Research into quarrying techniques and their chronological and spatial evolution has shown that the start of mining activity coincided with the Neolithisation process of southern Italy (Defensola A mine). The mine appears to have been active as early as the first centuries of the 6th millennium BC. During subsequent phases in the Early and Middle Neolithic the exploitation and circulation of flint was intensified and became systematic. The Defensola mine was in use for about 800 years. During the later phases of the Neolithic (corresponding to Serra d'Alto and Diana *facies*) mining activity was reduced, perhaps as a consequence of local changes in settlement. Mining activity was resumed in the Copper Age with important differences in excavation techniques that can also probably be explained in relation to general cultural changes.
The numerous underground extraction structures in the Gargano promontory pose some important questions regarding modes of production and social organisation. Can we consider the mine workers to have been specialists? What does 'specialist' mean in the context of Early and Mid Neolithic society?
On the basis of ethnographic comparisons and archaeological data from contemporary contexts in southern Italy, a definition of part-time specialists can be proposed. Extraction activities were carried out by people who can be appropriately described as specialists given their technological skills, but who carried out this activity in a periodic and irregular way. Extraction may have been a collective activity which functioned according to the same cyclical or seasonal mechanisms of temporary cooperation typical of some agricultural or non-agricultural activities.
A Neolithic exchange system with nearby communities for the raw material, which was mainly used in blade production and for tranchet axes, seems to have already been identified through the technological and typological studies of lithic industries at Neolithic sites in south-eastern Italy. A first attempt to characterise the geological flint and then distinguish different flint mine groups through chemical analyses was carried out by a team from the Italian CNR led by Alberto M. Palmieri (D'Ottavio *et al.* 2000; D'Ottavio 2001; Volterra *et al.* 2002). Their study aimed to discover the chemical fingerprint of each type of flint and then to identify the exchange network of tools supposedly made with flint from the Gargano Promontory. In order to try to identify each mine chemically, ICP-AES chemical analyses were carried

out on flint nodules from seven of the Neolithic flint mines identified in the Gargano Promontory which were dug into two different geological formations (fig. 2). Cluster and discriminant analyses on nine trace elements (Al, Ba, Ca, Cr, Fe, Mg, K, Li and Ti) allowed the mines to be separated into two groups corresponding to the two geological formations. Moreover, it was also possible to separate out the mines located within the same formation. Analysis was then carried out on some artefacts which had been sampled from two Early Neolithic sites in the Tavoliere area (Monte Aquilone and Ripa Tetta), located about 50-80 km from the Gargano mines. In some cases flint samples were attributed to mines where flint nodules had been mined. Following this first pioneering study, a more complete spatial and chronological flint database is now under construction to generate a larger model of flint movements and to discover exactly how far flint types travelled.

Obsidian

In recent years numerous methods have been proposed in order to locate obsidian source areas: some of these methods are minimally destructive, such as electron-probe microanalysis coupled with wavelength-dispersive (WD) X-ray spectrometry, or inductively-coupled plasma mass spectrometry (ICP-MS), with or without laser ablation. Other techniques are entirely non-destructive, such as X-ray fluorescence, using peak intensity ratios of various el-

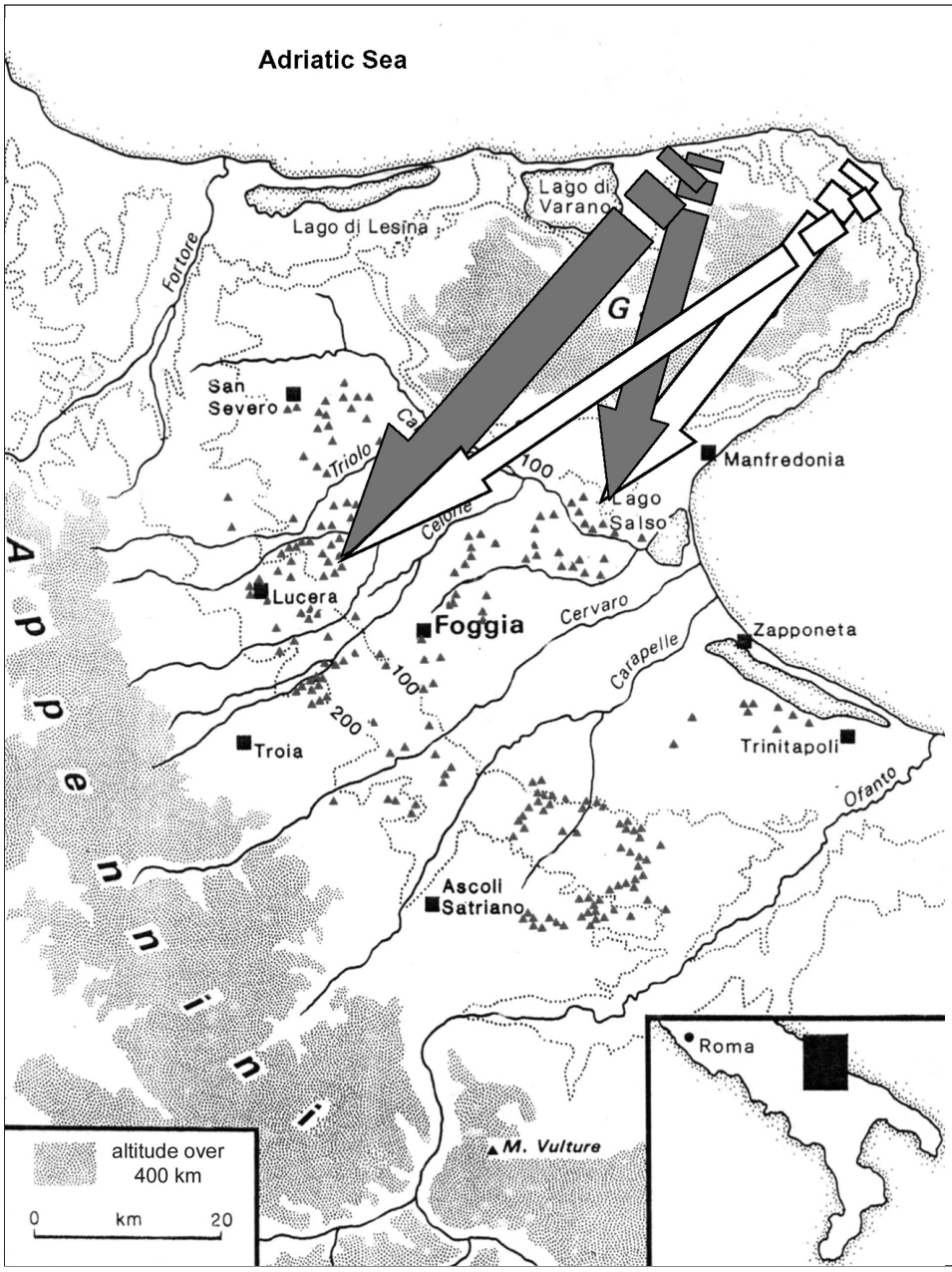
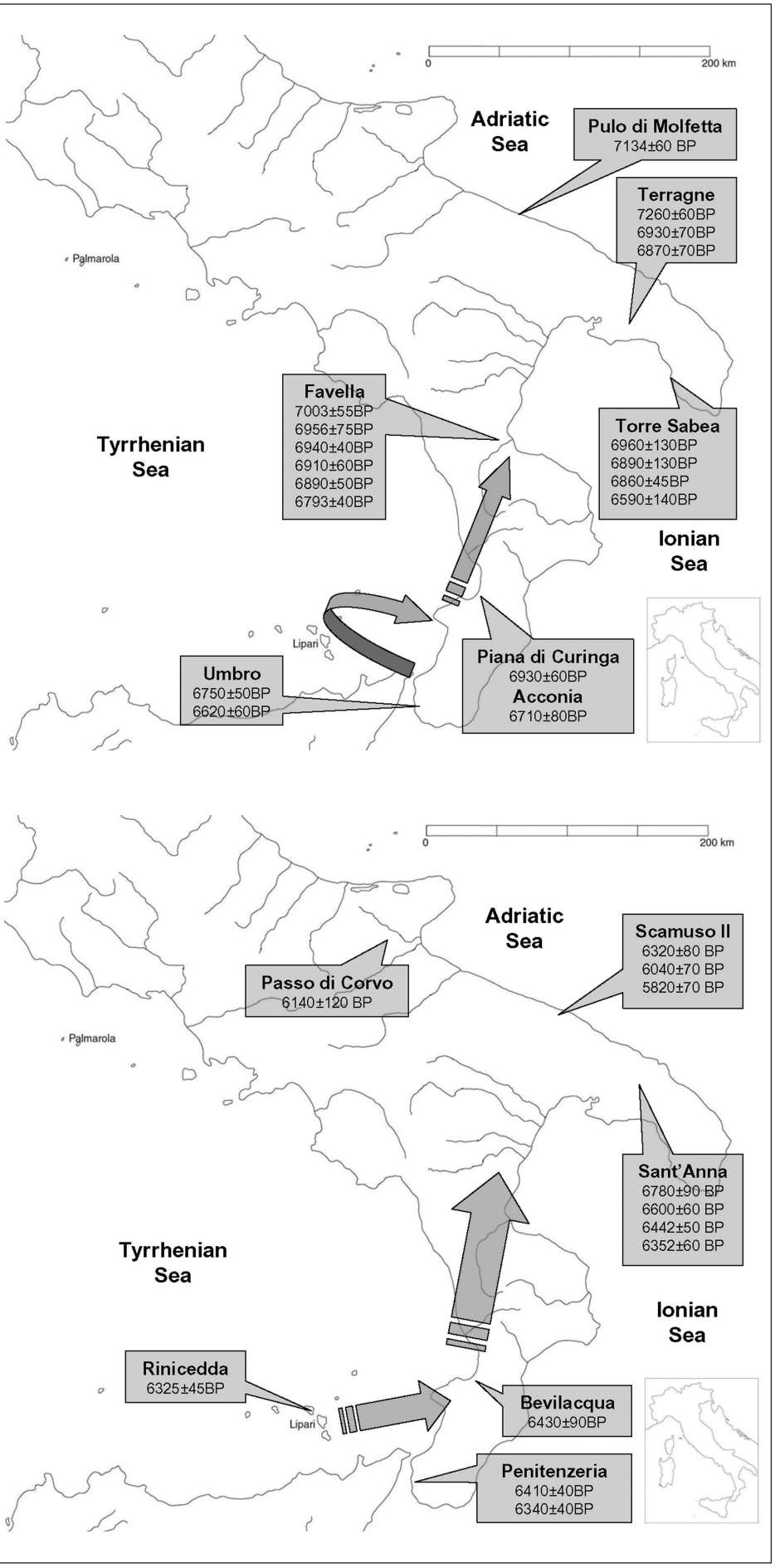


FIGURE 2. The exchange network of flint (data from D'Ottavio *et al.* 2000; D'Ottavio 2001; Volterra *et al.* 2002) from the two main mining districts in the Gargano Promontory to two Early Neolithic settlements (Monte Aquilone near Manfredonia and Ripa Tetta near Lucera) in the Tavoliere area (triangles = Neolithic settlements in the Tavoliere plain; the width of the arrows is in relations to the relative proportion in each site of flint from the two different mining districts).



ements, or SEM-EDS microanalysis. Microanalyses of glass composition by SEM equipped with an ED detector are particularly appropriate when the obsidian artefacts are very small, at about 1 cm in length. The surface of specimens can be used instead of polished thin sections. This technique is low-cost, fast to perform and easily accessible to geoarchaeologists. Finally, for particular specimens, the characterization of the Fe-Mg microphenocrysts (pyroxene, amphibole and biotite) present in glass also allows some of the intra-island subsources to be distinguished.

A systematic programme of analyses carried out in the Geomineralogical Department of Bari University (Acquafredda *et al.* 2006) has provided a well-defined outline of the circulation of various Mediterranean sources (Monte Arci, Palmarola, Lipari, Pantelleria, Gyali and Melos). The provenance of Early to Late Neolithic obsidian artefacts has been established in an entirely non-destructive way, by comparing archaeological artefacts with a database of the various glass compositions of western Mediterranean obsidian sources. We are then able, by integrating our results with those of other university research projects (Bigazzi *et al.* 2005), to provide a well-defined outline of the obsidian network distribution in southern Italy. The identification of obsidian sources is, of course, only the first step necessary for studying its circulation: it is also essential to study the forms in which the material moved from sources to sites and between sites in exchange networks, the quantity of obsidian used[2], the reduction technology and the use-wear of obsidian artefacts.

FIGURE 3. The supposed exchange network of obsidian from Lipari: a) from 5900 to 5500 BC obsidian from the Aeolian Archipelago was probably traded before a stable settlement was established on the islands: in the figure the ^{14}C dated Impressed/ Cardial sites in Apulia and Northern Calabria, with very few obsidian from Lipari, and the Southern Calabria Stentinello settlements, with a very high percentage of obsidian, are localised; b) from 5500 BC a stable settlement was established on the islands and the circulation certainly intensified: in the figure the ^{14}C dated Apulian Mid Neolithic sites (Passo di Corvo, Scamuso II and Sant'Anna), that could have played a role as centres of redistribution, are also localised.

Lipari appears to have been the main source of obsidian in the central Mediterranean area and it clearly has the widest distribution throughout Italy. Our results, therefore, are consistent with those observed at many other Early[3] to Late Neolithic sites in southern Italy: obsidian from Lipari is predominant, and sometimes the only source present, in all Neolithic periods. Obsidian finds along with Impressed/Cardial Wares in very Early Neolithic levels at Fondo Azzollini (Pulo di Molfetta), Terragne (lower level), Torre Sabea and Favella has prompted a broader reconsideration of the beginning of the circulation mechanisms of this raw material from Lipari (fig. 3).

Obsidian from the Aeolian Archipelago was probably traded before stable *Stentinello* settlements were established on the islands, such as at Castellaro Vecchio (Lipari) and Rinicedda (Salina). Along the Tyrrhenian coast of central and southern Calabria there are numerous and early Neolithic *Stentinello* settlements (Piana di Curinga, Umbro - III and V levels - and Acconia) dating to the beginning of the 6th millennium BC. They have shown a very high percentage of obsidian (more than 80% of the lithic industry): perhaps they were primary processing and distribution centres that were probably connected to the rest of the peninsula by sea and not along inland routes (Ammerman 1979) due to the rugged terrain of the region's interior.

During the subsequent phases of the Neolithic circulation certainly intensified and became systematic. Obsidian from Lipari became the absolutely prevailing type, sometimes to the exclusion of all others, from Mid Neolithic phases onwards (red-painted and Serra d'Alto ceramics). Moreover, there are some inland (Sant'Anna di Oria and Passo di Corvo) and coastal sites (Scamuso and Cala Colombo), where the obsidian percentage is higher than at other sites, and these could have played a role as centres of redistribution: consolidating exchange along the

2 Debate is still underway about the economic rather prestige value of these quantitatively very limited amounts of obsidian in Early Neolithic contexts.

3 Debate continues about the appearance of obsidian in Italian pre-Neolithic contexts, as suggested by the results of the 1984-1987 excavations at the rock-shelter of Perriere Sottano in Catania province, eastern Sicily (Aranguren and Revedin 1998). In level V of this site, dated around the second half of the 7th millennium BC, an obsidian flake from Lipari (Gabellotto source) was found. New data about the circulation of obsidian from the island of Pantelleria (Balata dei Turchi source) between the second half of the 7th and the second half of the 6th millennium BC come from the Hergla region, in eastern Tunisia (Mulazzani *et al.* 2010).

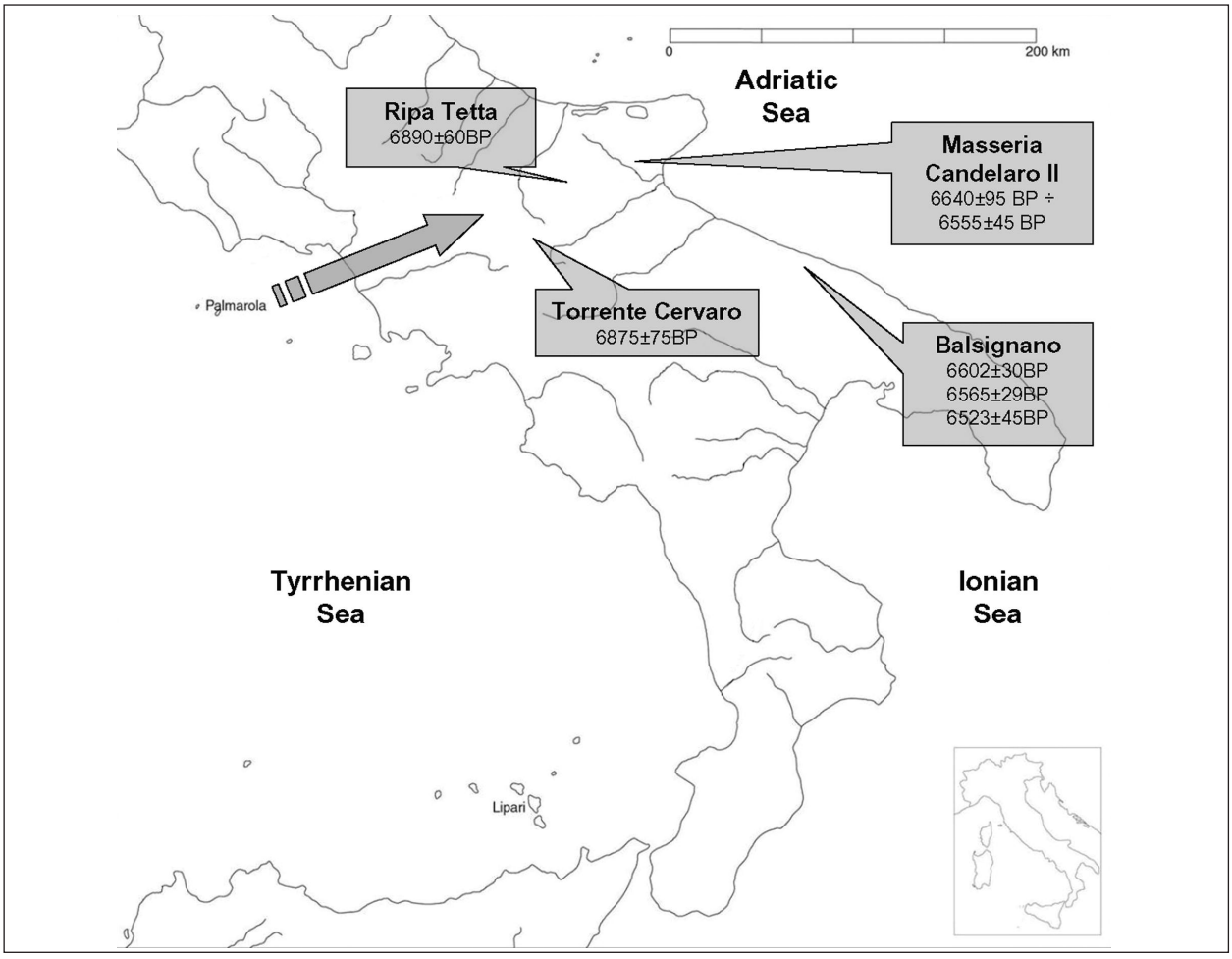


FIGURE 4. The supposed land-based and trans-Apennine exchange network of obsidian from Palmarola to Early and Mid Neolithic (5700-5400 BC) villages of inland Irpinia, Tavoliere and Murge Plateau.

Ionian coasts, and then north along the Adriatic coast. The presence of Palmarola obsidian at Early Neolithic sites is still under discussion, with Impressa/Cardial pottery found at Prato Don Michele (Tremiti Islands). The better documented presence of obsidian from Palmarola at the inland site of Torrente Cervaro (in Campania), with two radiocarbon dates of 7370±165 BP and 6875±75 BP (Langella *et al.* 2003), could confirm an Early Neolithic spread of Pontine obsidian along trans-Apennine routes to the west between the Tyrrhenian and Adriatic coasts. Obsidian from Palmarola is attested, together with artefacts from Lipari, in some Early to Mid Neolithic villages (5700-5400 cal BC) – such as Torrente Cervaro along the Fortore River, Ripa Tetta, Monte Aquilone, Masseria Candelaro and Passo di Corvo on the Tavoliere Plain, Olivento along the Ofanto River, and Balsignano on the Murge Plateau –suggesting land-based and trans-Apennine exchange networks over significant distances, from the Tyrrhenian coast to inland Irpinia and then to Tavoliere, the Ofanto Valley and the Murge Plateau along the Adriatic coast (fig. 4). In central Italian regions too, both along the Tyrrhenian and Adriatic coasts as well as inland (such as the settlements at La Marmotta, Santo Stefano, Catignano, Settefonti and Fossacesia), Palmarola and Lipari sources (from 6700-6600 BP) have always been found together.

No obsidian from Pantelleria, which accounts for most of the obsidian found in Sicily, has been found in southern Italy. Its glass appears to have been used in a restricted area of the Mediterranean. The provenance from Sardinia (SC type) of one very small bladelet found in Apulia, along the Adriatic coast in the karstic doline of Pulo di Molfetta (Acquafredda and Muntoni 2008), enlarges the geographical pattern of Monte Arci obsidian exploitation and distribution from the island to southern Italy during the Neolithic: this source has never before been documented either in southern Italy or along the Adriatic coast. The presence in Apulia of a single Mid/Late bladelet is probably consistent with a *down-the-line* trade mechanism (Renfrew 1975) where the frequency and the dimensions of obsidian would decrease with distance from its source. Sardinian sources account for all the obsidian found in Sardinia and Corsica. During the Early Neolithic, obsidian from the Monte Arci volcanic massif was only widely distributed in the Ligurian and Tyrrhenian areas. The trade routes for Sardinian glass are reasonably well documented. It was transferred to Corsica, from where it arrived in Tuscany via the natural island bridge of the Tuscan archipelago. From the Middle Neolithic onwards the spread of Sardinian obsidians seems to have extended to north-western Italy and to Lazio and now also to Apulia.

Conclusion

Since the Neolithic, human communities have developed specific competences, they have engaged in production and distributed either raw materials and/or specialized products. It is only through extensive long-term studies that the fullest possible picture of southern Italian Neolithic exchange can be obtained and insight gained into the inter- and intra-group organization of the many Neolithic communities who held so many other behavioural features in common.

There is a need for more integrated studies of all the objects and commodities (pottery, flint, obsidian, polished stone axes, etc.) that moved through Neolithic exchange networks. Different materials traded by the same communities seem to have followed a variety of provenance and distribution patterns. Archaeometric analyses also suggest the circulation of production models, rather than of finished objects, in different areas of southern Italy that underwent significant development during the Neolithic.

Manufacturing techniques and consumption are also factors affecting the exchange system and they could be analysed together over time. Moreover, manufacture and circulation networks could have had economic values, as well as being 'social signs' for indicating competitive status. There is a symbolic dimension to exchange relationships which is well known in anthropological literature, but which still seems to be in its infancy in Italian prehistory.

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