THE ITALIAN OBSIDIAN SOURCES

GIULIO BIGAZZI[1] -- MASSIMO ODDONE[2]--GIOVANNA RADI[3]

[1]Institute of Geosciences and Earth Resources, C.N.R., Via G. Moruzzi 1, 56124 Pisa, Italy. Ph: +39 050 3152283, e-mail: g.bigazzi@igg.cnr.it

[2]Institute for Energetics and Interphases, C.N.R., and Department of General Chemistry, University of Pavia, Viale Taramelli 12, 27100 Pavia, Italy. Ph: +39 0382 987334, e-mail: oddone@unipv.it

[3]Department of Archaeological Sciences, University of Pisa, Via S. Maria 53, 56126 Pisa, Italy. Ph: +39 050 2215815, e-mail: radi@arch.unipi.it

Kivonat

Európában az obszidián igen ritka nyersanyagnak számít, összehasonlítva más területekkel, például a Közel-Kelettel. Az olasz obszidián nyersanyagforrások négy vulkáni komplexumban találhatók meg, Szardínia, Palmarola, Lipari és Pantelleria szigetén. A szerzők áttekintést adnak a nyersanyagforrások geológiai, régészeti és archeometriai kutatásáról.

Az olasz obszidián források archeometriai vizsgálata igen korán megindult (optikai emissziós spektroszkópiai (OES) módszerrel), a tényleges elkülönítést azonban megbízhatóan a hetvenes, nyolcvanas évek vizsgálatai alapozták meg, neutron aktivációs analízis (NAA) és röntgen-spektroszkópia (XRF) segítségével. A továbbiakban izotóp-összetétel vizsgálatokkal, geokronológiai módszerekkel is sikerült a nyersanyagforrásokat jellemezni, többek között hasadási nyomvonal detektálás (FT) segítségével. A hatékony elkülönítésre több módszer együttes alkalmazásával van lehetőség.

A szerzők vizsgálják az obszidián régészeti elterjedését is, nyersanyagforrásonként és kronológiai periódusonként valamint kitérnek a jellemző eszköztípusokra.

Introduction

In Europe obsidian is a very rare material, in comparison with other sectors of Earth, such as, for example, the adjacent Near East. In Western Europe obsidian workable by prehistoric men was recognised only in four volcanic complexes, located in the Italian islands of Sardinia, Palmarola, Lipari and Pantelleria. Exploitation of all these source areas for tool making is well documented.

Description of the sources

Mt. Arci, Sardinia.

The Sardinian obsidians were studied since the 19th century (de la Marmora, 1839 - 1840). Although several authors reported information on these glasses, it was only in the 1970's that an exhaustive geological study of the Sardinian obsidian bearing volcanism was published (Assorgia et al., 1976). More recently detailed fieldwork aimed to enhance knowledge of the sources containing workable obsidians was carried out by Tykot (1992). The Mt. Arci volcanic complex is located in the hinterland of the gulf of Oristano, in western Sardinia. Morphologically, Mt. Arci is an elongated basaltic shield extending for ~ 28 km with north - south trending and reaches an elevation of 812 m. The volcanic activity developed during two cycles, in Oligo-Miocene and Pliocene. The volcanic series of the latter cycle cover Miocene marine deposits and can be grouped in four phases (from bottom to top):

1: rhyolitic flows
2: dacites and andesites
3: trachytes and trachyrhyolites
4: basalts.

Acidic lavas belonging to the first phase are very thick flows, sometimes vesicular, lithoid or transitional to perlitic-obsidianaceous facies (Assorgia et al., 1976) and cover relatively large areas **(Fig. 1)**. Several obsidian-bearing perlite outcrops are scattered over these volcanic rocks. North-east of the town of Uras perlites outcrop along the Riu Cannas valley. Below the Conca Cannas peak a perlite face with numerous obsidian block beds is exposed in an abandoned quarry (Uras quarry). This is probably the place were the best quality glass of Mt. Arci can be collected nowadays.

Northwest of Conca Cannas, a larger perlite outcrop extends at Su Paris de Monte Bingias. In this area only small pieces of obsidian can be found in situ. However, according to Francaviglia (1984) larger pieces tens of centimetres in size can be found along the creeks which cross the Su Paris de Monte Bingias perlites. Northward, obsidian-bearing deposits distribute over the west flank of the Mt. Arci massif. Obsidian blocks of various sizes, from few cm up to several tens of cm, can be found at various localities between Bruncu Perda Crobina, Cucru Is Abis and Punta su Zippiri.

HU ISSN 1786-271X; urn:nbn:hu-4106 © by the author(s)

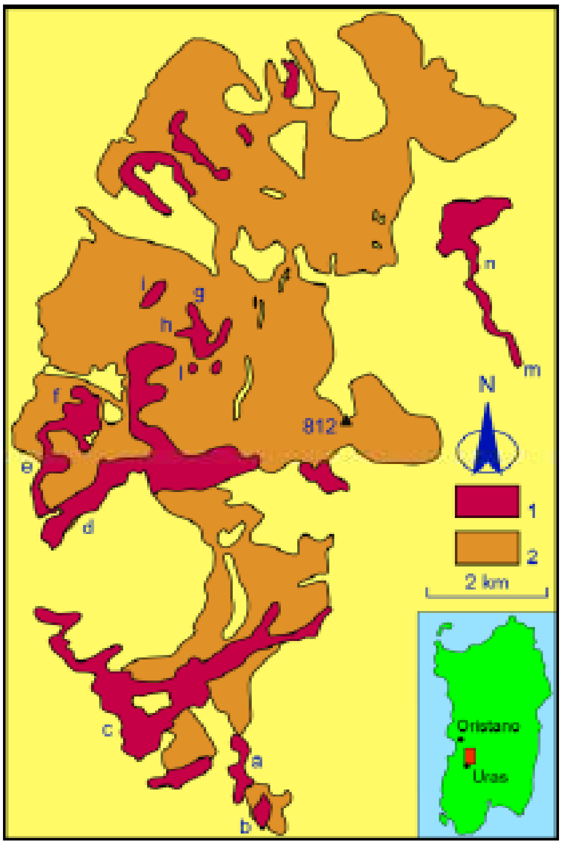


Fig. 1. Simplified geologic sketch map of the Mt. Arci volcanic complex showing the acidic lavas belonging the first phase of the Pliocene volcanism. 1: perlite and obsidian; 2: rhyolite and rhyodacite.

a: Conca Cannas (type SA obsidian); b: Uras quarry (SA); c: Su Paris de Monte Bingias; d: Bruncu Perda Crobina (SB2); e: Seddai (SB2); f: Cucru Is Abis (SB2); g: Punta Su Zippiri (SB1); h: Cuccuru Porcufurau (SB1); i: Punta Nicola Pani (SB1); l: Monte Sparau (SB1); m: Punta Pizzighinu (SC1); n: Perdas Urias (Sc1, SC2). (Redrawn, after Assorgia et al., 1976).

In the north-eastern side of Mt. Arci, obsidians can be found in situ near Punta Pizzighino, in the Perdas Urias source area, where redeposit obsidian blocks can be found at various localities.

Other minor perlitic or pyroclastic deposits containing small pieces of obsidian not useful for tool making are scattered through the Mt. Arci volcanic complex.

Montanini and Villa (1993) using the $^{40}Ar/^{39}Ar$ method established that the Pliocene volcanic activity of Mt. Arci developed during a very short time span - between 3.24 and 3.16 Ma. These authors stated that K-Ar data previously published by various authors (between 3.8 ± 0.3 and 2.7 ± 0.2 Ma, see Montanini and Villa, 1993, and references therein) were unreliable because of excess of Ar. Previous fission-track (FT) ages of obsidians were much older (5.57 ± 0.53 - 4.59 ± 0.28 Ma, Bigazzi et al., 1976), whereas more recent determinations yielded ages which are in better agreement with those measured using the $^{40}Ar/^{39}Ar$ method (3.59 ± 0.22 and 3.50 ± 0.21 Ma, Bellot-Gurlet et al., 1999).

Palmarola

Palmarola is the westernmost island of the Pontine archipelago, located around 35 km west of the Italian coast, approximately at the latitude of Naples (~41°). All the five islands of this archipelago have a volcanic origin and, by a geographical and geological standpoint, can be divided into two groups: (1) Ponza, Palmarola and Zannone (Pontine Islands sensu stricto), and (2) Ventotene and S. Stefano. Only in the Palmarola Island volcanic glasses useful for tool making were recognised (Buchner, 1949). In this island are present various lava domes. One of them forms Mt. Tramontana, the northernmost headland of Palmarola **(Figs. 2, 3)**.

Fig. 2. Geologic sketch map of the island of Palmarola. (1): post-middle Pleistocene deposits. (2): Submarine hyaloclastic facies. (3) Lithoidal cores of the feeder dykes. (4): Pliocene clay sediments. (Redrawn, after De Rita et al., 1986).

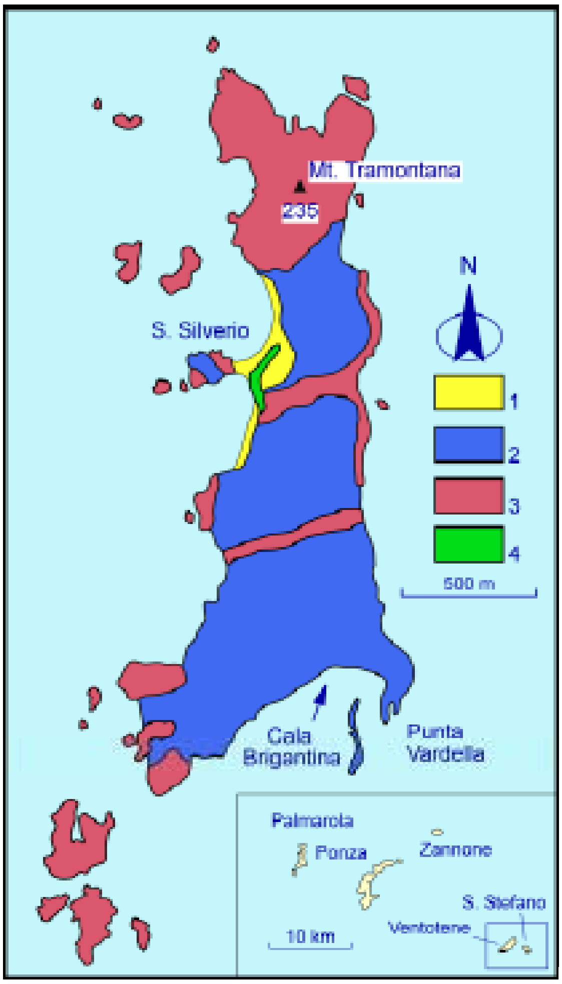


Fig. 3.

The island of Palmarola seen from the island of Ponza. From the left (South) end are visible the two stacks located south of the south-western pit of the island, the Cala Brigantina cliff and then Punta Vardella. On the right end (North) it is visible the Mt. Tramontana dome.

Obsidian flows are found in the southern side of Mt. Tramontana (235 m), in a domal crust that transects the island (Francaviglia, 1984). This is the only in situ obsidian of Palmarola.

In the southern part of the island abundant obsidian pieces are found in a detritical deposit which covers large areas and reaches Punta Vardella, the south-eastern tip of Palmarola, and the top of the cliff of Cala Brigantina. According to Buchner (1949), the presence of this wide detritical deposit implies the existence of a disappeared rhyolitic dome. Numerous detritical obsidian pieces are found also in other deposits along the east coast of Palmarola and along the coasts surrounding Mt. Tramontana. Although this island was scantily inhabited, human activities determined significant morphological changes, mainly due to the terracing made for agricultural purposes in the second half of the 18th century, especially in the southern side: this may be at least partially responsible for the disappearance of obsidian outcrops.

Belluomini et al. (1970) published an age of 1.60 ± 0.20 Ma for the Mt. Tramontana obsidian. Recent analyses of the Mt. Tramontana and Punta Vardella obsidians yielded FT ages of 1.57 ± 0.21 and 1.69 ± 0.10 Ma, respectively (Bellot-Gurlet et al., 1999).

Lipari

Lipari is the largest island of the Aeolian Archipelago, composed by seven volcanic islands - Stromboli, Panarea, Alicudi, Filicudi, Salina, Lipari itself and Vulcano, located some tens km north of eastern Sicily. Following Pichler (1980) volcanic activity developed during various phases, since upper Pleistocene up to historical times. During the last two phases, (1) Late Würm II, Würm III and IV (approximately between 40,000 and 10,000 a) and (2) Holocene, multiple eruptions produced large amounts of pumice deposits and impressive lava flows. Alkali rhyolites and rhyolites belonging to the older of these two phases cover large areas of the southern part of the island, whereas those erupted during the youngest one cover almost the whole north-eastern part of Lipari **(Fig. 4)**.

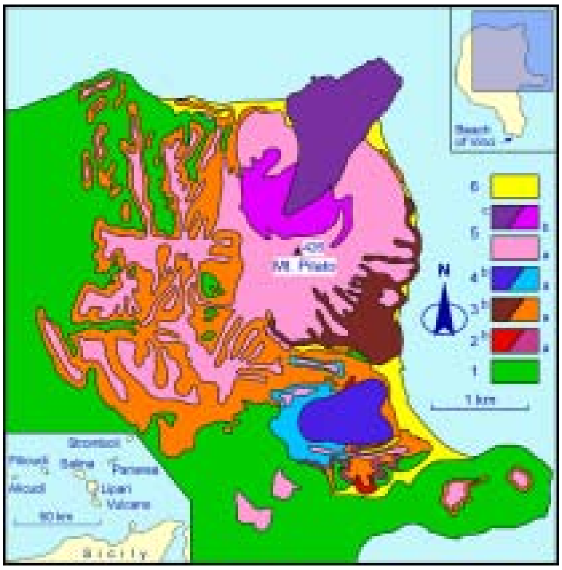


Fig. 4.

Geologic sketch map of the north-eastern part of the island of Lipari showing volcanic units belonging to the youngest phase of volcanic activity (< 10,000 a). (1): deposits from the previous volcanic periods. (2) Canneto Dentro VSU, (a) tephra, (b) lava flow. (3): Gabellotto - Fiume Bianco VSU, (a) Gabellotto - Fiume Bianco tephra, (b): Pomiciazzo lava flow. (4): Forgia Vecchia VSU, (a): tephra, (b): lava flow. (5): Mt. Pilato - Rocche Rosse VSU, (a) Mt. Pilato tephra, (b): Rocche Rosse tephra, (c) Rocche Rosse lava flow. (6): recent and present-day sediments. (Redrawn, after Cortese et al., 1986).

The volcanism corresponding to the older phase does not bear obsidian, with the exception of the dome which represents the southernmost part of Lipari. Obsidian flames can be found on the wall of the cliff which overhangs the beach of Vinci, in front of the island of Vulcano.

Fig. 5. View of the historical obsidian flow of Forgia Vecchia, Lipari Island.

Obsidian pebbles few centimetres in size can be found also in the beach itself. No documentation exists about prehistoric exploitation of these glasses, which have a FT age of ~ 30,000 a (Arias et al., 1986a).

During the last phase formed the three main obsidian flows of Lipari, named Forgia Vecchia **(Fig. 5)**, Pomiciazzo and Rocche Rosse. The latter flow, which represents the north-eastern pit of the islands, is one of the most majestic volcanic edifices of Europe and attracted several scientists since the 18th century. Following Cortese et al. (1986) which performed a detailed study of the geology of the rocks of the north-eastern side of Lipari for reconstructing the youngest phase of the effusive volcanic activity of the island, the deposits of this area can be grouped in four volcano-stratigraphic units (VSU). The stratigraphic sequence is shown in **Fig. 4.**

From archaeological point of view, only the Pomiciazzo and Canneto Dentro flows are important, because Forgia Vecchia and Rocche Rosse formed during the most recent effusive volcanic activity of Lipari, in historical times. Buchner (1949) had already observed that these two flows were much younger than the first ones. This author had also hypothesized that absence on these flows and their proximities of obsidian splits attributable to prehistoric exploitation might indicate that they were too young. ^{14}C ages (between 4810 ± 60 a and 1220 ± 100 a, Keller, 1970) of a paleosol containing obsidian tools where the upper tephra rest, and two low precision ages determined using the FT dating method - 1400 ± 450 a for Rocche Rosse and 1600 ± 380 a for Forgia Vecchia (Bigazzi and Bonadonna, 1973) - confirm this hypothesis. Pichler (1980) indicates for these flows an approximate age of 1400 a, and reports that the ashes that had preceded their effusion had covered the Greek-Roman necropolis of Lipari. Therefore, the only obsidian flow of Pomiciazzo - as well as minor occurrences located in the north-eastern side of the island, such as the Canneto Dentro flow quoted above - are the only potential natural sources that might have been exploited by our ancestors. In addition, numerous obsidian blocks of various sizes can be found in the large pumice deposits of the last volcanic phase. Blocks from the oldest ones might have been used for tool making. Bigazzi and Bonadonna (1973) determined a FT age of 11400 ± 1800 a for the Pomiciazzo flow (called Gabellotto by these authors). Few years later Wagner et al. (1976) published for this flow an age of 8600 ± 1500 a, obtained using the same technique. A further FT age determination - 8600 ± 1600 a - is reported by Arias et al. (1986b). Identification of the real ancient obsidian extraction places is an arduous task, as north-eastern Lipari is mostly covered by the more recent volcanic rocks. However, in the creek deposits of the narrow Gabellotto valley **(Fig. 6)** which marks the southern boundary of the Pomiciazzo flow innumerable obsidian tools can be found.

Fig. 6. View of the southern margin of the obsidian flow of Pomiciazzo, engraved by the narrow Gabellotto valley.

In the Aeolian archipelago, obsidians can also be found in two flows which outcrop on the flanks of the volcano of the homonymous Vulcano Island, adjacent to Lipari. Also these obsidians are from historical eruptions and were thus unavailable to prehistoric men.

Pantelleria

Pantelleria **(Fig. 7)** is a small island located in the Sicily Channel, about 90 km east of Cap Bon, Tunisia, which is exclusively formed by volcanic rocks. This island is very well known by geologists and petrologists, because it is the type locality of peralkaline acid rocks that constitute the very great part of the outcropping rocks. Typical of Pantelleria are the green obsidians known as pantellerites, which cover large areas. These obsidians can be easily distinguished by the other European obsidians, as well as by most of those of the Near East, for their peculiar colour.

Fig. 7. Sketch map of the island of Pantelleria. (1): pre-caldera rocks where pantellerites useful for tool making can be found. (Redrawn, after Villari, 1974).

The volcanic activity in this island developed during two main cycles (Villari, 1974). The first cycle ended with the formation of a large dome that constitutes "Montagna Grande" (big mountain), with an elevation of 836 m, located in the centre of the island and with the subsequent formation of a large caldera around Montagna Grande, more than 6 km in diameter. After the caldera collapse, the volcanic activity started again with the eruption of the typical green ignimbrite which covered almost 50% of the surface of the island (approximately 50,000 a, Civetta et al., 1984). Multiple eruptions produced large amounts of pantellerites both during the first as well as during the second cycle. However, most of these obsidians, especially those of the second cycle (post-caldera pantellerites) are not useful for tool making, as they break into small fragments.

The well known Balata dei Turchi flow which constitutes the southern pit of Pantelleria was the main extraction place of raw material during prehistoric times. However, obsidian flames and minor occurrences can be found in the pre-caldera sequence, such as at Salto della Vecchia and near the lake named Bagno dell'Acqua **(Fig. 7)**. FT ages between 127,000 ± 15,000 and 141,000 ± 17,000 a and two FT ages of 71,000 ± 8,000 and 73,000 ± 9,000 a have been determined for glasses from Balata dei Turchi and Fossa della Pernice (near Bagno dell'Acqua), respectively (Arias-Radi et al., 1972, Arias et al., 1986b).

Characterisation of Italian obsidian sources

Since early 1960s (Cornaggia-Castiglioni et al., 1962, 1963) characterisation studies of Mediterranean obsidians were performed in order to discriminate the potential natural sources of raw material used for tool making and to identify the provenance of artefacts. Whereas the common chemical wet analysis of major elements did not turn to be an efficient method for full separation of the Mediterranean sources, Cann and Renfrew (1964) proved that the trace elements chemical composition determined using optical emission spectroscopy could be a more powerful tool for differentiating these sources. However, it was during the 1970s and 1980s that further research on the characterisation of the Mediterranean obsidians using neutron activation analysis (NAA) and X-ray fluorescence (XRF) produced an abundant data-set on their chemical properties (Hallam et al, 1976; Shelford et al., 1982; Francaviglia, 1984, Bigazzi et al., 1986). Using these techniques authors were able to identify the volcanic complexes where artefacts originated from, as well as to prove that more than a unique obsidian occurrence had been exploited in the Mt. Arci source. Hallam et al. (1976) identified three different chemical groups based on artefacts analysis - SA, SB and SC - they were not able to attribute to specific occurrences, excepted that for SA (Conca Cannas), the only geological source they had analysed.

More recently, a significant contribution to a better knowledge of the Mt. Arci obsidian occurrences and of their chemical properties was given by Tykot (1992, 1996, and 1997). Based on systematic fieldwork and numerous analyses using electron microprobe analysis, ICP mass spectrometry (ICP - MS), XRF and NAA this author reached a full chemical characterisation of the Sardinian sub-sources. The conclusion of Tykot's research is that there are five chemical groups corresponding to meaningful source groups of workable glass in the Mt. Arci area. These groups are as follows (**Fig. 1**; Tykot, 1997):

SA: Conca Cannas

SB1: Cuccuru Porcufurau, Punta Nigola Pani, Punta Su Zippiri and Mt. Sparau

SB2: Cucu Is Abis, Seddai and Bruncu Perda Crobina

SC1: Punta Pizzighinu and secondary deposits near Perdas Urias

SC2: Secondary deposits near Perdas Urias.

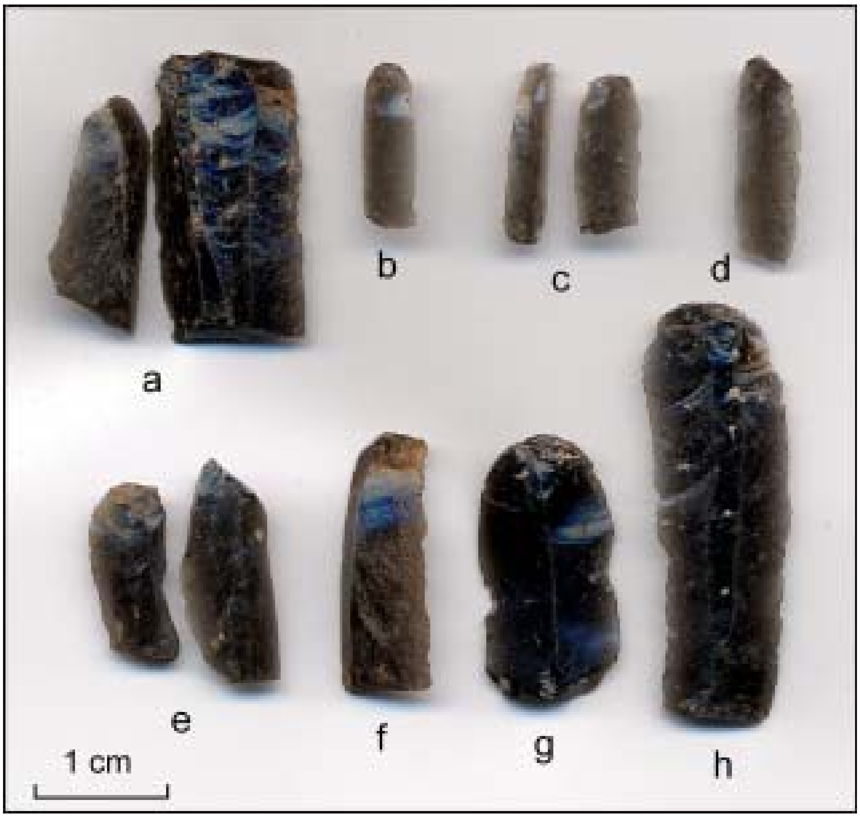


Fig. 8.

Artefacts originated from the Lipari Island found in Italian Neolithic sites.

a: Filicudi (Aeolian Archi-pelago, Diana culture),

b: Settefonti (Abruzzi, Late Neolithic),

c: Ripoli (Abruzzi, Middle Neolithic B),

d: Catignano (Abruzzi, Middle Neolithic A),

e: Grotta della Trinita (Apulia, Middle Neolithic B),

f: Grotta del Leone (Tuscany, generic Neolithic - Copper Age),

g: Monte Aquilone (Apulia, Early Neolithic B),

h: Serra d'Alto (Lucania, generic Neolithic).

Other techniques for differentiating Mediterranean obsidians were also tested. Gale (1981) proved that combination of strontium isotopes and strontium and rubidium contents could be successfully used to discriminate the Mediterranean sources. Less promising turned to be the application of Mössbauer spectroscopy (Longworth and Warren, 1979; Aramu et al., 1983) and the use of magnetic parameters (McDougall et al., 1983). Contrary to the conclusions of Longworth and Warren (1979) and Aramu et al. (1983), recently Scorzelli et al. (2001) have shown that also the Mössbauer spectroscopy could be an efficient tool for discrimination of Italian sources.

Another approach that was used since early seventies for provenance studies of Italian obsidians is the determination of their geological age using the FT dating method (Arias-Radi et al., 1972; Bigazzi and Bonadonna, 1973). As FT dating is based on different parameters (age and track densities), this method is considered an efficient technique complementary to the more popular approaches based on chemical composition studies. However, whereas FT dating is an ideal method for differentiating the Italian source areas, often it can not point to specific obsidian occurrences. In many volcanic complexes obsidians were erupted during short time spans. FT dating has not enough resolution to easily discriminate among flows whose age difference is small in comparison with their age itself. For this reason, the Mt. Arci obsidians as well as those from Palmarola can not be differentiated by their FT ages. On the contrary, this technique fully discriminates those of the Pomiciazzo flow from those of the Vinci beach and from the historical flow and the two dated flows of the young islands of Lipari and Pantelleria, respectively. However, the FT method discriminates the Mt. Tramontana and the Punta Vardella obsidians. Although they have

HU ISSN 1786-271X; urn:nbn:hu-4106 © by the author(s)

indistinguishable ages, they show different track densities. The Mt. Arci obsidians are divided into two main groups based on track densities. Those of chemical groups SA and SB1 and SB2 have higher U contents than those of groups SC1 and SC2. Therefore obsidians from the latter groups show lower track areal densities.

Bigazzi et al. (1986) claimed that a multidisciplinary approach may be a very efficient tool for obsidian provenance studies.

Geographical distribution of raw material from the Italian obsidian sources during Neolithic

An exhaustive review on prehistoric circulation of Italian obsidians, integrated by new analyses made by the author himself, has been published by Tykot (1996). In this section we mainly refer to this article which includes also a rich reference list, as well as to the review on provenance studies of Italian artefacts using the FT method published by Bigazzi and Radi (1998), integrated by new unpublished determinations made by the same authors.

In western Mediterranean prehistoric sites only the Italian sources are virtually represented. Since this statement is based on numerous analyses, referring to sites distributed everywhere in Italy and southern France and referring to a large time interval, it is reasonable to conclude that penetration of non-Italian raw material, when occurred, was a sporadically event. An exception is the identification made, in the outskirts of the Italian sector, of some artefacts originated from Carpathian sources at Grotta della Tartaruga (Trieste) (William-Torpe et al., 1979), together with glasses from Palmarola and Lipari, and at Sammardenchia (Udine), together with artefacts from Lipari (Pessina and Muscio, 1998, Pessina, 1999).

Puxeddu (1958) published an early review on more than 300 Sardinian sites, including numerous extraction places and workshops on the Mt. Arci area, which illustrates the wide use of obsidian made in prehistoric Sardinia. Tykot (1996) has shown that type SA, SB and SC obsidians distribute with different frequencies in different sectors of the island. Whereas in northern Sardinia type SB is more abundant than SA, in the southern part it is very rare. Frequency of type SC is substantially constant. These evidences can be explained by geographical criteria. However, other evidences appear hardly to be explained, such as the relatively low frequency of type SB in the Oristano area sites, for which the SB obsidians are the closest. Contrarily to one could expect, type SB obsidian is about twice more frequent in northern Corsica than in southern Corsica. Tykot (1996) suggests that chronology may provide some of the explanation. Results referring to Sardinian and Corsican sites indicate that type SB obsidian is more abundant in Early Neolithic, but its use decreases in Middle and Late Neolithic. Therefore, frequency in a given site of a type of glass may be related with the age of the site itself, rather than with its geographical position.

From Corsica Mt. Arci obsidians distributed in the Tuscan Archipelago and, using this natural bridge, reached the western coast of Italy since Early Neolithic (Pianosa, Casa Querciolaia, Podere Uliveto, Tuscany - the region with most frequent overlapping of the three Italian main sources - and Suvero and Arene Candide, Liguria, Impressed Pottery sites). From the coastal areas it crossed the Apennines and distributed in the whole Po river valley up to the south slope of the Alps. Following a north-western trade way, it widely diffused in Liguria and southern France as far as the Spanish border in advanced phases of Neolithic. In southern France the obsidian from Lipari is predominant during central phases of Neolithic (specially, the Square Mouth Pottery culture). The Sardinian glasses, which are represented in most Lagozza culture settlements, become predominant in Chassean sites. It is not clear the reason for which in southern France such as in some sites of northern Italy the type SA glass is widely predominant in comparison with SB and SC glasses.

Southward, Sardinian obsidian diffusion was almost limited: the southernmost site with documented presence of this glass is Ischia di Castro, northern Latium.

As expected, considering the size of the island and the amount of obsidian available, exploitation of the Palmarola obsidians has been more limited in comparison with Mt. Arci and Lipari glasses. Nevertheless, recently it was realised that the diffusion area of this obsidian is somewhat larger than considered before. Its knowledge since archaic Impressed Pottery Culture was already proved. Analyses of artefacts indicate an almost intense exploitation during central and southern Italian Impressed Pottery Culture, with a relatively wide distribution network which involved the Tyrrhenian regions and islands as well as some areas of the Po river valley and southern France (Vaquer, 2003). In the archaic sites of La Marmotta, Latium (Fugazzola Delpino et al., 1993), Colle S. Stefano, Abruzzi, and Faenza - Fornace Cappuccini, Romagna (Bermond Montanari et al., 1994), the obsidian assemblage is composed only by glasses from Lipari and Palmarola. The latter consists of a remarkable aliquot.

Several internal sites in the Italian peninsula prove continuity of use of this material during whole

Neolithic as well as an eastward expansion trend to the Adriatic coastal regions. It reached also areas located at long distance, such as western Liguria, the surroundings of Trieste, the Ionian slope of Calabria, even though it was identified here only in one site. Recently Salotti et al. (2000) identified an artefact from Palmarola also in northern Corsica, at the Castiglione site. This is the unique non-Sardinian obsidian found in this island. Except the oldest settlements of western Liguria (and, obviously, in Corsica), where also the Sardinian sources are represented, in most sites the Palmarola obsidian is association with that one from Lipari. FT data revealed that even though to a minor extent compared with the glasses that can be found along the coast of the island, also the Mt. Tramontana glass was exploited.

The more recent settlements yielded a progressively reduced aliquot of Palmarola obsidian, in relationship with the Lipari glass, which appears to become prevalent, in terms of extension of trade and amount of material.

The identification of artefacts originated from Lipari also in southern Italian archaic cultures (Torre Sabea, Campi Latini and Fontanelle, south-eastern Apulia) documents knowledge of the Aeolian glass since Early Neolithic at least. Moreover, the identification made of a Liparian artefact in a Mesolithic level at Perriere Sottano, Sicily, for which two ^{14}C age determinations are available (8700 ± 150 BP and 8460 ± 70 BP, Aranguren and Revedin, 1998), suggests knowledge by our ancestors of the Lipari raw material since the eruption of the Pomiciazzo obsidian flow (~ 8500 a BP). This surprising result has to be regarded with caution at the present stage, as it is based on a unique finding.

Lipari became the most important source in western Mediterranean area. It is documented in the whole Italian peninsula, and in the southernmost regions it appears virtually exclusive **(Fig. 8)**. North of the Apennines, Lipari is widely documented up to the Alpine regions and diffused westward through Liguria and Mediterranean France. In these regions the Lipari glass was widely distributed during Neolithic central phases, especially in Square Mouth Pottery culture sites.

As mentioned before, more recently in some areas the Mt. Arci obsidian appears to replace it, in connection with southern French Chassean and Lagozza cultures. This connection is documented in Tuscany also (Neto di Bolasse, Podere Casanuova, Grotta dell'Onda, Grotta del Leone - Agnano).

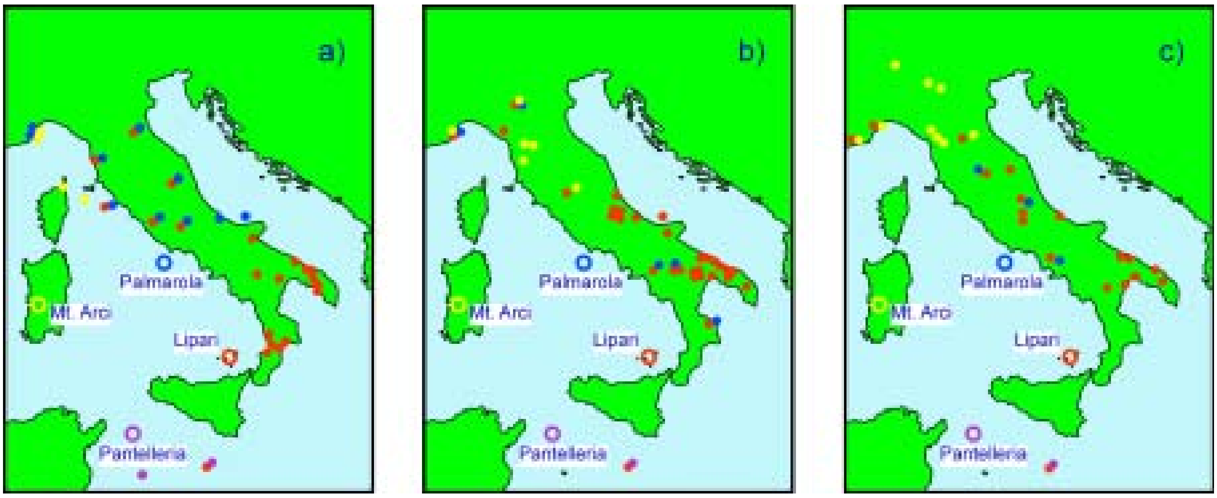
Exploitation of the Pomiciazzo (or Gabellotto) obsidian flow is well documented. However, on microscopic visual characteristics of many glass artefacts, it is very probably that other unidentified extraction places were also used. Unfortunately, neither chemical composition nor FT dating can discriminate between the older obsidians of the last volcanic phase of Lipari.

None of the artefacts analysed using the FT method originated from the older obsidian of the southernmost part of the island.

The Pantelleria glass appears to have been used in a restricted area of the Mediterranean Sea. This glass is well documented in the settlements of the island of Lampedusa (~ 150 km S-SE of Pantelleria) and, with the obsidian of Lipari, at Malta (~ 200 km SE of Pantelleria). It reached also Sicily and northern Africa, where also the Aeolian glass is documented. In general the analysed artefacts originated from the Balata dei Turchi flow, but some artefacts have shown different FT ages (Arias-Radi et al., 1972) which suggest the use of another source at least.

Correlation of artefacts with their natural sources determined using the FT method for different phases of Neolithic are shown in **Fig. 9.**

Fig. 9. Distribution of obsidian from the four Italian sources during (a) the archaic phases of Neolithic, (b) in Middle Neolithic and (c) in Late Neolithic (based on Bigazzi and Radi, 1998). During the Impressed Pottery Early Neolithic, The Lipari obsidian is predominant in southern Italy. In the central regions diffuses the Palmarola obsidian, somewhere in association with the Lipari obsidian. The Mt. Arci source is represented, somewhere in association with the Palmarola glass, in the northern part of the Tyrrhenian coastal areas, in the islands and in Liguria. With the Painted Pottery and Square Mouth Pottery cultures, the Lipari obsidian becomes prevalent in most regions of Italy, with some association with Palmarola (in the central - south regions) and Sardinian (to the north) obsidians. During the last phases of Neolithic, persists a certain association of the Lipari glass with that one from Palmarola in the sites related to the Diana culture, whereas in the Chassean in southern France and northern Italy the Sardinian obsidian is predominant, the only exception being Arene Candide (Liguria).



Although exploitation of the Italian sources began in the early phases of Neolithic, it is noteworthy that the oldest traces of human activities in the islands of Lipari, and, specially, Palmarola and Pantelleria, are significantly younger.

Modalities of circulation of Italian obsidians

Detailed studies on peculiar characteristics of obsidian artefacts in relationship to the whole lithic assemblages aimed to outline the modalities of distribution of the raw material in Europe and to understand the specific value of this glass are rather poor. An exception is Calabria (Ammerman, 1979). This region was a first landing place for people coming from the nearby island of Lipari. Numerous workshop-sites in which the raw material had been prepared for distribution over the Italian Peninsula were studied. These sites belong to the Stentinello culture, which represents an advanced phase of Early Neolithic. These studies have shown that in this region sea transportation was preferred to inland transportation. All sites located along the Tyrrhenian coast yielded large amounts of obsidians, in relation to flint stone (around 80-100 % of the lithic assemblage). On the contrary, in sites located on the Ionian slope that was reached through land travelling the maximum obsidian percentage attains 20-40 %. Moreover, some sites did not yield obsidian.

Also in central and north-central regions of Italy in Early Neolithic obsidian transportation appears to have followed Tyrrhenian Sea courses. The internal areas of the Tyrrhenian regions and the Adriatic slope were reached through land travelling. In sites belonging to the ancient phases of Neolithic located in the islands of the Tuscan archipelago and along the coasts of Tuscany and Liguria obsidian is relatively abundant, with peaks that reach 6-7 % (an exception is represented by the Le Secche site of the Giglio Island, where obsidian attains 20 %). For example, in the Cala Giovanna site of the island of Pianosa the percentage of obsidian is 5.6 %, 3 % at Casa Querciolaia, Leghorn, 7 % at Arene Candide, Liguria (Ammerman and Polglase, 1997, Tozzi and Weiss, 2000). Similar percentages are also present in internal sites, such as Faenza - Fornace Cappuccini and Colle S. Stefano, where obsidian attains around 8 %. On the contrary, this glass is absent or very rare in the Adriatic coastal sites.

In these archaic Neolithic phases, obsidian trade appears to be related to the Impressed Pottery Culture, and during these times it reached also southern France. On the contrary, in the Early Neolithic sites of northernmost Italian regions this glass is virtually absent, the only certain exception being the site of Sammardenchia mentioned above. In these regions the lithic assemblage consists of very good quality flint collected from the Lessini Mountains (Verona), very probably traded by the populations of the Fiorano Culture (Pessina, 1999).

During the following Neolithic phase and the development of the Painted Pottery and Square Mouth Pottery cultures in central-southern and northern Italy, respectively, distribution of obsidian covered the whole Italian Peninsula and large areas of France. The amount of obsidian present in the lithic assemblages significantly increased. For example, at S. Anna di Oria, Apulia, percentage of obsidian attained 64 % (Ingravallo, 1985). Also in sites of the Adriatic slope the obsidian percentages are significantly higher than those of the previous phase, such as at Passo di Corvo (Ronchitelli, 1983), where obsidian attains 10 %.

During the more recent Neolithic phases the documented use of obsidian in the eastern coastal areas of Italy suggests that Adriatic Sea courses had been established. Obsidian percentages became significant in coastal sites, such as Cala Colombo, Apulia (35 %), and Fossacesia, Abruzzi (8 %). Lipari, which is the closest source for sea transportation, appears to be the only one represented in these sites (Bigazzi and Radi, 2003).

Although in these Neolithic phases obsidian reached also very distant regions and had a widespread distribution, in some sites its use appears to wane, such as in the site of Arene Candide mentioned above, where the levels corresponding to the Square Mouth Pottery Culture and the following ones with Chassean features yielded rather insignificant amounts of obsidian.

Few data are available on characteristics of glasses that were transported during Neolithic. Obsidian findings from the Calabrian Stentinello Culture workshop-sites studied by Ammerman (1979) indicate that roughed-out blocks of glass were manufactured for distribution. On the contrary, in two sites (those of Colle S. Stefano and Le Secche mentioned above), characteristics of numerous glass splinters and micro-splinters, including cortex splits, indicate importation of crude blocks of raw material and local manufacturing (Radi and Danese, 2003).

In other sites, such as at Arene Candide, obsidian findings suggest importation of finished tools, although presence of some cores reveals partial local splintering.

Typology of obsidian tools manufactured in Europe

Typology of obsidian artefacts mainly consists of small blades without retouching, however also endscrapers, truncations, geometrics and, more rarely, burins and borers are documented, especially in Painted Pottery Culture sites. Some of these artefacts manufactured during Early Neolithic and more advanced phases consisted of the functional part of tools composed by a wooden handle where, for better adherence, the retouched part of the artefact was inserted, whereas the functional part was its sharp edge.

In the more recent Neolithic phases typology of obsidian artefacts does not vary in a significant way, with the exception of Sardinia.

In this island, where raw material was abundant, more sophisticated objects, such as foliated tools manufactured with refined retouching and arrow-heads of various morphologies were produced. These kinds of tools were only rarely found in continental sites.

Since the beginning of the metal age, use of obsidian for tool making progressively reduced. However, a certain use of this volcanic glass continued also during historical times, mainly for ornamental objects, such as mirrors or jewellery, but also medical properties and magical power were attributed to obsidian.

References

AMMERMAN, A. J. & POLGLASE, C. (1997): Analyses and descriptions of the obsidian collections from Arene Candide. In: MAGGI R. (ed.), Arene Candide: a functional and environmental assessment of the Holocene Sequence (Excavations Bernabo Brea - Cardini, 1940-50). *Mem. Ist. It. Paleontologia Umana, Nuova Serie,* **5,** 573-592.

AMMERMAN, A. J. (1979): A study of obsidian exchange networks in Calabria. *World Archaeology*, **11**, 95-110.

ARAMU, F., MAXIA, V., SERCI, S. & URAS, I. (1983): Mössbauer study of Mount Arci (Sardinia) obsidian. *Lettere al Nuovo Cimento*, **36**, 102-104.

ARANGUREN, B. & REVEDIN, A. (1998): Il giacimento Mesolitico di Perriere Sottano. *Boll. Paletnologia It.*, **89**, 31-79.

ARIAS, C., BERNARDES, C., BIGAZZI G., BONADONNA, F. P., CESAR, M. F., HADLER, N. J. C., LATTES, C. M. G., OLIVEIRA, J., X. & RADI, G. (1986a): Identificação da proveniência de manufaturados de obsidiana através da datação com o método do traço de fissão. *Ciência e Cultura*, **38,** 285-308.

ARIAS, C., BIGAZZI, G., BONADONNA, F. P., CIPOLLONI, M., HADLER, J. C., LATTES, C. M. G. & RADI, G. (1986b): Fission track dating in archaeology. A useful application. In: PARRINI, P. L. ed., Scientific Methodologies Applied to Works of Art. Montedison, Progetto Cultura, Milano, 151-159.

ARIAS-RADI, G., BIGAZZI, G. & BONADONNA, F. P. (1972): Le tracce di fissione. Un metodo per lo studio delle vie di commercio dell'ossidiana. *Origini*, **6,** 155-170.

ASSORGIA, A., BECCALUVA, L., DI PAOLA, M., MACCIONI, L., MACCIOTTA, G., PUXEDDU, M., SANTACROCE, R. & VENTURELLI, G. (1976): Il complesso vulcanico di Monte Arci (Sardegna centro-occidentale). Nota illustrativa alla carta geopetrografica 1 : 50.000. Boll. Soc. Geol. It., **95**, 371-401.

BELLOT-GOURLET, L., BIGAZZI, G., DORIGHEL, O., ODDONE, M., POUPEAU, G. & YEGINGIL, Z. (1999): The fission-track analysis: an alternative technique for provenance studies of prehistoric obsidian artefacts. *Radiat. Measurements,* **31**, 639-644.

BELLUOMINI, G., DISCENDENTI, A., MALPIERI L. & NICOLETTI M. (1970): Studi sulle ossidiane italiane II. Contenuto in ^{40}Ar radiogenico e possibilità di datazione. *Periodico di mineralogia*, **39**, 469-479.

BERMOND MONTANARI, G., MASSI PASI, M. & MENGOLI, D. (1994): L'insediamento neolitico di Fornace Cappuccini di Faenza (Ravenna), *Preistoria Alpina*, **27**, 173-195.

BIGAZZI, G. & BONADONNA, F. P. (1973): Fission track dating of the obsidian of Lipari Island (Italy). *Nature*, **242**, 322-323.

BIGAZZI, G. & RADI, G. (1998): Prehistoric exploitation of obsidian for tool making in the Italian peninsula: a picture from a rich fission-track data-set, *XIII International Congress of Prehistoric and Protohistoric Sciences, Forlì, Italy, 8/14 September 1996. Proceedings,* **1,** 149-156.

BIGAZZI, G. & RADI, G. (2003): L'ossidiana in Abruzzo durante il neolitico, Atti XXXVI Riunione Scientifica Istituto Italiano Preistoria e Protostoria "Preistoria e Protostoria dell'Abruzzo", Chieti-Celano 27/30 settembre 2001, 619-624.

BIGAZZI, G. & RADI, G. (1998): Prehistoric exploitation of obsidian for tool making in the Italian peninsula: a picture from a rich fission-track data-set. *XIII International Congress of Prehistoric and Protohistoric Sciences, Forlì, Italy, 8/14 September 1996. Proceedings*, **1**, 149-156.

BIGAZZI, G., BONADONNA, F.P., MACCIONI, L. & PECORINI, G. (1976): Research on Monte Arci (Sardinia) subaerial volcanic complex using the fission track method. *Boll. Soc. Geol. It.*, **95**, 1555-1570.

BIGAZZI, G., MELONI, S., ODDONE, M. & RADI, G. (1986): Provenance studies of obsidian artifacts: trace element analysis and data reductionm. *J. Radianal. Nucl. Chem*., **98**, 353-363.

BUCHNER, G. (1949): Ricerche sui giacimenti e sulle industrie di ossidiana in Italia. *Riv. Sci. Preist.*, **4**, 162-186.

CANN, J. R. & RENFREW, C. (1964): The characterization of obsidian and its application to the Mediterranean region. *Proc. Prehistoric Soc.*, **30**, 111-133.

CIVETTA, L., CORNETTE, Y., CRISCI, G., GILLOT, P. Y., ORSI, G. & REQUEJO, C. S. (1984): Geology, geochronology of the island of Pantelleria. *Geol. Magazine*, **121**, 541-668.

CORNAGGIA-CASTIGLIONI, O., FUSSI, F. & D'AGNOLO, G. (1962): Indagini sulla provenienza dell'ossidiana utilizzata nelle industrie preistoriche del Mediterraneo occidentale. Parte prima. *Atti Soc. It. Sci. Nat. and Mus. Civ. Sci. Nat. Milano*, **101**, 12-18.

CORNAGGIA-CASTIGLIONI, O., FUSSI, F. & D'AGNOLO, G. (1963): Indagini sulla provenienza dell'ossidiana utilizzata nelle industrie preistoriche del Mediterraneo occidentale. *Atti Soc. It. Sci. Nat. and Mus. Civ. Sci. Nat. Milano*, **102**, 310-322.

CORTESE, M., FRAZZETTA, G. & LA VOLPE, L. (1986): Volcanic history of Lipari (Aeolian Islands, Italy) during the last 10,000 years. *J. Volc. Geoth. Res.*, **27**, 117-133.

DE LA MARMORA, A. (1839-1840): Voyage en Sardaigne. Turin, J. Bocca.

DE RITA, D., FUNICIELLO, R., PANTOSTI, D., SALVINI, F., SPOSATO, A. & VELONA, M. (1986): Geological and structural characteristics of the Pontine Islands (Italy) and implications with the evolution of the Thyrrenian margin. *Mem. Soc. Geol. It.*, **36**, 55-65.

FRANCAVIGLIA, V. (1984): Characterization of Mediterranean obsidian sources by classical petrochemical methods. *Preistoria Alpina*, **20**, 311-332.

FUGAZZOLA, DELPINO M., D'EUGENIO, G. & PESSINA, A. (1993): "La Marmotta" (Anguillara Sabaudia, RM). Scavi 1989. Un abitato perilacustre di età neolitica, *B.P.I.*, **84**, N.S. II, 181-304.

GALE, N. H. (1981): Mediterranean obsidian source characterisation by strontium isotope analysis. *Archaometry*, **23**, 41-51.

HALLAM, B. R., WARREN S. E. & REFREW C. (1976): Obsidian in the western Mediterranean: characterization by neutron activation analysis and optical emission spectroscopy. *Proc. Prehistoric Soc.*, **42**, 85-110.

INGRAVALLO, E. (1995): L'industria litica dell'insediamento neolitico di S. Anna (Oria - Brindisi). *St. Ant.*, **8**, 161-170.

KELLER, J. (1970): Datierung der Obsidiane und Bimstuffe von Lipari. *Neues Jahrbuch für Geologie und Paläeontologie*. **Monatshefte 1**, 90-101.

LONGWORTH, G. & WARREN, S. E. (1979): Mössbauer spectroscopy and the characterisation of obsidian. *J. Archaeol. Sci.*, **6**, 179-193.

McDOUGALL, J., TARLING, D. & WARREN, S. E. (1983): Magnetic sourcing of obsidian samples from the Mediterranean. *J. Archaeol. Sci*. **10**, 441-452.

MONTANINI, A. & VILLA, I. M. (1993): $^{40}Ar/^{39}Ar$ chronostratigraphy of Monte Arci volcanic complex (Western Sardinia, Italy). *Acta Vulcanologia*, **3**, 229-233.

PESSINA, A. & MUSCIO, G. eds., (1998): Settemila anni fa il primo pane, Catalogo della Mostra, Udine 1998-1999, Udine.

PESSINA, A. (1999): Manufatti in ossidiana dal sito neolitico di Sammanderchia - Cueis. In: FERRARI, A. & PESSINA, A. eds., Sammanderchia - Cueis. Contributi per la conoscenza di una comunità del primo neolitico. *Edizioni Museo Friulano di Storia Naturale*, Udine, **Pub. N. 21**, 287-290.

PICHLER, H. (1980): The island of Lipari. Rend. *Soc. It. Min. Petr.*, **36,** 415-440.

PUXEDDU, C. (1958): Giacimenti di ossidiana del Monte Arci in Sardegna e sua irradiazione. *Studi Sardi*, **14-15**, 10-66.

RADI, G. & DANESE, E. (2003): L'abitato di Colle Santo Stefano di Ortucchio (l'Aquila), Atti XXXVI Riunione Scientifica Istituto Italiano Preistoria e Protostoria "Preistoria e Protostoria dell'Abruzzo", Chieti-Celano 27/30 settembre 2001 145-161.

RADI, G., BOSCHIAN, G., CALANI, L., PISTOIA, A. R. & ZAMAGNI, B. (2001): Nuovi dati dal villaggio a ceramica impressa di Colle Santo Stefano (Ortucchio), Atti II Convegno di Archeologia "Il Fucino e le aree limitrofe nell'Antichità" Celano Paludi 26/28 novembre 1999, Avezzano, 70-81.

RONCHITELLI, A. (1983): L'industria litica dell'area beta. In: TINE, S. ed., Passo di Corvo e la civiltà neolitica del Tavoliere. SAGEP, Genova, 101-122.

SALOTTI, M., BELLOT-GOURLET, L., COURTOIS, J.-Y., DUBOIS, J.-N., LOUCHART, A., MOURER-CHAUVIRE, C., OBERLIN, C., PEREIRA, E., POUPEAU, G. & TRAMONI, P. (2000): La fin de Pléistocéne et le début de l'Holocene en Corse: apports paléontologique et archéologique du site de Castiglione (Oletta, Haute-Corse) *Quaternaire*, **11**, 219-230.

SCORZELLI, B. R., PETRICK, S., ROSSI, A. M., POUPEAU, G. & BIGAZZI, G. (2001): Obsidian archaeological artefacts provenance studies in the Western Mediterranean basin: an approach by Mössbauer spectroscopy and electron paramagnetic resonance. *C. R. Acad. Sci.* Paris, **332** série II a, 769-776.

SHELFORD, P., HODSON, F., COSGROVE, M. E., WARREN, S. E. & RENFREW, C. (1982): The source and characterisation of Melian obsidian. In: An Island Polity: The Archaeology Exploitation in Melos. RENFREW, C. & WANGSTAFF, J. M., eds., Cambridge University Press, Cambridge, 182-192.

TOZZI, C. & WEISS, M.C., eds. (2000): Le premier peuplement holocene de l'aire corso - toscane. Il primo popolamento olocenico dell'area corso - toscana. ETS, Pisa.

TYKOT, R.H. (1992): The sources and distribution of Sardnian obsidian. In: Sardinia in the Mediterranean: a footprint in the sea. TYKOT, R. H. & ANDREWS, T.K. eds., Sheffield Academic Press, Sheffield, 57-70.

TYKOT, R. H. (1996): Obsidian procurement and distribution in the central and western Mediterranean. *J. Mediterranean Archaeol.*, **9**, 39-82.

TYKOT, R. H. (1997): Characterization of the Monte Arci (Sardinia) obsidian sources. *J. Archaeol. Sci.*, **24**, 467-479.

VAQUER, J. (2003): L'obsidienne dans le Néolithique a l'ouest des Alpes. *Atti XXXV Riunione Scientifica Istituto Italiano Preistoria e*

Protostoria "Le comunità della preistoria italiana. Studi e ricerche sul neolitico e le età dei metalli", in memoria di L. Bernabo Brea, Lipari 2-7 giugno 2000, 1027-1030.

VILLARI, L. (1974): The island of Pantelleria. *Bull. Volcanologique*, **38**, 680-724.

WAGNER, G. A., STORZER, D. & KELLER, J. (1976): Spaltspurendatierung quartärer Gesteinsgläser aus dem Mittelmeerraum. *N. Jb. Miner. Mh.,* **2**, 84-94.

WILLIAM-THORPE, O., WARREN, S. E. & BARFIELD, L. H. (1979): The sources and distribution of archaeological obsidians in northern Italy. *Preistoria Alpina*, **15**, 73-92.

HU ISSN 1786-271X; urn:nbn:hu-4106 © by the author(s)