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# Characterization and Provenance of Archaeological Obsidian from Pirozza-Spalmatore, a Site of Neolithic Colonization on the Island of Ustica (Sicily)

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Original Study

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**Abstract:** This article presents the first archaeometric research carried out so far on a group of obsidian artifacts collected in the promontory of Pirozza-Spalmatore, the site of a Neolithic settlement on the small island of Ustica (Sicily, Italy). The obsidian assemblage, consisting of 28 artifacts, was subjected to optical, typological and geochemical analyses, the latter carried out by means of a portable pXRF, in order to determine their provenance. The results indicate that 89% of the fragments come from geologic obsidian outcrops on the island of Lipari, and 11% from the island of Pantelleria. It is thus ascertained that, during the Neolithic, Ustica used two different sources of obsidian, located 150–250 km away from the site. These obsidian sources were typical of some western Sicily prehistoric villages, while eastern Sicilian villages seem to have imported obsidian exclusively from Lipari. The analyses indicate that all the obsidian artifacts attributed to Lipari come from the geological deposit of Gabellotto, while those attributed to Pantelleria come from the two distinct deposits of Lago di Venere and Balata dei Turchi.

**Keywords:** Obsidian, Ustica (Italy), pXRF, Neolithic, Lipari, Pantelleria

## 1 Introduction

Visible from the northern coast of western Sicily, the small island of Ustica has the profile of a turtle floating on the sea (Figure 1). This was its appearance to the inhabitants of the Neolithic villages that populated the coast of Palermo around the 6th millennium BC, when for the first time they decided to travel to the island on fragile boats and settle there permanently, bringing with them all the resources necessary to survive in this previously uninhabited place.

In the late 1990s, the archaeologist Giovanni Mannino discovered dozens of ceramic fragments during surface surveys of private gardens in Punta Spalmatore Village, a tourist resort on the south-west coast of the island. These discoveries suggested the previous existence of a Neolithic colony on the site. The surveys allowed him to identify a promontory overlooking the sea, the Pirozza hill, which was the place of

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the first Neolithic settlement, and a larger adjacent area, now partly occupied by the tourist village, where successive prehistoric and protohistoric settlements developed over subsequent millennia (Mannino, 1998; Spatafora & Mannino, 2008; Mannino & Ailara, 2016).

In the spring of 2016, the first author of this paper (Foresta Martin) collected 28 fragments of obsidian from the surface of the Neolithic site, with the permission of the tourist village's owners. The obsidian artifacts were first submitted to a visual assessment, and then chemical analysis with a portable XRF instrument by the co-author of this paper (Tykot), in order to determine their typological and geochemical character, thus establishing their provenance. In this study, the authors report the results of these analyses, and in the absence of specific stratigraphic contexts, they also discuss the possible relationship of the obsidian finds with the Spalmatore prehistoric settlements. The obsidian collection has been reported to the Soprintendenza per i Beni Culturali e Ambientali di Palermo, and is currently stored at the Laboratorio Museo di Scienze della Terra Isola di Ustica.


**Figure 1**. The island of Ustica as seen from the coast of Palermo on a clear day (courtesy of G. Liga).

## 2 Ustica Geologic Outline

Ustica (38°42’00”N, 13°11’00”E) is a volcanic island located in the southern Tyrrhenian Sea, about 70 km north of Palermo and 100 km west of the Aeolian Islands (Figure 2). The island, with a surface of 8.6 $km^2$ and a perimeter of about 16 km, is the small top of a vast, submerged volcanic complex that rises about 2,000 m from the sea floor.

The origin of Ustica dates back to the middle Pleistocene, approximately one million years ago, when the expansion of the Tyrrhenian basin generated deep faults, causing the rise of a magma plume directly from the Earth’s mantle and thus beginning the formation of the Ustica seamount. After about half a million years of underwater eruptive activity, the top of the seamount emerged, becoming the first subaerial volcano of the island, now known as Monte Guardia dei Turchi, at 248 m asl. Subaerial volcanic activity continued with the formation of other eruptive centers characterized by various kinds of activity: effusive, Strombolian, explosive. About 426,000 years ago, Ustica’s volcanism recorded a sub-Plinian event in the Tramontana site, with the formation of a high eruptive column and the fallout of ash that contributed to the thick pyroclastic deposits of Grotte del Lapillo. The island’s volcanic activity ended about 130,000 years ago, with the explosive Falconiera's hydro-magmatic eruption and the formation of a tuff cone whose northern slope then collapsed and fell into the sea (Romano & Sturiale, 1971; de Vita, 1993; de Vita, Laurenzi, Orsi, & Voltaggio, 1998; Peccerillo, 2003; de Vita & Foresta Martin, 2017) (Figure 3).

Throughout this history of volcanic events, there have been several cycles of marine ingressions and regressions, resulting from the fluctuation of average global temperatures and the associated variations in sea level. Over the last 350,000 years, these phenomena have caused the stationing of sea water on Ustica, with the formation of typical sedimentary terraces that today cover the areas of Tramontana, Piano dei Cardoni, Oliastrello, and Spalmatore districts (de Vita & Orsi, 1994; Buccheri, D'Arpa, & Foresta Martin, 2014).

The volcanics of Ustica show Na-alkaline affinity, ranging in composition from basalts to trachytes. The most evolved trachytic products of Ustica belong to the volcanic unit of Grotte del Lapillo and consist of pumice and ash fall-out layers, without subaerial effusive products, which instead are found as submarine lavas in the Colombara shoal. This unit represents the only silica-rich volcanic event that could have generated glassy/obsidianaceous rocks; however, geological obsidian outcrops have never been reported (Romano & Sturiale, 1971; Cinque, Civetta, Orsi, & Peccerillo, 1988; de Vita, 1993; Bellia, Hauser, & Rotolo, 2000). Therefore, all the abundant obsidian artifacts found on Ustica do not derive from local geological outcrops but were imported from distant sources in prehistoric times (Foresta Martin, Di Piazza, D'Oriano, Carapezza, Paonita, Rotolo, & Sagnotti, 2016, 2017).


**Figure 2.** Ustica in the Tyrrhenian Sea (modified from Google Earth).

## 3 Prehistoric Settlements at Ustica and Obsidian Trade

Prior to the discovery of the Neolithic finds at Pirozza-Spalmatore hill on Ustica, several prehistoric settlements had already been identified (Figure 4).

A Middle Bronze Age site, known as Faraglioni Village, was discovered on the north coast of the island (Mannino, 1970, 1979), and excavations were later carried out there by Mannino (1982), Holloway and Lukesh (1995, 2001), and by Spatafora (2005). Elsewhere, in the southern district of Piano dei Cardoni, the existence of an Eneolithic (Chalcolithic) settlement has also been reported (Mannino, 1991) while an Early Bronze Age

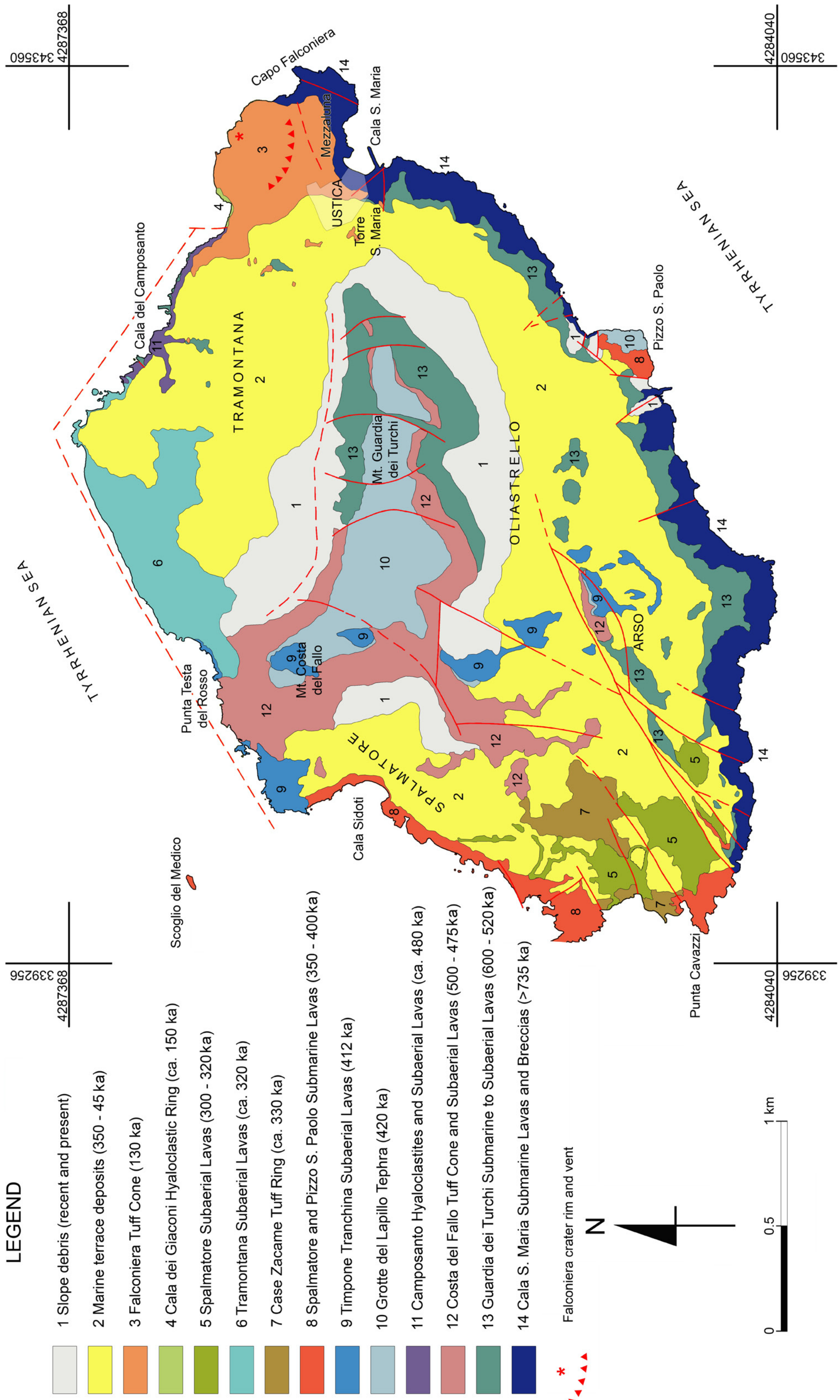


**Figure 3.** Ustica geological map (after de Vita & Foresta Martin, 2017).

settlement with an annexed necropolis was discovered near the top of Monte Guardia dei Turchi on the Culunnella hill (Mannino, 1991, 1997). Therefore, the discovery of Neolithic finds at Spalmatore completes a picture of Ustica's occupation since the introduction of agriculture to the central Mediterranean. Of all the archaeological sites mentioned above, only the Faraglioni village was systematically excavated; all the other sites have been described only on the basis of surface finds.


**Figure 4**. Ustica main archaeological settlements: 1. Neolithic Pirozza (Spalmatore) Village; 2. Eneolithic Piano dei Cardoni Village; 3. Early Bronze Age Culunnella Village; 4. Middle Bronze Age Faraglioni Village (modified from Google Earth).

The concentration of obsidian artifacts in the Ustica countryside generally correlates with the archaeological sites mentioned above, with some exceptions. In several instances, obsidian fragments have been found hundreds of meters away from known settlements. For example, obsidian flakes are known from Tramontana Sopravia, 500–800 m south of the Faraglioni village, scattered over a large area that extends to the hill slopes of Monte Guardia dei Turchi. The dispersion of obsidian across the large district of Tramontana could be due to several factors: the existence of other small settlements not yet identified; natural transport phenomena over the millennia, such as recurrent autumnal-winter floods; or agricultural work carried out by occupants of the land in recent centuries.

For a long time researchers have believed that the obsidian fragments found in Ustica were imported only from Lipari, located to the east in the Aeolian Islands. In recent years, extensive investigation on the provenance of obsidian found on Ustica has led to the discovery that while the island received most of its prehistoric imports of volcanic glass from Lipari, it also procured glass from Pantelleria (Tykot, 1995) and occasionally from other distant sources, e.g. Palmarola (Foresta Martin et al., 2017). Extensive pXRF source analysis on hundreds of obsidian fragments collected from different parts of the island determined that about 85% of obsidian artifacts come from Lipari, and 15% from Pantelleria (Tykot & Foresta Martin, 2017; Foresta Martin & La Monica, 2018).

## 4 The Pirozza-Spalmatore Neolithic Site

Pirozza is a small hill overlooking the sea that rises about 50 m asl, on the southwest coast of the Spalmatore district. Viewed from above, it has a rhomboidal shape, with a surface of about 1500 $m^2$ (Figure 5). It is striking that the top of the hill is surrounded by natural buttresses of columnar basalts, reinforced in some places with boulders carried there by people (Figure 6). Moreover, the protected top of the hill is flat, due to the erosive action of the Crotonian marine transgression (MIS 7 of Shackleton and Hopdike curve), that occurred about 240 ka BP leveling some reliefs (de Vita, 1993). For these reasons, the Pirozza hill was suspected to be an ideal site for a prehistoric settlement well before the overwhelming evidence of Neolithic occupancy had been found (Mannino, 1998). The top of the hill is now abandoned and overgrown by seasonal Mediterranean shrubs.


**Figure 5**. Aerial view of the Pirozza hill and Spalmatore touristic village at Ustica Island, as seen from the north.The red asterisk indicates the place where Neolithic ceramics and obsidian were found (modified from Google Earth).


**Figure 6.** Street view of the Pirozza hill, in the Spalmatore district, as seen from the north. On the left, the area now occupied by the tourist village.

On its northern and eastern sides, the Pirozza hill extends over a much larger area of approximately 50,000 $m^2$ at a lower altimetric level, between 25 and 40 m asl, which also is naturally protected by basaltic buttresses. This area is nowadays occupied by the bungalows of the Spalmatore tourist village (Figure 5).

Evidence of Neolithic settlement in the Pirozza area was found on the northeastern flank of the hill, which is connected by a gentle slope to the tourist village zone. From that slope Mannino (1998) collected dozens of ceramic fragments with engraved or impressed decoration, which can be attributed to three specific Neolithic facies—Stentinello, Trichrome, and Diana—plausibly dating between the 6th and 4th millennia BC, attesting to a connection with coeval villages on the Palermo coast (Figure 7). Periodic maintenance work on the gardens led to the emergence of these buried materials (Mannino, 1998; Spatafora & Mannino, 2008).

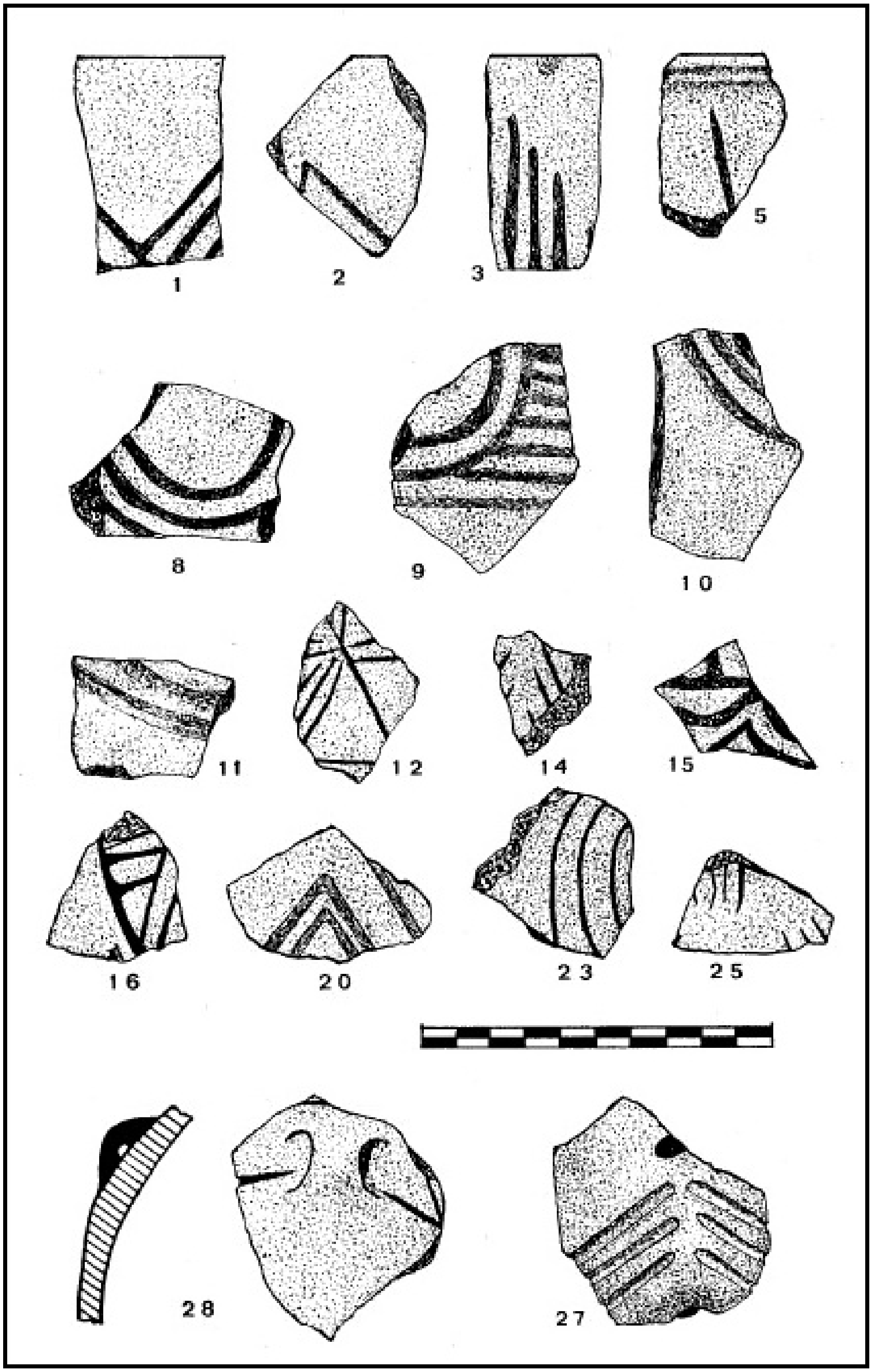


**Figure 7.** Neolithic ceramic fragments found near the Pirozza hill, at Spalmatore, Ustica (from Mannino, 1998).

In the area surrounding the Pirozza hill where clear evidence of a Neolithic presence was discovered, ceramic fragments of subsequent eras, including the Eneolithic, Bronze Age, and Greek and Roman periods, were also found. This evidence suggests that settlement continued in the area following the Neolithic period, developing beyond the area now occupied by the tourist resort (Mannino & Ailara, 2016).

However, construction of tourist bungalows on the site caused the partial destruction of the underlying archaeological settlements and mixed the ceramic assemblages.

In light of these circumstances, a stratigraphic correlation of the Pirozza Neolithic finds with their contemporary settlement is at present impossible and can only be carried out if deep excavations are done, permitting study of the still-intact parts of the original settlement.

## 5 Sampling and Visual Characterization of Obsidians

The 28 fragments of obsidian analyzed in this work were collected in spring 2016 from the surface of a flowerbed, on the northeastern slope of the Pirozza-Spalmatore hill, in a small area of about 200 $m^2$ (coordinates: 38°41'48.75"N, 13°09'28.91"E; elevation 45 m asl). The sampling area is private property, part of the Punta Spalmatore tourist resort and represents a small portion of the largest area in which a lot of ceramic finds had been previously reported (Mannino, 1998) (Figure 5).

All 28 obsidian fragments are small, 2–3 cm on average. From a typological point of view they can be classified this way: 13 are waste or debitage, i.e. pieces removed from a core in order to produce a tool; 8 are blades with very sharp cutting edges; 6 are flakes without a specific shape, but possibly used as a tool; and 1 is a chunk, i.e. an unworked piece of obsidian (Table 1 and Figure 8). A visual analysis of macroscopic physical characteristics of the 28 obsidian fragments allows us to make some distinctions.

**Table 1.** Visual characteristics of the Pirozza-Spalmatore obsidian artifacts (the transparency index is expressed in a scale from 0 to 5).

| USF # | Sample | Type | Color | Phenocrysts | Transparency |
|---|---|---|---|---|---|
| 28655 | Uspalm01 | debitage | black | N | 5 |
| 28656 | Uspalm02 | Blade | dark-grey | N | 4 |
| 28657 | Uspalm03 | debitage | dark-grey | N | 4 |
| 28658 | Uspalm04 | debitage | dark-grey | N | 4 |
| 28659 | Uspalm05 | Flake | dark-grey | N | 4 |
| 28660 | Uspalm06 | Flake | black | N | 1 |
| 28661 | Uspalm07 | Flake | black-green | N | 0 |
| 28662 | Uspalm08 | Blade | grey | N | 5 |
| 28663 | Uspalm09 | Blade | grey | N | 5 |
| 28664 | Uspalm10 | Blade | grey | N | 3 |
| 28665 | Uspalm11 | Blade | grey | N | 5 |
| 28666 | Uspalm12 | Flake | dark-grey | Y | 5 |
| 28667 | Uspalm13 | Chunk | grey | Y | 3 |
| 28668 | Uspalm14 | Blade | dark-grey | Y | 5 |
| 28669 | Uspalm15 | Blade | dark-grey | N | 5 |
| 28670 | Uspalm16 | debitage | black-green | N | 0 |
| 28671 | Uspalm17 | debitage | dark-grey | N | 3 |
| 28672 | Uspalm18 | Flake | grey | N | 5 |
| 28673 | Uspalm19 | Blade | grey | N | 5 |
| 28674 | Uspalm20 | Waste | dark-grey | Y | 4 |
| 28675 | Uspalm21 | Flake | black-green | N | 0 |
| 28676 | Uspalm22 | Waste | grey | Y | 4 |
| 28677 | Uspalm23 | Waste | dark-grey | N | 5 |
| 28678 | Uspalm24 | Waste | dark-grey | Y | 5 |
| 28679 | Uspalm25 | Waste | dark-grey | N | 4 |
| 28680 | Uspalm26 | Waste | grey | N | 5 |
| 28681 | Uspalm27 | Waste | grey | N | 4 |
| 28682 | Uspalm28 | Waste | dark-grey | N | 4 |


**Figure 8.** The Pirozza-Spalmatore obsidian assemblage.

The largest group, made of 25 pieces (highlighted in Table 1), includes fragments that when observed in white, reflected light look grey to black in color, with a glassy luster. Many of the obsidian artifacts in this group have a high transparency index: 4–5 on a scale from 0 to 5, and if observed in white, transmitted light they exhibit a grey or light-grey color. A few fragments of this group have undergone a devitrification process, in which involves the formation of millimetric spherical structures made by radially disposed needle-like crystals known as phenocrysts (e.g. samples Uspalm 13, 22).

The minority group, made up of only three pieces (Uspalm 7, 16, 21), exhibit opaque surfaces with intense black color reflections. These fragments are characterized by a transparency index equal to 0. If they are exposed to an intense white light it is possible to see a greenish color filtering through at the thinner edges.

In both groups all the fragments show evident conchoidal fractures. Most of the fragments are aphiric, with only a few (e.g. Uspalm 12, 13, 14) exhibiting macroscopically visible phenocrists.

As discussed further below, the mere visual distinction between the two groups of obsidian artifacts allows us to advance well-founded hypotheses on the provenance of the obsidian from Pirozza-Spalmatore.

## 6 Obsidian Sourcing

In the central Mediterranean, there are well-known obsidian sources on the four islands of Lipari, Palmarola, Pantelleria, and Sardinia, and many studies have been done using different methods of analysis to successfully distinguish between them (e.g. Acquafredda, Andriani, Lorenzoni, & Zanettin, 1999; Acquafredda, Muntoni, & Pallara, 2018; De Francesco, Crisci, & Bocci, 2008; Tykot, 2002). While some have sufficient visual characteristics to attribute them to specific islands (Pantelleria obsidian is peralkaline and typically is dark green, while the other sources have some differences in their black/grey color, transparency, and presence of phenocrysts), each of the islands have multiple subsources that were used in antiquity and these vary visually as well. Their usage also changed over the course of the Neolithic period, thus requiring appropriate methods of chemical analysis to assign artifacts to specific subsources and better understand the socioeconomic circumstances of the prehistoric cultures involved (Tykot, 2017a).

## 7 Analytical Methods

Since the 1970s, a variety of analytical methods have been used to successfully distinguish among Mediterranean obsidian sources, including neutron activation analysis, laser ablation ICP-mass spectrometry, and X-ray fluorescence, while in recent years the use of portable, non-destructive XRF instruments have dominated (Tykot, 2002, 2017a, 2017b).

In this study, non-destructive elemental analysis was performed on the Pirozza-Spalmatore obsidian artifacts using a portable X-ray fluorescence (pXRF) spectrometer, a Bruker III-SD model equipped with a silicon drift detector (SDD). The beam size of 5x7 mm allowed the analysis of a substantial horizontal area, while obsidian is known to be quite homogenous at that scale. Analyses were conducted for 90 seconds with settings of 40 kV and 11 μA, and using a filter of 12 mil Al, 1 mil Ti and 6 mil Cu. This filter reduces the background and enhances the results for elements including Fe, Rb, Sr, Y, Zr, and Nb, which are well known as useful for distinguishing obsidian sources in many parts of the world. The same instrument and settings have been used to analyze a large number of geological obsidian samples from all of the Mediterranean/European sources and subsources, allowing direct compositional comparisons with these artifacts, while the numeric results have been calibrated using software produced by MURR (Tykot, 2016, 2017b) (Table 2). The calibration software is based on 40 obsidian standards analyzed by XRF, INAA and LA-ICP-MS. Trace element ratios were used in X-Y graphs to distinguish between sources (Sr/Nb, Rb/Nb) and certain subsources (Rb/Sr, Fe/Sr).

**Table 2.** pXRF analyses (data in ppm).

| USF# | Sample # | Source | Subsource | Fe | Rb | Sr | Y | Zr | Nb | Fe/Sr | Rb/Nb |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28655 | Uspalm01 | Lipari | Gabellotto | 11144 | 283 | 18 | 38 | 178 | 39 | 612 | 7.3 |
| 28656 | Uspalm02 | Lipari | Gabellotto | 12522 | 312 | 18 | 54 | 180 | 43 | 691 | 7.2 |
| 28657 | Uspalm03 | Lipari | Gabellotto | 12647 | 310 | 22 | 43 | 176 | 39 | 568 | 7.9 |
| 28658 | Uspalm04 | Lipari | Gabellotto | 12615 | 314 | 21 | 46 | 181 | 36 | 603 | 8.7 |
| 28659 | Uspalm05 | Lipari | Gabellotto | 11948 | 286 | 18 | 41 | 169 | 40 | 649 | 7.1 |
| 28660 | Uspalm06 | Lipari | Gabellotto | 11969 | 287 | 16 | 47 | 168 | 33 | 739 | 8.6 |
| 28661 | Uspalm07 | Pantelleria | LdV2 | 51746 | 104 | 9 | 88 | 820 | 179 | 6030 | 0.6 |
| 28662 | Uspalm08 | Lipari | Gabellotto | 13776 | 340 | 15 | 49 | 181 | 39 | 912 | 8.7 |
| 28663 | Uspalm09 | Lipari | Gabellotto | 11808 | 307 | 16 | 38 | 183 | 37 | 747 | 8.3 |
| 28664 | Uspalm10 | Lipari | Gabellotto | 12519 | 299 | 18 | 46 | 172 | 32 | 679 | 9.5 |
| 28665 | Uspalm11 | Lipari | Gabellotto | 13377 | 317 | 18 | 46 | 189 | 40 | 738 | 7.9 |
| 28666 | Uspalm12 | Lipari | Gabellotto | 11021 | 280 | 18 | 37 | 162 | 34 | 603 | 83 |
| 28667 | Uspalm13 | Lipari | Gabellotto | 10583 | 255 | 23 | 41 | 164 | 34 | 456 | 7.5 |
| 28668 | Uspalm14 | Lipari | Gabellotto | 11863 | 288 | 13 | 42 | 172 | 36 | 886 | 8.1 |
| 28669 | Uspalm15 | Lipari | Gabellotto | 12780 | 308 | 22 | 50 | 17.3 | 40 | 573 | 7.6 |
| 28670 | Uspalm16 | Pantelleria | BdT | 54797 | 171 | 15 | 179 | 1669 | 350 | 3617 | 0.5 |
| 28671 | Uspalm17 | Lipari | Gabellotto | 13659 | 301 | 19 | 40 | 179 | 35 | 723 | 8.7 |
| 28672 | Uspalm18 | Lipari | Gabellotto | 12471 | 308 | 22 | 46 | 182 | 44 | 573 | 7.0 |
| 28673 | Uspalm19 | Lipari | Gabellotto | 15847 | 364 | 20 | 52 | 200 | 37 | 801 | 9.7 |
| 28674 | Uspalm20 | Lipari | Gabellotto | 12276 | 297 | 22 | 47 | 173 | 40 | 555 | 7.5 |
| 28675 | Uspalm21 | Pantelleria | LdV2 | 59186 | 111 | 10 | 104 | 916 | 214 | 5668 | 0.5 |
| 28676 | Uspalm22 | Lipari | Gabellotto | 11757 | 278 | 19 | 42 | 175 | 36 | 617 | 7.7 |
| 28677 | Uspalm23 | Lipari | Gabellotto | 12099 | 290 | 21 | 48 | 172 | 38 | 583 | 7.7 |
| 28678 | Uspalm24 | Lipari | Gabellotto | 12866 | 296 | 23 | 51 | 176 | 38 | 568 | 7.8 |
| 28679 | Uspalm25 | Lipari | Gabellotto | 13389 | 307 | 20 | 48 | 184 | 40 | 664 | 7.8 |
| 28680 | Uspalm26 | Lipari | Gabellotto | 15184 | 358 | 17 | 49 | 194 | 40 | 896 | 9.0 |
| 28681 | Uspalm27 | Lipari | Gabellotto | 14791 | 320 | 23 | 52 | 203 | 35 | 651 | 9.0 |
| 28682 | Uspalm28 | Lipari | Gabellotto | 12770 | 291 | 18 | 40 | 182 | 36 | 704 | 8.1 |

# 8 Results and Discussion

All of the obsidian artifacts tested in this study were assigned to either the Lipari (25) or Pantelleria (3) island sources, by comparison with elemental data obtained with the same pXRF for many geological samples (Tykot, 2017b) (Figure 9). These source attributions were not unexpected, given results obtained from previous studies on Ustica (Tykot, 1995; Foresta Martin et al., 2017), the visual studies done on this collection, and the relative proximity of these sources when compared to others in the Mediterranean. This analytical study was also able to assign the artifacts to specific subsources on Lipari (all Gabellotto, Figure 10) and Pantelleria (1 Balata dei Turchi, 2 Lago di Venere, Figure 11).

The proportion of Lipari (89%) vs. Pantelleria (11%) obsidian used at this site is very similar to that found for the study of 170 artifacts in the surface finds collection by C.G. Seminara in the Museo della Parrocchia di San Ferdinando Re (Foresta Martin et al., 2017), although that collection likely represents multiple sites and perhaps a much broader chronological range of culture periods than Pirozza-Spalmatore. All the Lipari artifacts were assigned to the Gabellotto Gorge subsource, while multiple subsources from Pantelleria were in use, following the pattern found throughout Sicily. These findings suggest that the socioeconomic characteristics of acquisition and distribution of obsidian and perhaps other materials to Ustica were part of a large geographic region of prehistoric activities (Tykot, 2017a; Tykot, Freund, & Vianello, 2013).

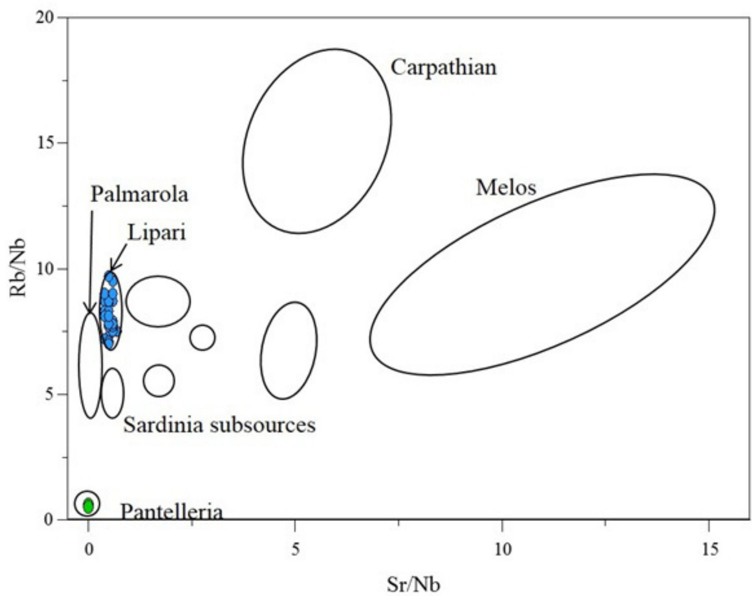


**Figure 9**. Graph of Rb, Sr, and Nb ratios showing assignment of the Spalmatore obsidian artifacts to ellipses based on many geological samples analyzed with the same pXRF.

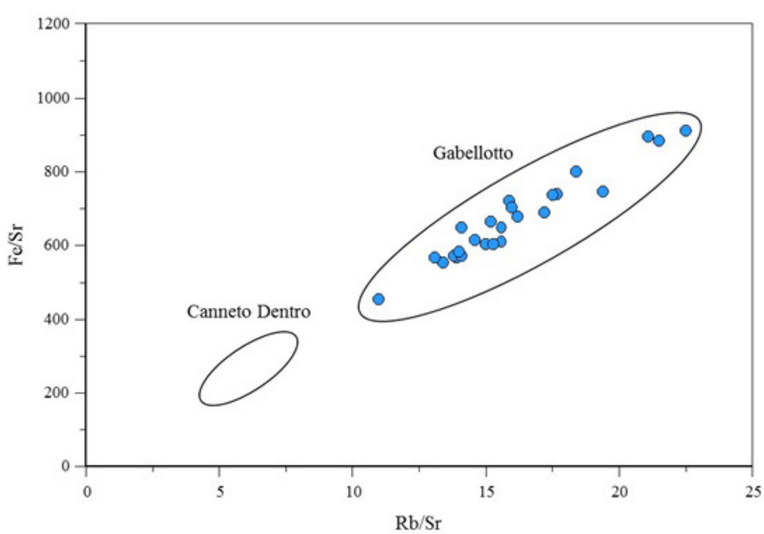


**Figure 10.** Graph of Fe, Rb, and Sr ratios showing assignment of all Lipari artifacts to Gabellotto using ellipses based on many geological samples analyzed with the same pXRF.

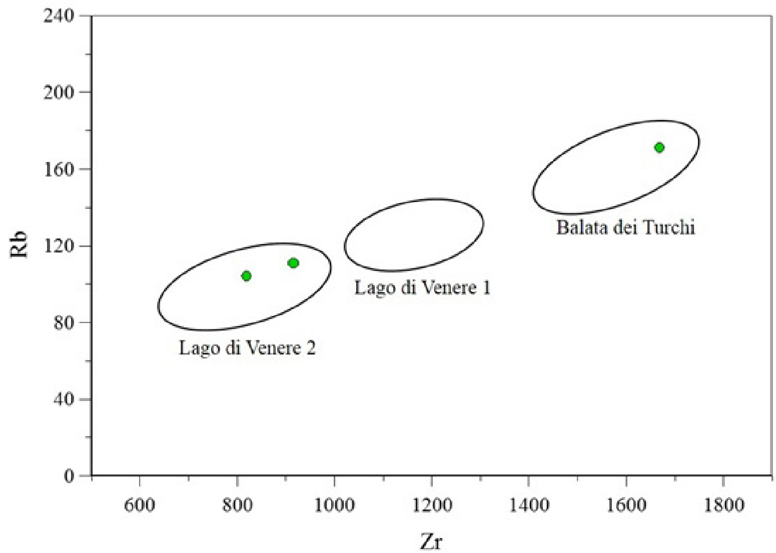


**Figure 11.** Graph of Rb and Zr values (in ppm), showing assignment of Pantelleria artifacts to two of three subgroups depicted as ellipses based on many geological samples analyzed with the same pXRF.

# 9 Conclusion

This study provides the first geochemical characterization of a group of 28 obsidian artifacts collected on the Pirozza hill, characterised by some archaeologists as a Neolithic settlement, and likely representing the first human presence on the island of Ustica (Mannino, 1998; Spatafora & Mannino, 2008; Mannino & Ailara, 2016). The presence of a small but not negligible amount (11%) of obsidian imported from the island of Pantelleria, compared to the majority imported from Lipari (89%), suggests that since the 6th millennium BC Ustica was part of a complex long-distance maritime distribution network for production materials. Procurement from two island sources is typical of some other prehistoric settlements in western Sicily, while the prehistoric settlements of eastern Sicily seem to have been supplied almost exclusively with Lipari obsidian, as shown by recent source analysis of large obsidian assemblages (Tykot et al., 2013).

Since Pantelleria is located on the opposite (southern) side of Sicily from Ustica, it is possible that obsidian imports from there were not as direct as from Lipari, but instead passed through western Sicily, following a model described by some authors as 'down-the-line' procurement (Freund, 2018).

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