INVENTARIA PRAEHISTORICA HUNGARIAE

BEYOND THE GLASS MOUNTAINS

PAPERS PRESENTED FOR THE 2019 INTERNATIONAL OBSIDIAN CONFERENCE

27-29 MAY 2019, SÁROSPATAK

EDITED BY
KATALIN T. BIRÓ and ANDRÁS MARKÓ

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CONTENTS

NEW RESULTS FROM SOURCING THE EARLY NEOLITHIC OBSIDIAN ARTEFACTS FROM POLLERA CAVE (LIGURIA, NW ITALY)

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Abstract: The authors present the results of new chemical characterizations of Early Neolithic obsidian artefacts yielded by the excavations carried out at Cave Pollera in 1971-1973. We analysed four artefacts from the Impresso-Cardial layer III, level XXII. The finds had already been analysed by neutron activation (INAA) at the end of the 1970s during Lawrence H. Barfield's pioneering obsidian circulation research in northern Italy. The scope of the new characterizations was to solve some problems raised from previous publications (i.e. 3 artefacts, one of which was generically attributed to the Impressed Ware Culture, the second from the XXII level and the third from level XVII, published by Williams-Thorpe and others in 1979, whilst G. Odetti in her 1991 paper reported 4 artefacts, all from level XXII). This contradictory information did not allow us to identify each analysed artefact and attribute it to its original source (at that time determined as Lipari and Sardinia). Moreover, the presence of obsidian imports from Lipari in the upper Tyrrhenian Sea region during the Early Neolithic does not agree with more recent data obtained from obsidian samples characterised from the neighbouring Arene Candide Cave. Therefore, the four artefacts have been re-analysed at IRAMAT-CRP2A by non-destructive methods (PIXE at CENBG [AIFIRA platform] and EDXRF). The new results exclude the presence of Lipari obsidian from the Early Neolithic Pollera deposits. In contrast, they outline a picture more coherent with that obtained from the analyses of coeval obsidian samples collected from sites located in the Liguro-Provençal Alpine arc. Finally, this research pinpoints to the need of reviewing the characterizations published during the first pioneering archaeometric obsidian studies with more precise sourcing databases and methods, to be applied especially when they seem to contrast with a new, more reliable archaeological evidence.

Keywords: *obsidian sourcing, PIXE, EDXRF, Early Neolithic, Pollera Cave (Liguria, Italy)*

Introduction: the site, its context and importance

The Pollera Cave, also known as Arma Pollera-Buio, opens at 284 m asl at Montesordo, on the left of the Rio della Valle (Finale Ligure, Western Liguria, NW Italy) (***Fig. 1a***).

The cave opens at the contact between the Pietra di Finale and the oldest, impermeable substrate along the underground course of the Rio di Montesordo, whose waters spring out at the resurgence of the Grotta del Buio. After the large entrance hall (***Fig. 1c***), a steep slope marks the beginning of the hypogeal branch ca 1534 m long, explorable only with speleological equipment.

Fig. 1.: a) Map showing the location of Pollera Cave and the Western Mediterranean obsidian sources. b) Map of the Monte Arci obsidian primary and secondary sources (modified from LUGLIÈ et al. 2006, fig. 2). c) View of the entrance of the Pollera Cave from the main hall.

The Pollera Cave, after the Arene Candide, is undoubtedly one of the most important karstic cave archaeological deposits of the Finalese whose Holocene anthropogenic sequence started to be explored in the nineteenth century[1].

Material culture remains retrieved during the nineteenth century by the first explorers are stored in the collections of several Italian museums among which are the Genova-Pegli's Ligurian Archeology Municipality Museum and Turin's Museum of Antiquities. According to the present evidence, the cave started to be settled during the Early Neolithic and its human use continued until the middle Bronze Age[2].

[1] ODETTI 1972.

[2] ODETTI 1974; TINÉ 1974, 1999; TINÉ & TRAVERSO 1991-92; DEL LUCCHESE & STARNINI 2013; 2015.

Between 1971 and 1973, the Soprintendenza Archeologica della Liguria promoted several new excavation campaigns in the entrance hall of the Pollera Cave, whose scope was to re-investigate the Neolithic deposits. The excavations, directed by the late S. Tiné, were carried out on an area of a few square metres, removing the Neolithic deposit by arbitrary levels or spits. Four occupation phases were identified, called layer Ia (levels I-VIII), layer Ib (levels IX-XV), layer II (levels XVI-XVIII) and layer III (levels XIX-XXIV). Layers Ia and Ib were attributed to the middle Neolithic Square-Mouthed Pottery (SMP) Culture, layer II to the "Pollera Style" and layer III to the Early Neolithic "Impressed Ware"[3]. The obsidian specimens from the Pollera sequence are 9 (***Fig. 2.***, ***Table 1.***). More precisely 4 pieces come from level XXII (layer III)[4], while 5 are without clear stratigraphic context. The analysed specimens described in this paper are the 4 found in association with characteristic Early Neolithic potsherds attributable to different chrono-cultural horizons of the Impresso-Cardial Complex (ICC) (***Fig. 3.***), dated to the VI millennium BCE[5]. However, after a careful techno-typological study, most of the other pieces were attributed to the ICC.

State of the problem: previous studies on Pollera Cave's obsidian provenance

The elemental chemical composition of 3 obsidian artefacts from the 1971-1973 excavations has been analysed at the end of the 1970s during Lawrence H. Barfield's pioneering research on obsidian circulation in northern Italy[6].

At that time, these artefacts, one published as coming from level XXII, one from level XVII (perhaps a mistake in typing the number, confusing X with V?) and one from a generic "Impressed Ware" layer, were analysed by means of neutron activation (INAA).

[3] ODETTI 1991.

[4] ODETTI 1991.

[5] BINDER & SENEPART 2010; PANELLI 2019.

[6] WILLIAMS THORPE et al. 1979.

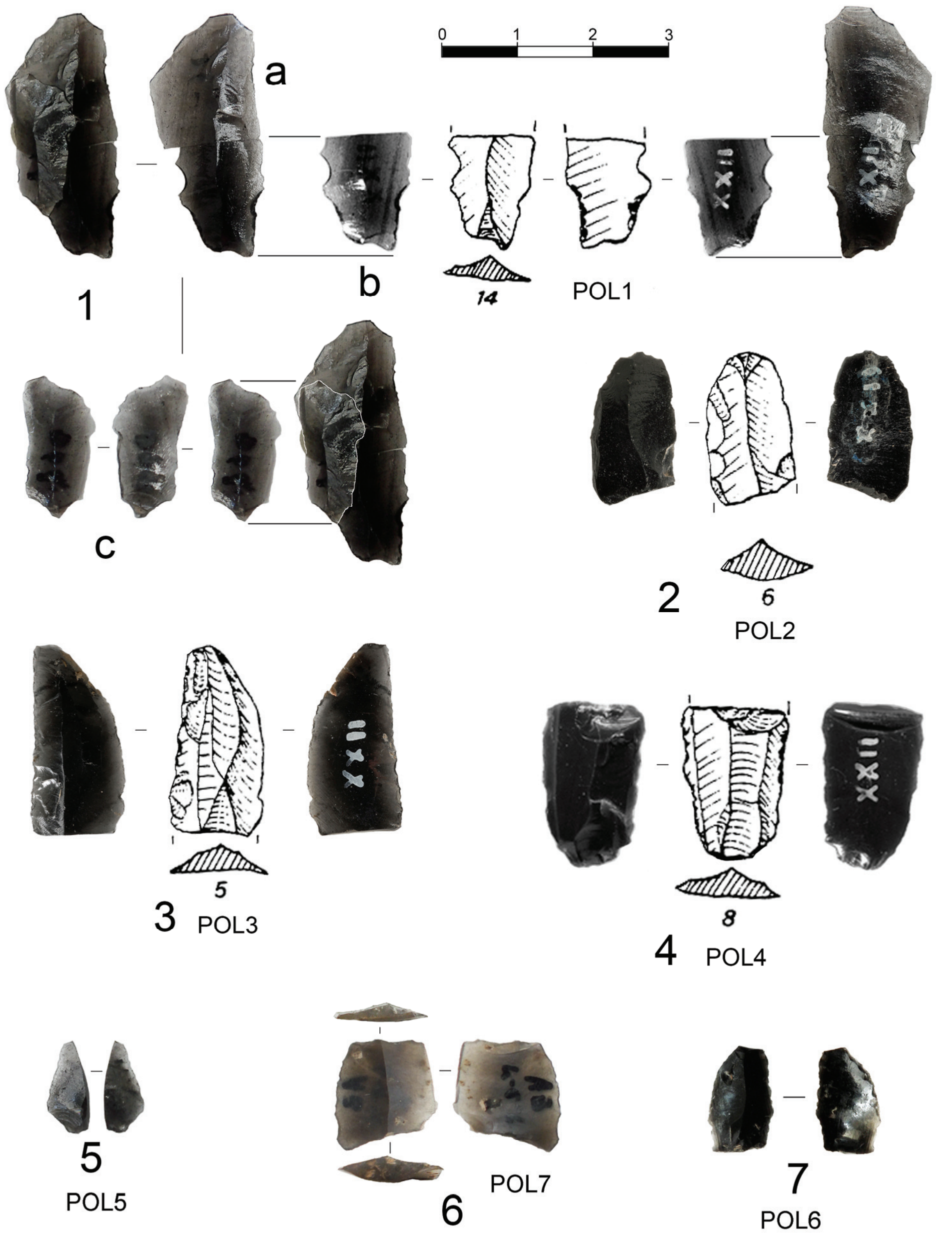

Fig. 2.: Pollera Cave, 1971-73 excavations. 1-4) Obsidian artefacts from the Early Neolithic level XXII, re-analysed with PIXE and EDXRF in this work [the earlier provenance determinations performed at Bradford University, reported in ODETTI 1991: 134-135, were: Lipari (POL1 and POL4) and Sardinia (POL 2 and POL3)]; 1) sample POL1 (b) and two refitting pieces (a, c) from Monte Arci source-SB2; 2) POL2, flakelet fragment from Monte Arci source-SC; 3) POL3, distal fragment of bladelet from Monte Arci source-SB2; 4) POL4, proximal fragment of bladelet from Monte Arci source-SB2; 5) POL5, proximal fragment, from unknown layer, unpublished, analysis in progress; 6) POL7, geometric armature, stray find from squares A-B 4-5-6, unpublished, analysed and non-obsidian; 7) POL6, proximal fragment of retouched bladelet, from unknown layer, unpublished, analysis in progress (drawings from ODETTI 1991: fig. 46, n. 14, 6, 5, 8, modified. Photographs by E. Starnini).

Fig. 3.: Early Neolithic, ICC potsherds from Pollera Cave. 1-2) *Impressa* fragments decorated with *sillon d'impressions*, from level XXII; 3) *Impressa* fragment decorated with *sillon d'impressions* from level XXIII; 4) *Impressa* fragment decorated with instrumental impressions, stray find; 5) *Impressa* fragment decorated with instrumental impressions from level XX; 6) fragment decorated with impressed plastic cordon, stray find; 7) fragment with Cardial decoration, stray find (photographs by E. Starnini).

Table 1.: Description and stratigraphic provenance of the obsidian artefacts from the Pollera Cave with source identification of the analysed samples. For comparison, also the results of the previous characterizations are reported in parenthesis.

layer/level marks stratigraphic information	sample n.	description (LAPLACE 1964)	measures (mm)	weight (g)	new PIXE-EDXRF analyses	n. in ODETTI 1991 fig. 46	Fig.
III/XXII/ Early Neolithic	POL1	proximal fragment of bladelet	(15)x11.5x2	0.51	Monte Arci - SB2	14 (Lipari)	2, 1b
D6 d/g 1972/ Early Neolithic	= POL1	distal fragmentof bladelet (conjoins with POL1)	(17)x14x2	0.59	Monte Arci - SB2	unpublished	2, 1a
III/XXII / Early Neolithic	POL2	fragment of flakelet	16.5x(20)x5.5	1.18	Monte Arci - SC	6 (Sardinia)	2, 2
III/XXII / Early Neolithic	POL3	distal fragment of bladelet	(24)x11.5x2.5	0.95	Monte Arci - SB2	5 (Sardinia)	2, 3
III/XXII / Early Neolithic	POL4	proximal fragment of bladelet	(20.5)x13x4	1.33	Monte Arci - SB2	8 (Lipari)	2, 4
unreadable (D6)	= POL1	microbladelet (joins with POL1)	18.5x8.5x1	0.25	Monte Arci - SB2	unpublished	2, 1c
unreadable	POL5	proximal fragment of flakelet	(12)x(5)x2	0.12	analysis in progress	unpublished	2, 5
AB 4-5-6 / stray find	POL7	Geometric (T2.T2)	14x13x3	0.55	not obsidian	unpublished	2, 6
stray find	POL6	proximal fragment of retouched bladelet (LD1)	(14.5)x9x3	0.39	analysis in progress	unpublished	2, 7

Table 2.: Early Neolithic ^{14}C dates available for the Pollera Cave (calibrated with CalPal: http://www.calpal-online.de/). Animal bones identification: courtesy by P. Rowley-Conwy.

Layer/level/ square	Excavation campaign	Dated material	Labora-tory n.	Uncal BP date	Cal. BC 68%	δ13C (‰; IRMS)	C:N	Reference
III/XXIV	1971-73	undetermined charred wood	MC-756	6950±100	5848±99	-	-	Tiné 1974: 52
III/XXI	1971-73	undetermined charred wood	MC-1148	6880±100	5788±95	-	-	Odetti 1990: 143
III/XXVII/B5	1971-73	collagen (sheep radius)	GrM-19996	6865±30	5752±27	-19.73	3.3	this study
III/XXIII	1971-73	undetermined charred wood	MC-757	6580±100	5526±83	-	-	Tiné 1974: 52
III/XXX/B5	1971-73	collagen (sheep metatarsal)	GrM-19997	6465±28	5433±38	-20.66	3.2	this study
II/XVIII/C4	1971-73	collagen (sheep/goat carpal)	GrM-19992	6390±28	5391±52	-20.75	3.2	this study
III/XXVIII/B5	1971-73	collagen (pig phalanx)	GrM-19995	6191±21	5135±45	-20.33	3.2	this study

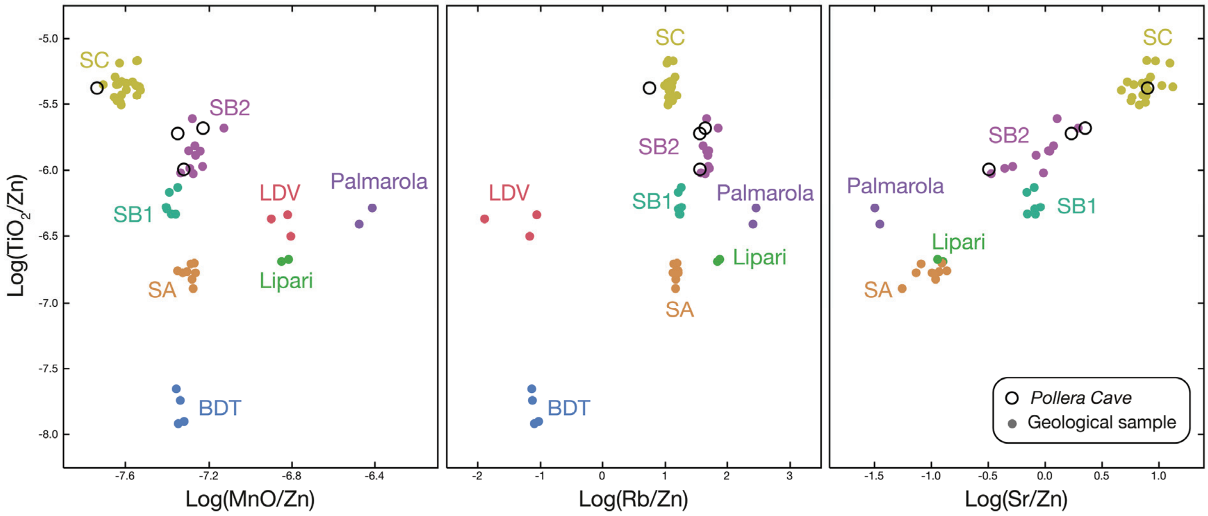

Fig. 4.: Diagrams comparing logarithmic ratios determined by PIXE for the four obsidians samples from Pollera Cave and the Mediterranean sources of Lipari, Palmarola, Pantelleria (BDT: Balata dei Turchi; LDV: Lago di Venere), and Sardinia (SA, SB1 SB2, SC). Strontium (Sr) is not calculated in Pantelleria's sources (BDT and LDV).

These previous non-destructive analyses allowed to determine their provenance from Lipari (sample 670/12) and from the SC Sardinian source (samples 670/18 and 670/13).

Later, G. Odetti[7] republished these obsidian artefacts, though in her paper she reported the presence of 4 specimens all from level XXII (***Fig. 2.***). The contradictory information regarding the reported number and stratigraphic provenance of the samples did not allow us to identify each individual analysed artefact and to attribute them with certainty to their respective sources. Therefore, the re-analysis of the 4 pieces from level XXII became a mandatory task to solve the question.

New analysis: materials and methods

To date, all the obsidian artefacts retrieved from Western Mediterranean Neolithic sites have been shown to come from the island sources of Pantelleria, Lipari, Palmarola, or Sardinia (***Fig. 1A.***). The unique chemical fingerprint of each obsidian flow allows distinguishing these sources with great precision: we can discriminate between the different Mediterranean islands as well as the multiple sources within the same flow (***Fig. 1B.***).

[7] ODETTI 1991.

As part of a general review of the Neolithic assemblage from the Pollera Cave (***Fig. 2. 1b., 2.-4., Table 1.***), four obsidian artefacts from the ICC level XXII have been characterised by two new methods, following non-destructive protocols: PIXE (Particle Induced X-ray Emission) at the CENBG - *Centre d'Études Nucléaires de Bordeaux Gradignan* (AIFIRA platform)[8] and EDXRF (Energy Dispersive X-ray Fluorescence). The characterisation was made at the *Institut de recherche sur les Archéomatériaux – Centre de recherche en physique appliquée à l'archéologie* (IRAMAT-CRP2A, UMR 5060, Pessac)[9].

This non-destructive set of techniques allows a multi-elemental analysis with high detection sensitivity, to measure the chemical elements that are particularly indicative of the genetic processes that profiled the volcanic glass. Measuring these elements hence enables us to discriminate between the obsidian sources of the different islands of the Mediterranean, and the sub-source among the multiple flows within the same volcanic source[10].

[8] SORIEUL et al. 2014.

[9] LECK et al. 2018.

[10] ORANGE et al. 2017.

Discussion of the results

The results of the geochemical analyses conducted on the archaeological artefacts (***Figs. 4. and 5.***) were compared to the data obtained with similar analytical methods from obsidian geological samples of potential "island-sources" in the Western Mediterranean.

A comparison of the PIXE and EDXRF results obtained on the specimens from Pollera Cave with reference data collected by our research group[11] shows that their geochemical signatures are compatible only with those of the volcanic complex of Monte Arci in Sardinia[12], and exclude the other Italian island sources of Lipari, Palmarola, and Pantelleria as possible origin.

Moreover, ***Figures 4 and 5*** show the logarithmic ratios, which allow to ascertain that the obsidians from Pollera Cave belong to two distinct groups of the Monte Arci volcanic complex of Sardinia (***Figs. 1B. and 5.***), SB2 (POL1, POL3 and POL4) and SC (POL2).

During the re-examination of the whole chipped stone assemblage from the cave[13], four more obsidian artefacts have been found, plus one dubious piece (POL7) but, unfortunately, they did not preserve any useful stratigraphic information (***Fig. 2. 1a, 1c, 5-7.***). However, after a technological study, two of them could be reconjoined and refitted with sample POL1 (***Fig. 2.1.***) and therefore attributed to the same Monte Arci - SB2 source. The third is a small flakelet fragment without any typological characteristic (***Fig. 2.5.***), whilst the fourth item (POL7, ***Fig. 2.6.***) obtained from a vitreous, transparent greenish gray rock very similar to a volcanic glass is a transversal geometric armature obtained by two opposite abrupt-retouched truncations, typologically very similar to a Sardinian specimen attributed to the Classic Cardial phase of the Sardinian ICC coming from the Su Carroppu-Carbonia Rock shelter[14]. Although the geometric armature is a stray find, it was submitted to archaeometric analyses since based on typological ground, also this item can be undoubtedly attributed to the ICC. Preliminary results indicate that it is not made of obsidian.

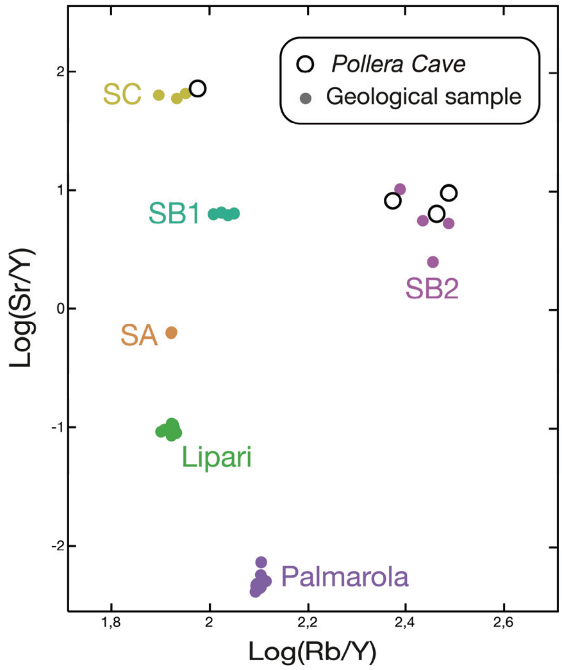

Fig. 5.: Bivariate plot comparing logarithmic ratios determined by EDXRF for the four obsidians samples from Pollera Cave and the different sources of Lipari, Palmarola, and Sardinia.

Finally, the last piece (POL6, analysis in progress, ***Fig. 2.7.***) is a proximal fragment of a back-retouched bladelet with undeterminable use-wear traces (courtesy of B.A. Voytek). All the other obsidian artefacts have been analysed for use-wear traces with a low-power microscopy, though no traces could be observed.

Conclusions

The new analyses established that all the four re-analysed obsidian artefacts found in the Early Neolithic horizons of the Pollera Cave (all marked as from level XXII) can now be ascribed to only two different chemical compositional groups (SB2, SC) of the Monte Arci Sardinian source.

These new results are in better agreement with the data obtained from the Arene Candide Cave[15], and offer a new input for discussing the dynamics of circulation of this volcanic glass in

[11] LUGLIÈ et al. 2007, 2008, 2009, 2014; MULAZZANI et al. 2010; NICOD et al. 2019; POUPEAU et al. 2000.

[12] TYKOT 1997; LUGLIÈ et al. 2006, 2011.

[13] BRUSCHINI 2019.

[14] LUGLIÈ 2018, Fig. 6.

[15] AMMERMAN & POLGLASE 1997.

the Tyrrhenian Sea region during the Neolithization process (VI millennium BCE).

The discrepancy between our data and previous results can be explained considering the pioneering stage of the research during the 1970s, when only a few uncertain comparative data were available for obsidian source identification, possibly biasing the attribution. The occurrence of typing mistakes reporting the information can be another explanation for the contradictory data.

In this respect, it is useful to remind that a similar case occurred with the results from the Early Neolithic site of Peiro Signado in south France where new investigations, conducted with different analytical methods, re-attributed the obsidian samples, first determined as from Lipari, to Sardinia (SB2) and the Pontine Islands (Palmarola) [16].

The old radiocarbon dates available for the Pollera Cave (***Tab. 2***.), though they are not considered precise enough due to the nature of the samples (bulk samples of undetermined charred wood) and the high standard deviation of the measures (obtained with the obsolete Conventional Beta Counting method), placed the first Neolithic occupations in the first two centuries of the seventh millennium BP (first half of the VI millennium BCE)[17]. A new set of more precise radiocarbon dates on domesticated animal bone samples employing the new high precision AMS-MICADAS (MIni CArbon DAting System)[18] facility at Groningen University Isotope Laboratory (CIO) (NL) confirms the presence of different chronological moments of occupation of the Pollera Cave starting from the first half of the VI millennium BCE.

Unfortunately, the occurrence of ceramic fragments belonging to different cultural horizons of the ICC in layer III (***Fig. 3***.) does not allow a more refined chrono-cultural attribution of the obsidian artefacts. Therefore, at present it is difficult to define in better detail the times, pace and modes that may have regulated the Early Neolithic obsidian routes that reached Liguria from the different supply sources of the central Mediterranean. In fact, we cannot exclude that provenances from different sources might have a precise chrono-cultural meaning, marking contact routes, phases and preferential directions during the neolithization process along the north-western Mediterranean coasts. Moreover, obsidian circulation networks complement information obtained from pottery sourcing, shedding light on long-distance mobility and seafaring in the north-western Mediterranean[19]. It is important to mention that recent excavations at ZAC de la Farigoule 2 (Aubord, Gard), an *Impressa* site in south France, yielded 4 obsidian artefacts, among which is one core. They all have been characterised with our same analytical methods as coming from Palmarola[20].

Therefore, the new data on obsidian sourcing of the Pollera artefacts that exclude the presence of Lipari obsidian in the Early Neolithic horizons of the cave, outline a picture much more coherent with that emerged from the analyses of obsidian artefacts from the ICC levels of the Arene Candide cave and more generally from Early Neolithic sites of the Liguro-Provençal arc[21].

Finally, this research points to the need of a systematic reviewing of the previous source attributions determined during the first pioneering archaeometric investigations of obsidian artefacts with more precise sourcing databases and modern methods, especially when they are in contradiction with new and more reliable archaeological evidence.

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The re-analyses of the obsidian artefacts from Pollera Cave have been authorized by Dr. Angiolo Del Lucchese of the *Soprintendenza Archeologia, Belle Arti e Paesaggio per la città metropolitana di Genova e le provincie di Imperia, La Spezia e Savona*. This project was partly funded by the National Research Agency (LaScArBx ANR-10-LABX-52). The AIFIRA facility is financially supported by the CNRS, the university of Bordeaux and the Région Nouvelle Aquitaine. We thank the technical staff members of the AIFIRA facility Philippe Alfaurt and Dr. Stéphanie Sorieul. The new radiocarbon dates have been funded by ES

[16] BRIOIS et al. 2009.

[17] BINDER et al. 2017; PEARCE 2013.

[18] WACKER et al. 2010.

[19] CAPELLI et al. 2017; GABRIELE et al. 2019.

[20] MANEN et al. 2019.

[21] AMMERMAN & POLGLASE 1997; BRIOIS et al. 2009; NICOD et al. 2019.

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