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Original Study

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Lipari (Aeolian Islands) Obsidian in the Late Neolithic. Artifacts, Supply and Function

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Abstract: This study focuses on the Neolithic, particularly on the emergence and development of the Diana Culture in the Aeolian Islands. Since the 1950s, the archaeological excavations unearthed parts of a settlement in a plain near the sea, contrada Diana in Lipari. We discuss the technological and typometric study of obsidian from trenches XVII, XXI, and XXXVI. A series of pXRF analyses on obsidian were carried out to identify their sources. A selection of retouched and non-retouched artifacts was examined, showing the higher variability in forms than at importing sites. This significance of this workshop area on prehistoric trade is assessed.

Keywords: obsidian; Mediterranean; exchange network; trade; Itali

1 The Obsidian Source in Lipari

The formation of deposits of obsidian on the island of Lipari, the largest in the Aeolian archipelago (Fig. 1.1), continued into historic times until less than 800 years ago. The most ancient obsidian formation is located in southwest Lipari: the Monte Guardia and Monte Giardina formations consist of pumiceous lapilli and obsidian and lithic rhyolite layers formed 27,000–24,000 years ago (Forni et al., 2013). The known eruptions producing obsidian used for stone tools (Fig. 1.2) by prehistoric people, occurred on northern Lipari (today the area is known as Monte Pilato Volcano) by the Gabellotto-Fiume Bianco system, almost 9000 years ago. This time was followed by a long period of calm lasting many millennia, during which the human cultures of the Neolithic, Copper, Bronze, and Iron Ages developed, and the same geological outcrops continued to be used by the Greeks and Romans. The obsidian sources present during the prehistoric period are believed to have been located mainly in the Vallone del Gabellotto and in the Canneto district (Keller, 1970; Cavalier, 1979, 1997; Tykot et al., 2013; Tykot, 2019; Freund, 2018).

In the early Middle Ages (in the year 729 AD according to the testimony of St. Willibald, a monk from Sussex) Monte Pilato awoke with a powerful cycle of eruptions that covered in volcanic ash both the prehistoric settlements and the obsidian flows present during the Neolithic. The violent medieval explosion formed a new cone, together with high-altitude deposits of pumice. Thus, in Lipari there were three Holocene periods of obsidian production: Gabellotto-Pomiciazzo (8700–8400 BP); Forgia Vecchia

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(776 AD, uncertain radiocarbon analysis); and Rocche Rosse-Lami (1200 AD). The obsidian flow of Rocche Rosse marked the end of all volcanic activity on the island of Lipari (Forni et al. 2013, pp. 247–248, 272, and geological map, p. 228).

Identifying possible prehistoric quarries (Buchner, 1949; Tykot, 2019; Tykot et al., 2006) will always be subject to objective limitations, due to the considerable transformation of the north-eastern slopes of the island of Lipari. The beginning of a stable population in the Aeolian Islands occurred in the Middle Neolithic with the *facies* of Stentinello. A group of people came from Sicily or Calabria to live on the islands of Lipari (settlement of Castellaro: Cavalier, 1979; Bernabò Brea & Cavalier, 1957; Nomi & Speciale, 2017) and Salina (settlement of Rinicedda: Bernabò Brea & Cavalier, 1995). The pottery was impressed (Stentinello style) and painted in red bands. There is one radiocarbon date from a piece of charred *Erica cf. arborea* from the Neolithic site of Rinicedda on Salina: 6325 ± 45 BP (Lab-code LTL4329A), 5390–5210 cal BC with 90.4% probability and 5470–5440 cal BC with 5% probability, using 2σ calibration with software OxCal 3.10. This date places the arrival of Neolithic peoples in the Aeolian Islands in the later 6th millennium BC, raising the chronology of Aeolian prehistory (Martinelli, 2016).

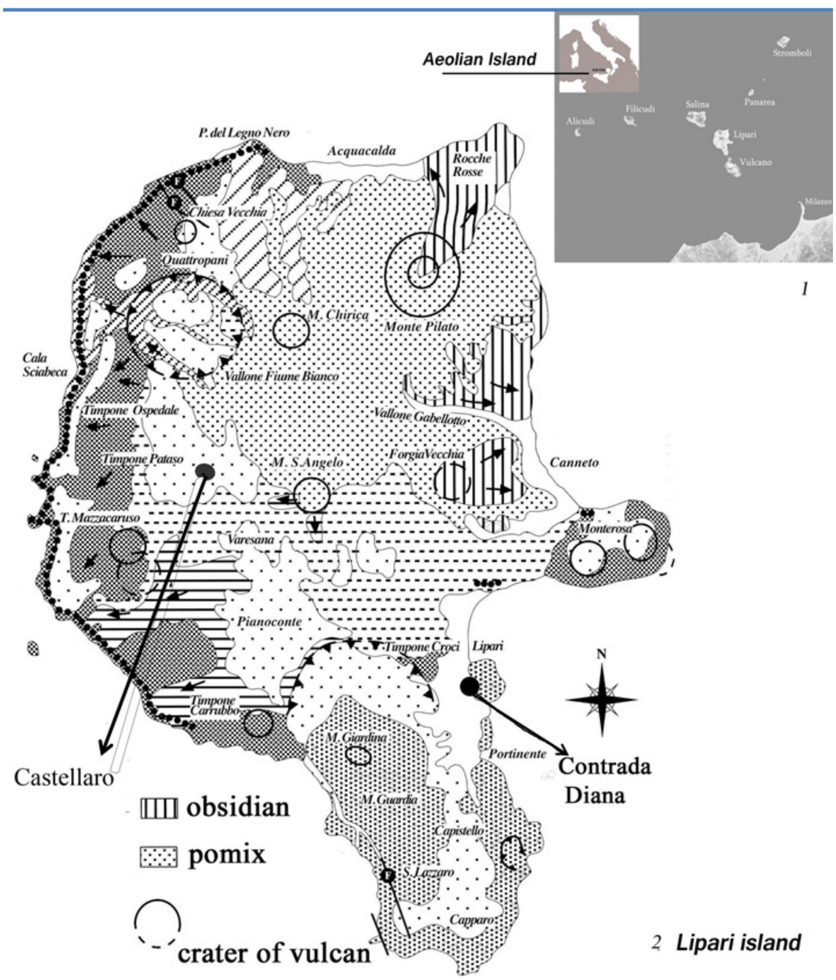

Figure 1. 1. Map Aeolian island and Italy. 2. Map obsidian flow in Lipari.

2 Intensive Exploitation of the Obsidian at Lipari

The period of greatest production of obsidian artifacts in Lipari is the Late Neolithic. In the Aeolian Islands there was a population increase with the presence of many settlements dated to the Diana culture, characterized by red surface pottery. At Contrada Diana (Fig. 2.1), today at the center of the town of Lipari, are the remains of a great settlement probably organized as groups of huts. During the Greek and Roman periods, the plain of Contrada Diana was the site of a large necropolis that damaged and partially destroyed the Neolithic layers. Some of these layers have preserved remains of hearths and pottery and a huge amount of obsidian that made it possible to interpret the Neolithic settlement as the main workshop station of the archipelago (Bernabò Brea & Cavalier, 1960).

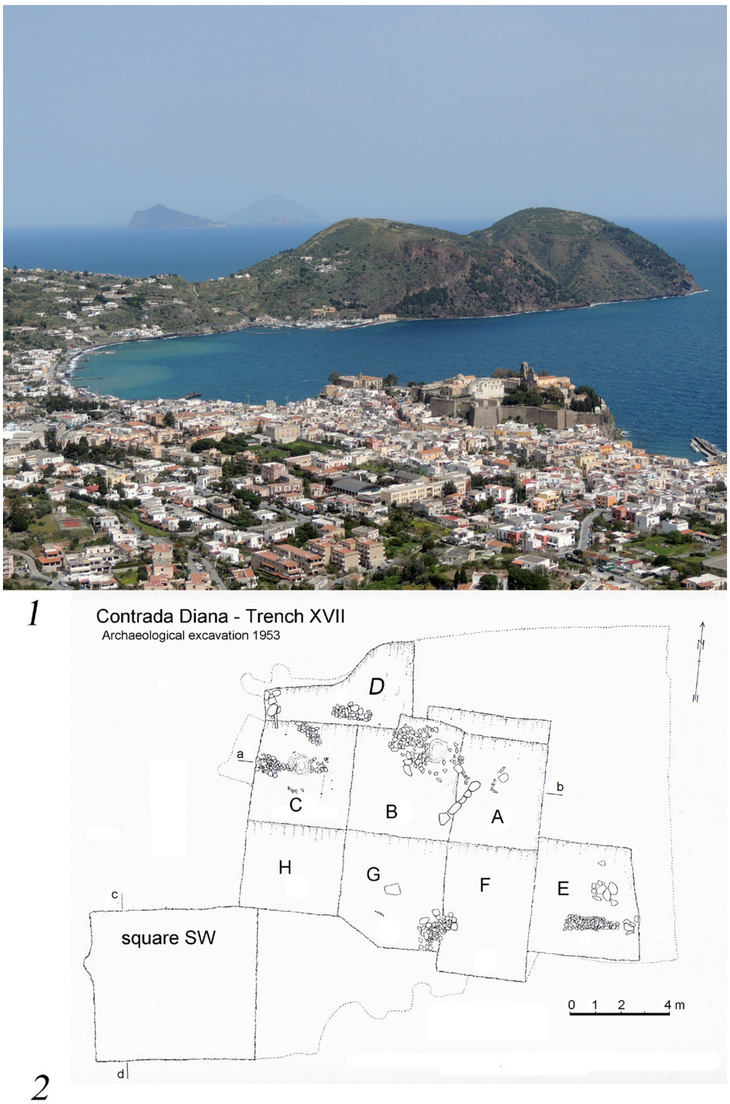

Figure 2. 1. Lipari Island: Contrada Diana area and Acropoli. 2. Lipari, Contrada Diana settlement: Map trench XVII (Bernabò Brea & Cavalier, 1960, p. 8 and figure 2).

2.1 Typological and Technological Study of a Sample of Obsidian Artifacts from the Contrada Diana Settlement

The systematic study started on obsidian knapping waste and artifacts from the workshop in Contrada Diana proved to be rather difficult given the number of products (flakes, blades, cores, etc.) collected in the various excavation trenches investigated since 1950 (Bernabò Brea & Cavalier, 1960). A typological and technological study will be necessary to understand the collection methods and knapping technique to identify economic and social behavior (Iovino & Martinelli, 2008; Negrino & Radi, 2006). Based on macroscopic observation, confirmed by mineralogical analysis (Bullock, et al., 2017), we can distinguish three main obsidian types: black, black with phenocrysts, and gray. The first type is predominant, the others are present with amounts equal to approximately 5%. It appears that the ancient inhabitants of Lipari performed a selection of the raw material.

The partial results of the typological study show an obsidian lithic assemblage with very specialized characteristics. We were able to record all the stages of the *chaîne opératoire* required to produce blades and bladelets. In the **first stage**, the block of natural obsidian was cut and prepared at the extraction source as attested by two quarry points discovered by Buchner in 1949 inside the Gabellotto Valley. The resulting pieces were then brought into the settlement to be decorticated and cleaned from surface impurities, mostly caused by pumice. The knapping proceeded through the **second stage** by detaching surfaces to obtain blades and bladelets of medium, small and tiny dimensions, and some as flakes. The work in the village produced a lot of knapping waste that cluttered the floor.

At present, all the artifacts coming from trench XXXVI (Martinelli, 1994, pp. 257–269) were analyzed while the obsidian lithic industry coming from trench XVII (square A–H) is being studied (Fig. 2.2). This trench preserves integral the Neolithic layer in which four fireplaces were discovered. In this paper, we present the data obtained from the matrix squares G cut 1–2, square F cut 4 and square E cut 3. The study highlights the massive production of blades. In two histograms, it is possible to note that 9194 artifacts from the production workshop, including about 7 kg (100 pieces) of raw material, have been rejected. Histogram 1 (Fig. 3) and table 1 include the products of the **second stage** of *debitage* (preparation of the core) with 6299 pieces which represent the production of flakes of varying dimensions (*debris)* from knapping the core with the percussion technique. Histogram 2 (Fig. 4) and table 2 include the quantity of artifacts reaching the **third stage** of knapping, the final product obtained from the core (blades). We have counted 2895 artifacts for which we could distinguish and classify the blades as not retouched (Galiberti, 1990). Histogram 2 includes cores, bladelets and retouched tools (Laplace, 1964) to show the different quantities between knapping products and finished products. The point of impact of percussion on the artifacts is flat and chipped with proximal abrasions. The length of the blades is between 25 and 90 mm. The bladelets are thin and transparent with thickness between 1 and 3 mm, typical width 15 mm, length 40–50 mm. The cores of pyramidal (15%) and prismatic (85%) shape have various sizes: their height ranges between 18 and 70 mm. The cores were exploited until they crumbled or cracked. They account for a low percentage compared to the total of the lithic assemblage. In the third stage we could recognize also some examples of pressure technique.

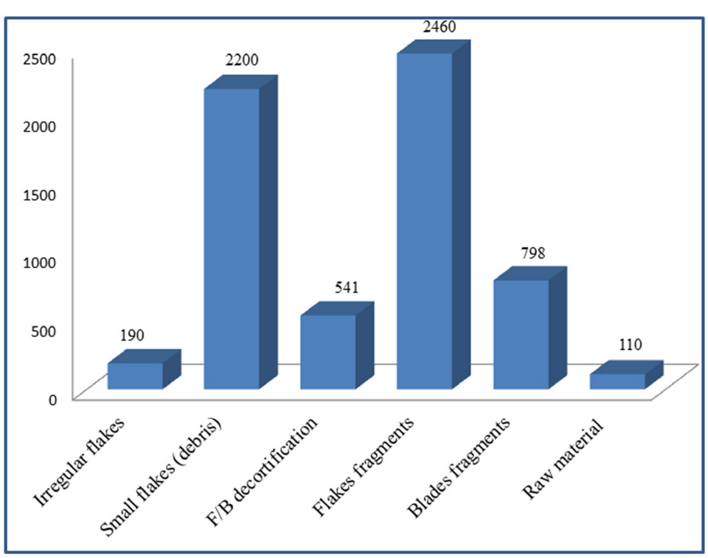

Figure 3. Lipari, Contrada Diana trench XVII. Histogram 1: products of the second stage of debitage.

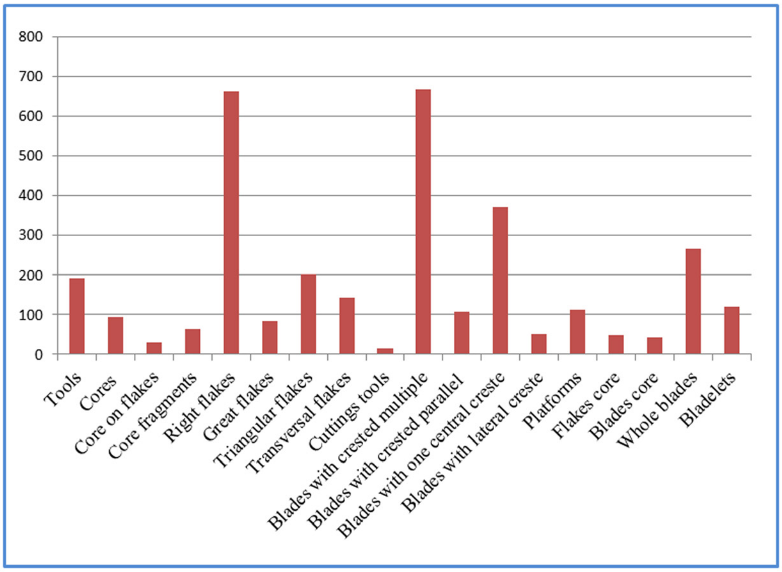

Figure 4. Lipari, Contrada Diana trench XVII. Histogram 2: quantity of artifacts reaching the third stage of knapping.

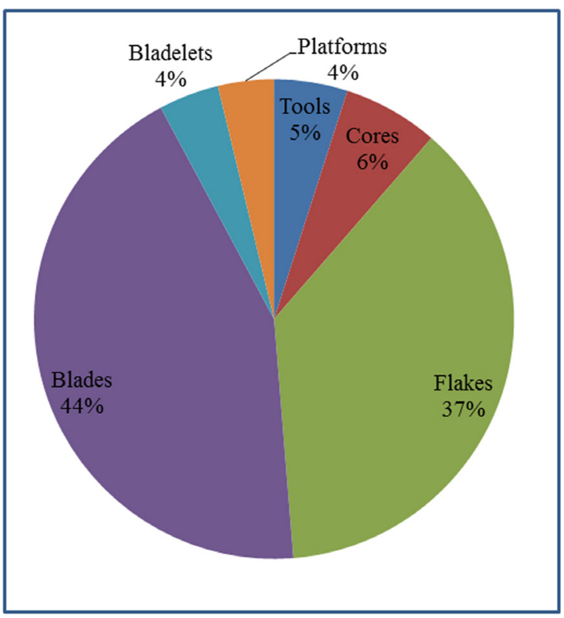

Figure 5. Lipari, Contrada Diana trench XVII. Histogram 3: synthesis of obsidian artifacts.

Table 1. Lipari, Contrada Diana trench XVII. Products of the second stage of debitage.

Irregular flakes	**190**
Small flakes (debris)	2200
F/B decortification	541
Flakes fragments	2460
Blades fragments	798
Raw material	110
total	6299

Table 2. Lipari, Contrada Diana trench XVII. Quantity of artifacts reaching the third stage of debitage.

Tools	**191**
Cores	95
Core on flakes	30
Core fragments	65
Right flakes	663
Great flakes	85
Triangular flakes	201
Transversal flakes	143
Cuttings tools	14
Blades with crested multiple	669
Blades with crested parallel	107
Blades with one central creste	371
Blades with lateral creste	52
Platforms	112
Flakes core	48
Blades core	44
Whole blades	266
Bladelets	120
TOTAL	2895

Histogram 3 (Fig. 5) and table 3 include the synthesis of 2895 obsidian artifacts from trench XVII. The obsidian tools represent a low percentage compared to the number of by-products from knapping. The manufacture of tools for local use was probably secondary to the production of blades. Instead, flint tools are found in greater numbers than the cores and other products from knapping the same raw material. The flint tools are typologically very rich, as shows the study of lithic groups from Contrada Diana trench XVII, XXI–XXIII, IX, XI, XII; XV, XVI (Martinelli, 2000), and include all types of instruments among which are distinguished backed blades and points, truncations, geometric rhomboids, tools with flat retouch and fragments of sickles. The sickles were not produced in obsidian at the Diana site.

We have recognized 175 obsidian tools divided by type (Laplace typology from 1964) as shown in histogram 4 (Fig. 6) and table 4. They are produced from thick blades. The burins (Fig. 7) are large with lengths between 50 and 120 mm, widths 20–40 mm, and average thickness between 8 and 20 mm. We have observed a specialization to prepare end-scrapers (Fig. 8), of long and short frontal types. Three end-scrapers were retouched on distal and proximal sides allowing their use on both sides. Another type of instrument present is the backed point prepared from a blade with the distal area retouched and rounded for use as an awl. The substratum group of artifacts includes a significant amount of points, blades and flake scrapers (Fig. 9), as well as denticulates. The retouch is marginal and scaled. The flat retouch is invasive in scrapers with ogival shape and large size (about 11x50x81 mm). A particular tool is an axe from a thick blade (12x36x67 mm) with two crests on the dorsal surfaces and two grooves on the sides. We have observed on the distal and proximal sides the retouch typical of the *Campignano* technique (Fig. 10). A lot of flakes present abrasion on sides caused probably by use or by accidental contact with surfaces. It may be difficult to understand the difference between deliberate retouching and accidental retouching within our limited selection.

Table 3. Lipari, Contrada Diana trench XVII. Synthesis of obsidian artifacts.

Tools	**5,00%**
Cores	6,50%
Flakes	37,70%
Blades	43,90%
Bladelets	4,10%
Platforms	3,80%

Table 4. Lipari, Contrada Diana trench XVII. Tools.

Burin	**18**
End-scraper	31
Truncation	4
Backed point	6
Backed blade	10
Backed and Truncation	1
Geometric	0
Flat retouche	1
Point	9
Blade scarper	41
Flake scraper	23
Blade scraper fr	9
Denticulate	10
Axe	1
Blade scarper with abrasion	12
Total	175

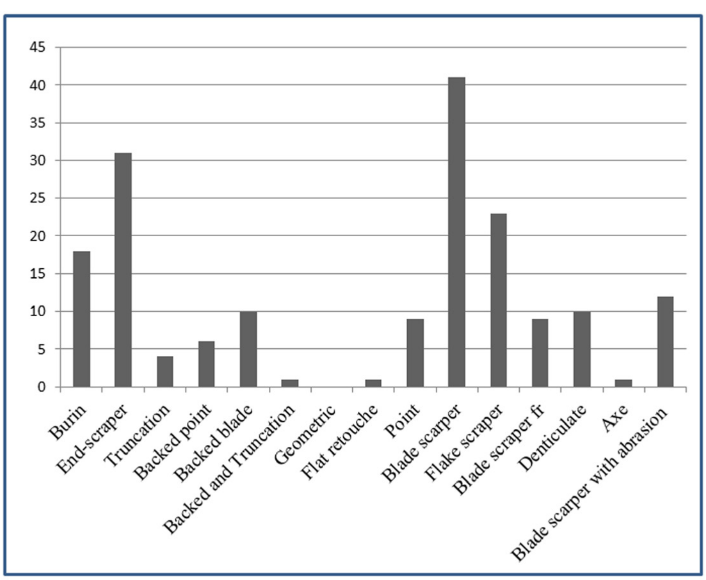

Figure 6. Lipari, Contrada Diana trench XVII. Histogram 4: tools.

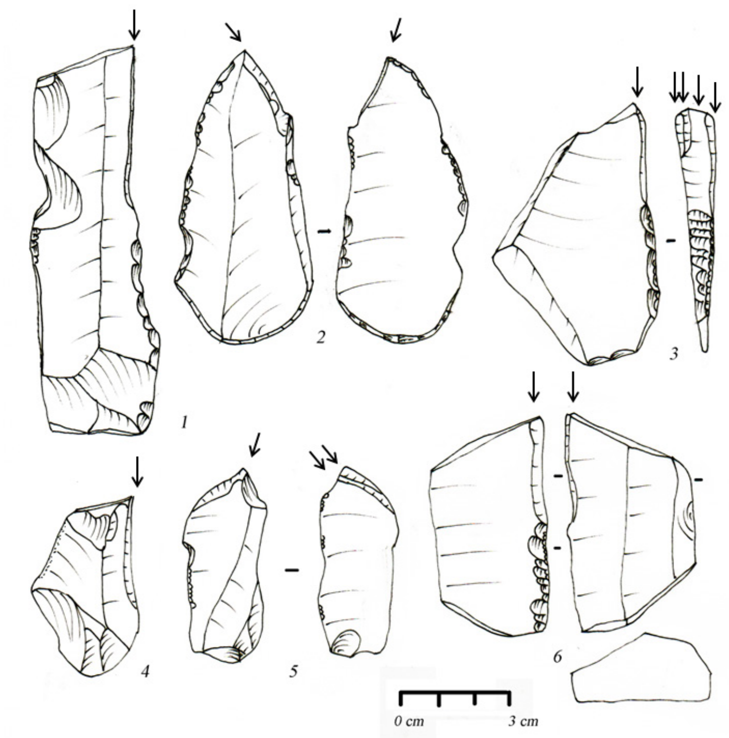

Figure 7. Lipari, Contrada Diana trench XVII. Drawing tools: 1) burins (1–6) (drawings M.C. Martinelli).

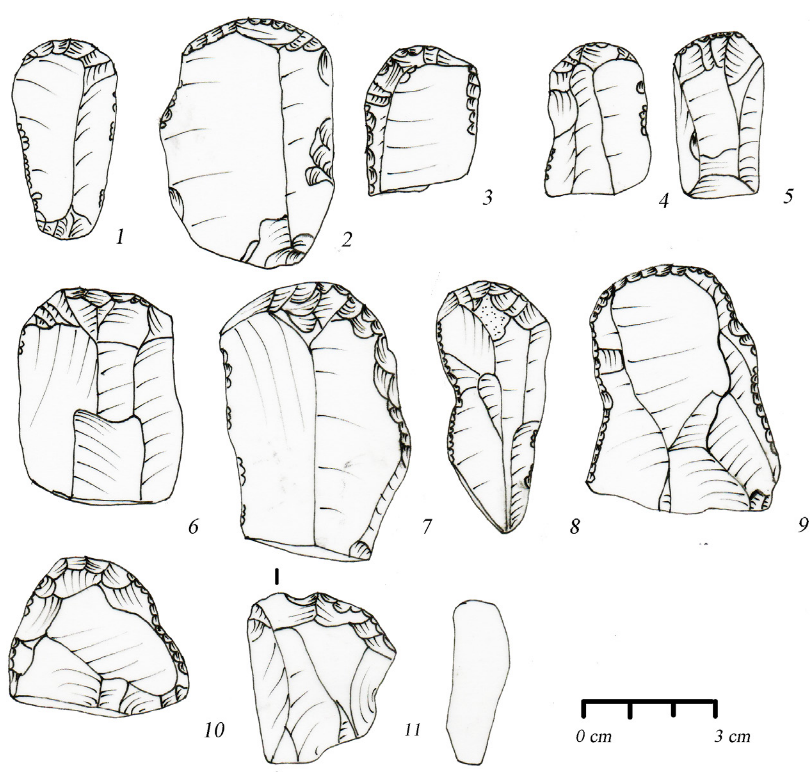

Figure 8. Frontal end-scrapers (1–10), Carinate type (11) (drawings M.C. Martinelli).

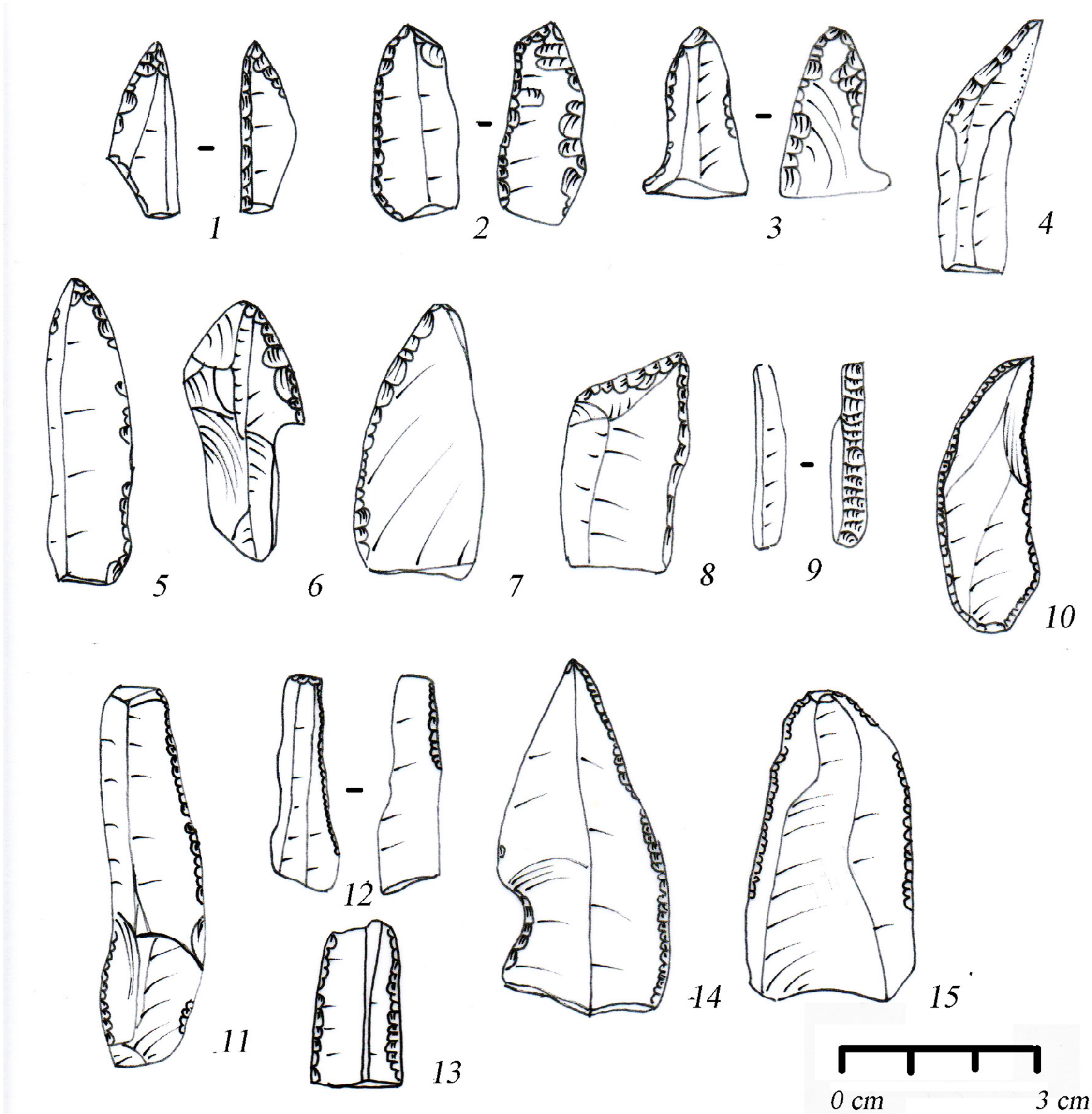

Figure 9. Backed tools (1–9, 12), blades scrapers (11, 13–15) (drawings M.C. Martinelli).

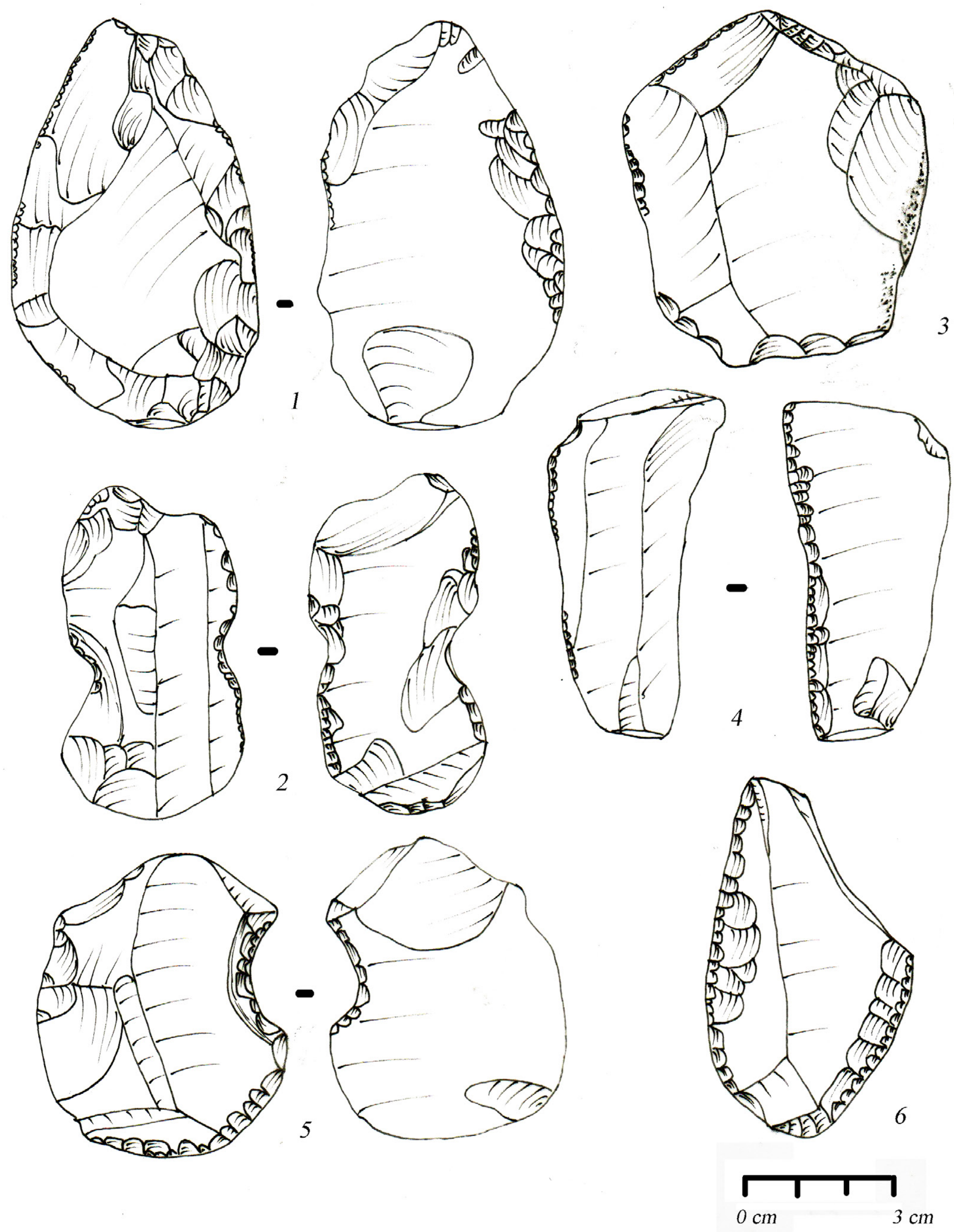

Figure 10. Scraper with flat retouche (1), axe *Campignano* technique (2), flake scrapers (3, 5–6), Blade scraper (4) (drawings M.C. Martinelli).

The Contrada Diana settlement at Lipari has returned a huge amount of obsidian proving an intense knapping activity on location. This study recognized *débitage* resulting from the production of bladelets (typical length: < 50 mm; thickness: < 3 mm) and middle sized blades (length: > 50 mm).

We can summarize the processing of obsidian that took place in three main stages:

1. Cut, collection and preparation of raw material at the source;
2. Preparation of cores and production of massive amounts of knapping waste in the settlement;
3. Exploitation of cores to produce blades in the settlement.

The percussion technique is attested during the first and second stages and the pressure technique during the third stage. The tools are retouched for local use (in tiny amounts) by selecting end-scrapers and backed blades. Obsidian is not used to produce sickles: flint was used exclusively for these tools. In the Aeolian production chain, the bladelets appear to be the finished product that was then exported. In fact, their production is massive and highly specialized already during the Late Neolithic (Diana culture).

3 Sourcing

A random selection of 150 obsidian artifacts, representing many different trenches and squares, were selected for sourcing analysis to confirm that they all came from geological outcrops on the island of Lipari. In the central Mediterranean, trace element analysis is a well-established method for distinguishing not only the different island sources of Lipari, Palmarola, Pantelleria, and Sardinia, but also sub sources within each island (Tykot, 2017). For Lipari, the ancient sources of Canneto Dentro, Gabellotto Gorge, and Monte Guardia have different trace element values, although obsidian from Monte Guardia does not seem to have been sufficient in size for producing tools, and the minor use of Canneto Dentro suggests it was quite limited in the size/quantity available (Tykot et al., 2006; Tykot, 2017, 2019).

Using a portable, hand-held Bruker III-SD model X-ray fluorescence (pXRF) spectrometer, analyses were conducted within the Lipari Museum complex using settings of 40 kV, 11 μA, and 90 second, with a filter that enhances the precision of trace elements Rb, Sr, Y, Zr and Nb. The data produced were calibrated against 40 known obsidian standards incorporated in a software program specifically for this instrument, and also directly compared with geological obsidian samples from Lipari analyzed with the same pXRF (Table 5).

The data obtained for the trace elements by the pXRF are highly precise and accurate. The values have been compared with those from geological samples analyzed on the same instrument, and those obtained using different technologies. XRF has limits in producing accurate values when used non-destructively on surface analyses when compared with destructive methodologies because of the low penetration of the X-ray on the artifact, which makes it vulnerable to the accidental analysis of eventual extraneous elements on the surface, as well as alteration of the original values due to weathering, although this is rarely an issue on smooth-surfaced glassy obsidian. The values obtained from the pXRF were calibrated using Compton normalization, mitigating the effects of air intrusion and variable artifact geometry, and the calibration software used incorporates 40 obsidian standards analyzed by INAA, LA-ICP-MS, and XRF by MURR. It is also possible to verify ratios of key trace elements, which are consistent for XRF instruments in general. There is a substantial literature assessing the scientific value of pXRF data in consideration to its technological limits (see Kasztovszky et al., 2018 for a recent discussion, including the Lipari geological samples, by a team not connected to the authors).

The trace element values, along with ratios of Fe/Sr and Rb/Sr, were used to determine that 149/150 of the artifacts tested specifically came from the Gabellotto Gorge subsource on Lipari, while one artifact (#25351) turned out not to be obsidian. Two of the artifacts (#25366, #25386) have slightly higher Sr values than the others, suggesting they may have come from a different area within the Gabellotto Gorge.

Table 5. Calibrated data for the pXRF analyses of 150 artifacts.

Sample	Area	Cut	Trench	USF #	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Zona A - 1 - trench 21	A	1	21	25312	347	10715	78	20	39	248	19	35	146	32
Zona A - 2	A	1	21	25313	366	10840	78	22	40	262	18	39	150	32
Zona A - 3	A	1	21	25314	501	10769	77	20	44	261	18	40	149	31
Zona A - 4	A	1	21	25315	438	11210	97	17	43	254	23	38	159	32
Zona A - 5	A	1	21	25316	421	10413	67	19	42	252	19	41	149	32
Zona A - 6	A	1	21	25317	361	9745	85	21	40	234	16	34	143	29

continued Table 5.

Sample	Area	Cut	Trench	USF #	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Zona A - 7	A	1	21	25318	589	10543	78	22	39	260	16	41	160	33
Zona A - 8	A	1	21	25319	503	11208	106	19	45	282	21	42	148	32
Zona A - 9	A	1	21	25320	429	10518	85	16	49	258	18	42	149	33
Zona A - 10	A	1	21	25321	503	11115	75	19	43	256	16	45	154	32
Zona A - Tg5 - 1	A	5	17	25322	374	11234	89	19	45	266	19	41	152	34
Zona A - Tg5 - 2	A	5	17	25323	633	10668	77	23	42	255	15	45	156	33
Zona A - Tg5 - 3	A	5	17	25324	433	10984	74	17	41	267	20	40	157	33
Zona A - Tg5 - 4	A	5	17	25325	335	10756	106	15	44	258	15	42	151	31
Zona A - Tg5 - 5	A	5	17	25326	436	10185	101	21	43	258	21	37	158	33
Zona A - Tg5 - 6	A	5	17	25327	362	10392	90	18	44	246	19	33	156	33
Zona A - Tg5 - 7	A	5	17	25328	434	10799	78	22	41	265	21	42	160	30
Zona A - Tg5 - 8	A	5	17	25329	472	10459	102	14	36	256	22	44	157	29
Zona A - Tg5 - 9	A	5	17	25330	466	10684	81	25	40	258	15	40	161	32
Zona A - Tg5 - 10	A	5	17	25331	538	11269	82	17	40	267	12	44	153	37
Zona B - 1	B		17	25332	442	10611	83	23	49	259	17	39	157	32
Zona B - 2	B		17	25333	518	10736	93	19	43	263	14	45	179	34
Zona B - 3	B		17	25334	522	10324	77	16	46	266	19	37	160	31
Zona B - 4	B		17	25335	457	10391	93	18	41	261	19	40	157	32
Zona B - 5	B		17	25336	392	11262	97	23	46	272	15	44	161	32
Zona B - 6	B		17	25337	466	11180	90	22	47	275	20	42	153	34
Zona B - 7	B		17	25338	457	10432	82	16	44	255	17	41	153	35
Zona B - 8	B		17	25339	519	10835	81	19	50	279	20	43	165	36
Zona B - 9	B		17	25340	394	10823	70	19	40	264	21	42	150	35
Zona B - 10	B		17	25341	492	10742	79	24	45	262	20	46	162	36
Zona C - T3 - 1	C	3	17	25342	504	11040	80	20	43	271	17	38	161	34
Zona C - T3 - 2	C	3	17	25343	486	10487	87	18	47	267	17	40	160	31
Zona C - T3 - 3	C	3	17	25344	522	11213	83	16	45	264	21	46	169	33
Zona C - T3 - 4	C	3	17	25345	498	10839	82	18	43	269	19	41	150	32
Zona C - T3 - 5	C	3	17	25346	520	11261	96	20	51	270	18	41	166	35
Zona C - T3 - 6	C	3	17	25347	445	10164	93	23	37	258	18	32	147	31
Zona C - T3 - 7	C	3	17	25348	523	11311	91	24	45	268	19	42	161	34
Zona C - T3 - 8	C	3	17	25349	427	11276	87	19	48	280	18	38	164	36
Zona C - T3 - 9	C	3	17	25350	451	11203	83	17	41	274	20	43	156	33
Zona C - T3 - 10 - not obsidian	C	3	17	25351	558	33593	144	28	16	123	1192	28	192	22
Zona D - 1	D		17	25352	424	11009	105	18	40	259	20	37	155	34
Zona D - 2	D		17	25353	500	11007	85	21	49	253	18	43	158	34
Zona D - 3	D		17	25354	481	10437	76	23	44	261	20	39	151	33
Zona D - 4	D		17	25355	535	10423	85	28	38	249	17	41	150	33
Zona D - 5	D		17	25356	628	10970	93	22	42	262	18	46	153	32
Zona D - 6	D		17	25357	507	10530	102	16	46	247	16	39	152	32
Zona D - 7	D		17	25358	540	10768	91	26	44	264	19	44	157	33

continued Table 5.

Sample	Area	Cut	Trench	USF #	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Zona D - 8	D		17	25359	434	10637	87	21	48	260	21	45	153	34
Zona D - 9	D		17	25360	421	11541	92	19	45	265	18	46	160	33
Zona D - 10	D		17	25361	441	10644	88	28	43	254	19	45	150	32
Zona E - 1	E		17	25362	420	10618	74	23	45	267	18	39	157	34
Zona E - 2	E		17	25363	461	10650	75	16	51	272	17	38	158	33
Zona E - 3	E		17	25364	377	11364	89	16	51	276	22	43	159	32
Zona E - 4	E		17	25365	371	10829	71	26	47	274	19	44	161	35
Zona E - 5	E		17	25366	448	12256	103	29	38	251	31	38	154	33
Zona E - 6	E		17	25367	356	11165	84	21	44	265	18	46	163	36
Zona E - 7	E		17	25368	442	10780	98	20	40	260	18	42	155	32
Zona E - 8	E		17	25369	399	10962	92	20	43	275	20	39	165	34
Zona E - 9	E		17	25370	442	11347	88	27	44	280	19	46	157	35
Zona E - 10	E		17	25371	419	12834	115	30	49	304	19	43	184	33
Zona F - T2 - 1	F	2	17	25372	443	11210	94	19	36	258	23	41	146	34
Zona F - T2 - 2	F	2	17	25373	518	11114	78	20	47	278	19	42	161	36
Zona F - T2 - 3	F	2	17	25374	508	10739	81	22	41	261	16	39	149	34
Zona F - T2 - 4	F	2	17	25375	452	10780	74	17	49	261	21	46	153	32
Zona F - T2 - 5	F	2	17	25376	323	10304	86	18	35	252	19	36	147	29
Zona F - T2 - 6	F	2	17	25377	533	10561	68	23	43	264	17	39	159	30
Zona F - T2 - 7	F	2	17	25378	462	11394	85	20	46	271	16	43	158	33
Zona F - T2 - 8	F	2	17	25379	508	11771	114	24	51	297	21	42	172	33
Zona F - T2 - 9	F	2	17	25380	543	11788	113	27	50	291	20	39	172	35
Zona F - T2 - 10	F	2	17	25381	458	11214	84	23	47	277	19	40	156	33
Zona F - Tg4 - 103	F	4	17	25382	429	11333	107	18	47	267	23	45	169	33
Zona F - Tg4 - 107	F	4	17	25383	415	10159	71	20	36	255	21	41	153	34
Zona F - Tg4 - 129	F	4	17	25384	522	10245	91	21	37	242	19	46	145	31
Zona F - Tg4 - 144	F	4	17	25385	465	10692	89	19	46	253	21	38	160	33
Zona F - Tg4 - 150	F	4	17	25386	461	10928	100	21	47	268	32	44	160	38
Zona F - Tg4 - 1 core	F	4	17	25387	497	10783	105	25	45	266	19	43	148	30
Zona F - Tg4 - 2 core	F	4	17	25388	483	12150	134	25	40	264	21	43	164	33
Zona F - Tg4 - 3 core	F	4	17	25389	426	9482	77	25	42	252	14	40	124	31
Zona F - Tg4 - 4 core	F	4	17	25390	530	10615	89	15	41	250	19	41	158	33
Zona F - Tg4 - 5 core	F	4	17	25391	433	10901	105	19	47	263	21	40	161	33
Zona F - Tg4 - 1 blade	F	4	17	25392	349	11111	104	28	40	270	20	42	165	28
Zona F - Tg4 - 2 blade	F	4	17	25393	667	11324	114	21	40	278	20	44	160	33
Zona F - Tg4 - 3 blade	F	4	17	25394	435	11559	97	25	51	282	22	42	173	35
Zona F - Tg4 - 4 blade	F	4	17	25395	608	11199	113	23	50	282	15	43	174	37
Zona F - Tg4 - 5 blade	F	4	17	25396	449	10722	62	26	40	264	21	38	158	33
Zona F - Tg4 - 1 tavoletta	F	4	17	25397	468	10427	89	22	35	241	18	34	140	29
Zona F - Tg4 - 2 tavoletta	F	4	17	25398	423	10565	94	18	48	259	17	41	153	32
Zona F - Tg4 - 3 tavoletta	F	4	17	25399	555	10117	86	17	42	252	20	48	156	31
Zona F - Tg4 - 4 tavoletta	F	4	17	25400	547	10743	64	28	52	269	22	43	159	33

continued Table 5.

Sample	Area	Cut	Trench	USF #	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Zona F - Tg4 - 5 tavoletta	F	4	17	25401	330	10544	95	24	37	264	17	36	157	30
Zona F - Tg4 - 70 burin	F	4	17	25402	374	10324	97	18	38	254	17	35	147	29
Zona F - Tg4 - 73 burin	F	4	17	25403	512	11025	96	22	41	274	18	45	159	33
Zona F - Tg4 - 75 burin	F	4	17	25404	483	10913	84	23	50	273	23	41	156	31
Zona F - Tg4 - 77 burin	F	4	17	25405	631	10806	76	23	47	268	18	38	158	32
Zona F - Tg4 - 147 burin	F	4	17	25406	465	10783	79	17	43	253	16	44	166	34
Zona F - Tg4 - 78 scraper	F	4	17	25407	362	11197	93	26	42	264	18	37	154	34
Zona F - Tg4 - 79 scraper	F	4	17	25408	476	10839	87	28	49	257	17	36	157	35
Zona F - Tg4 - 80 scraper	F	4	17	25409	393	10702	72	22	41	267	20	40	160	32
Zona F - Tg4 - 82 scraper	F	4	17	25410	519	10601	93	17	45	237	19	37	145	33
Zona F - Tg4 - 101 scraper	F	4	17	25411	455	10888	93	24	46	259	16	47	159	37
Zona F - Tg4 - 90 backed	F	4	17	25412	420	10679	88	21	40	260	19	44	156	31
Zona F - Tg4 - 91 backed	F	4	17	25413	454	11452	83	27	46	270	20	39	161	35
Zona F - Tg4 - 92 backed	F	4	17	25414	515	11614	90	23	43	289	17	39	170	35
Zona F - Tg4 - 93 backed	F	4	17	25415	410	10288	104	17	47	259	20	37	154	33
Zona F - Tg4 - 97 backedi	F	4	17	25416	469	10589	87	25	38	269	21	39	157	36
Zona G - Tg1-4 - 1	G	1-4	17	25417	399	10694	84	15	47	257	19	42	158	33
Zona G - Tg1-4 - 2	G	1-4	17	25418	398	11064	99	27	53	261	24	36	156	36
Zona G - Tg1-4 - 3	G	1-4	17	25419	446	10972	82	25	43	266	19	35	161	32
Zona G - Tg1-4 - 4	G	1-4	17	25420	256	10701	91	18	41	272	20	42	155	36
Zona G - Tg1-4 - 5	G	1-4	17	25421	356	10598	75	25	42	261	17	47	159	37
Zona G - Tg1-4 – Blade central creste 1	G	1-4	17	25422	626	10921	103	25	44	269	19	39	163	33
Zona G - Tg1-4 – Blade central creste 2	G	1-4	17	25423	541	11146	88	21	43	272	20	41	161	34
Zona G - Tg1-4 - Blade lateral creste 1	G	1-4	17	25424	466	11067	84	19	42	261	16	41	165	35
Zona G - Tg1-4 – Bladelet - 1	G	1-4	17	25425	509	12838	105	32	46	311	18	46	175	35
Zona G - Tg1-4 – Bladelet - 2	G	1-4	17	25426	576	11974	65	27	39	296	22	49	172	33
Zona G - Platform - 1	G	1-4	17	25427	535	11057	99	21	43	279	17	48	168	34
Zona G - Platform - 2	G	1-4	17	25428	420	11170	70	25	45	272	20	40	164	33
Zona G - Platform - 3	G	1-4	17	25429	546	10399	100	24	45	271	18	35	162	32
Zona G - Platform - 4	G	1-4	17	25430	386	11490	107	22	49	266	19	37	154	31
Zona G - Platform - 5	G	1-4	17	25431	367	11094	97	19	51	271	21	43	156	37
Zona G - Tg2 - Fragm. Core 1	G	2	17	25432	522	10980	87	21	43	272	18	40	157	33
Zona G - Tg2 - Fragm. Core 2	G	2	17	25433	465	11357	99	27	49	261	20	45	183	32
Zona G - Tg2 - Fragm. Core 3	G	2	17	25434	461	10794	77	25	47	255	20	40	149	32
Zona G - Tg2 - Fragm. Core 4	G	2	17	25435	417	10578	105	19	37	267	19	43	164	33
Zona G - Tg2 - Fragm. Core 5	G	2	17	25436	373	10430	82	22	43	264	19	41	155	36

continued Table 5.

Sample	Area	Cut	Trench	USF #	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Zona G - Tg2 - blade 1	G	2	17	25437	507	10806	88	17	42	274	18	37	161	35
Zona G - Tg2 - blade 2	G	2	17	25438	548	11196	96	18	43	266	16	40	164	36
Zona G - Tg2 - blade 3	G	2	17	25439	505	10732	83	25	56	265	18	41	165	33
Zona G - Tg2 - blade 4	G	2	17	25440	413	10973	86	24	42	275	16	45	165	35
Zona G - Tg2 - blade 5	G	2	17	25441	443	10967	77	22	50	259	15	44	154	33
Zona H - T1 - 1	H	1	17	25442	440	10996	95	19	43	274	16	38	154	32
Zona H - T1 - 2	H	1	17	25443	508	10754	79	20	32	262	18	37	154	30
Zona H - T1 - 3	H	1	17	25444	462	11086	81	21	43	270	19	47	160	35
Zona H - T1 - 4	H	1	17	25445	408	10878	80	18	45	274	19	41	152	34
Zona H - T1 - 5	H	1	17	25446	587	11617	105	23	48	271	21	42	169	31
Zona H - T1 - 6	H	1	17	25447	536	11223	68	20	38	269	17	38	153	34
Zona H - T1 - 7	H	1	17	25448	506	10538	80	18	47	258	16	42	154	32
Zona H - T1 - 8	H	1	17	25449	465	10404	82	19	38	266	20	36	146	33
Zona H - T1 - 9	H	1	17	25450	394	11090	96	22	42	285	22	40	163	37
Zona H - T1 - 10	H	1	17	25451	472	11227	97	24	41	276	19	43	166	36
Zona H - T2 - 1	H	2	17	25452	471	10650	76	24	44	264	19	39	159	32
Zona H - T2 - 2	H	2	17	25453	539	11013	69	18	43	271	17	38	169	36
Zona H - T2 - 3	H	2	17	25454	532	10808	87	20	41	266	19	37	156	33
Zona H - T2 - 4	H	2	17	25455	285	10735	81	17	38	273	19	46	160	32
Zona H - T2 - 5	H	2	17	25456	482	11176	86	20	38	262	16	45	159	35
Zona H - T2 - 6	H	2	17	25457	502	10389	82	18	39	271	18	47	164	34
Zona H - T2 - 7	H	2	17	25458	418	11310	95	23	41	267	22	45	149	36
Zona H - T2 - 8	H	2	17	25459	477	11194	91	20	42	265	19	39	167	36
Zona H - T2 - 9	H	2	17	25460	458	11679	100	24	41	260	21	47	155	34
Zona H - T2 - 10	H	2	17	25461	586	12390	96	31	53	282	17	50	171	40

4 Discussion

The massive production and exchange of Lipari obsidian started at the beginning of the local Middle Neolithic and continued into the early Bronze Age, as demonstrated by findings across Italy and in neighboring regions (Tykot, 2011; Tykot, Freund, & Vianello, 2013). During the middle Neolithic, it is likely that the island of Lipari was occupied seasonally (in summer) by people that benefited from calm seas for navigating and during those months the activity of obsidian tools production took place regularly (Robb & Farr, 2008, p. 40). During the Late Neolithic, the production was generally intense, but the original seasonality was nonetheless preserved given that most of the production was aimed for export, and export could only take place during late spring and summer. The impact that trade and exchange had on these communities is substantial, and should not be thought as a constant and febrile production to prepare artifacts that could be exported only for a short time during the year. We have suggested some preference for black obsidian, but even so, too much material, including raw material, was discarded, and this is better explained by seasonal cycles of production (e.g. fall arriving earlier than expected and scrapping the last shipment) than excessive precision in producing the finished products.

There is ample evidence that bladelets were the main tool produced (Tykot, 2017), and that they were used as far as the southern part of the Po Valley in Emilia Romagna, with much lower quantities further north. The Alps provided abundant alternative materials such as greenstone, limestone and schist and others, which significantly limited the need to import obsidian, but obsidian artifacts from Lipari still reached the Alps in mostly smaller quantities, reaching southern France, and also Croatia by crossing the Adriatic Sea (Tykot, 2014). There are very few variations in the typology, primarily the medium length blades are appreciated more west (in the Palermo area of Sicily) and north (Tuscany and Emilia Romagna). Such a gigantic distribution of a product whose origins are firmly based on a tiny island north of Sicily has effectively encircled other areas of production of obsidian tools. Pantelleria obsidian reached in significant quantity only western Sicily and Malta (Tykot, 2017, 2019; Tykot et al., 2013). Palmarola obsidian is also found in much of central Italy, even reaching the Adriatic, but almost always in much lesser percentage than Lipari. In both cases, these are small islands geographically located even farther away from the coast than Lipari. Sardinian obsidian did not circulate in any quantity in southern Italy, and only one piece has been identified so far in Sicily. There is some evidence for a limited (mostly on the southeastern coast of Sicily and in the immediate coastlines facing Lipari) direct trade of blades that is indirectly proven by lower presence of cores or debitage from cores and a high similarity in the morphometrics of the finished product (Freund, Tykot, & Vianello, 2015). In the rest of Italy, prepared cores are definitely the product that was exported, and this accounts for the small typological differences. Knapping obsidian requires skills that are in part different from those used for knapping flint, mostly due to the fact that obsidian is a glass that can shatter into a myriad of very sharp flakes if hit badly, and is therefore a hazard for people unfamiliar with the material. However, producing blades from cores must have reduced considerably this hazard, and may explain why obsidian travelled so far and its use changed so little in such a culturally diverse and vast region.

The size of the region and limited variability created also the conditions for substantial standardization in the manufacturing process, which is recognizable at Contrada Diana and elsewhere in Lipari. Most finished tools were bladelets and flakes, probably with a number of cores prepared to obtain the very same types, all were made in black obsidian and at least all those analyzed came from the same source, Gabellotto (Canneto Dentro accounts for 1% or less when detected, and the small size of the sample compared to the available evidence may have been insufficient to detect it).

The main form of distribution is through prepared cores, which were traded along main and secondary trade routes, and then worked (knapped) at regional centers, from where the blades were redistributed to individual sites. This type of trade is particularly evident in Calabria, where there are massive amounts of obsidian at Tyrrhenian sites facing the Aeolian Islands (e.g. Acconia Plain, Ammerman, 1985), with much smaller amounts and significant traces of cores on the Ionian coast (opposite). It is likely that people from both eastern Sicily and Tyrrhenian Calabria were involved in the exchanges, and whilst the activity may have been seasonal in Lipari due to the challenges presented by maritime crossings, in Calabria and elsewhere in peninsular Italy the trade may have been all year long.

The preparation of cores effectively prevented the production of other types of artifacts, and resulted in a standardization that encompasses the whole Italian peninsula, with minimal differences on the length of blades (they are longer in the north), but nothing substantial that would change the category of artifact or its function. This means that not only the type of artifact was the same, the function was the same as well, and consequently the needs that triggered its procurement were the same. For such a widespread use, across culturally different regions and throughout the whole Neolithic and Copper Age, we can only suggest a use inserted in a technological package associated with agriculture and farming. The local chronologies across the Italian peninsula may vary from the Aeolian one, and whilst the Aeolian chronology is one of the better studied and precise, at several sites obsidian is detected from the very beginning of the Neolithic period. Obsidian was not used as sickles or as an implement in threshing boards, but rather used as for tools aimed at cutting and slicing different materials. Working hides and cutting agricultural produce may have been an essential function.

The geographic distribution of obsidian matches the area covered by the "wave" of technological spread (Sargent, 1983; Brown, 1991; Skeates, 2000; Whitehouse, 2014) that arrived from Greece into the Tavoliere (Apulia) of southeastern Italy, and then spread northwards to reach the Po Plain, where a second wave from Central Europe arrived later (Isaac et al., 2010; Jones et al., 2012). This provides perhaps an insight into the patterns of distribution of Neolithic technologies. From radiocarbon evidence Zilhão (2001) suggested that the expansion of farming in the west Mediterranean (Italy to Portugal) followed the process of maritime pioneer colonization, in a fast (up to six generations) and recognizable pattern of diffusion.

The standardization of Lipari obsidian suggests that the Neolithic package included only broad technologies, and perhaps a variable sample of plant and animal domesticates and tools. Choices depended on the local environment and local culture. Obsidian can therefore be interpreted as a local solution to produce a needed tool given its availability. Interpreting its pattern of distribution results therefore in high standardization until a natural frontier was encountered such as a mountain range or a significantly different environment or cultural practices. Obsidian consumption drops almost immediately past this frontier, in Italy located at the Po Plain, despite evidence that the exchange networks were able to carry obsidian much farther. In this perspective, obsidian may be considered an essential cutting tool to enable a certain type of production and consumption, which must have been similar to other solutions adopted elsewhere, and yet characteristic of the Italian peninsula. This combination of ability to spread technologies within a few generations while maintaining significant local traits in culture and socioeconomic organization, only partly dictated by the environment, is not fully understood. If it will be confirmed by future research, then Neolithic exchange networks were far more active and efficient than previously thought, and they acted as long distance information gateways, and probably as corridors for human mobility as well, in addition to moving products and materials. This would translate in the network being more sophisticated than as it appears from tracking just material culture.

5 Conclusions

The production and consumption of obsidian in Lipari is very significant not for the amounts of material worked locally, or their antiquity, or the typological diversity of the tools produced, but for its range of distribution and high levels of standardization, which is not immediately apparent considering only the sites within Lipari itself. Obsidian production was obviously a primary economic activity at sites in Lipari (Martinelli, 2016), but it is difficult to assess consumption and the likely link with farming and the Neolithic package. The sample studied, even if partial, allows us to hypothesize equivalence at the production stage between artifacts for local use and for export. In histogram of fig. 4 the quantity of instruments and bladelets are similar. This confirms the stability of the Diana settlement during the late Neolithic (Diana facies), a period in which the population extend to inhabit the other islands of the Aeolian archipelago.

Yet, the analyses of obsidian tools across Italy are revealing the importance of this trade, and how the distribution of obsidian matches both chronologically (Early Neolithic up to Middle Bronze Age) and geographically a whole wave that introduced and developed locally farming activities in the Italian peninsula and Sicily, and extended to Sardinia and beyond. This provides a unique opportunity to assess a specific category of artifacts, obsidian blades, together with plant and animal remains to track the effects of the adoption of farming across a vast area.

Obsidian tells us a story of rapid adoption, from the earliest Neolithic, which is confirmed by radiocarbon dates at farming sites. It also reveals how the march of penetration into the peninsula used both maritime and land routes, and how the mechanisms of redistribution saw, in the Neolithic, artisans operate at short distance, with a redistributive system able to replicate tool production at major sites on these routes thanks to prepared cores, and subsequently irradiate the tools at smaller sites in the surrounding area. It is an extremely efficient system, which is still in use today, for example by logistics companies. This made possible for Lipari obsidian to be known and regularly used 1,500 kilometers from the island itself, and probably in less than the six generations required to reach Portugal. On account of distance, as little as two generations passed to reach the farthest corners of its regular use area. More impressively, obsidian tools lasted many generations, in fact millennia, which is a testament to the resilience of the exchange networks. We still do not know exactly what obsidian was used for, except for a somewhat generic assertion that the tools built with obsidian blades were very efficient at cutting and slicing, with very few use wear studies having been done. It is actually possible that they were used like knives in a modern kitchen, and therefore employed to prepare foods for storage and cooking, to help eating foods, and for other tasks that required their action (for example: wood and bone working, Iovino & Martinelli, 2008). There is nothing preventing obsidian blades to have been multi-purpose tools, with only the implements in which they were inserted limiting their use.

Indeed, the various proportions of domesticated plants and animals adopted by individual communities suggest that the obsidian tools we find today, without implements, are the materialization of a basic technological knowledge that spread far and fast. Their function may have been very different even at household level, with experimentation and adaptation to local needs always being a strong component. The sites on major routes received prepared cores and do not seem to have ever attempted to produce different tools, despite their varied lithic productions. Sites that received prepared blades were probably unable to request changes in the typology, but were probably free to experiment in obtaining different shapes from the available cores or use different implements. It is likely that the latter were more varied than we can detect, and the standardization we recognize today would have been lost to individual consumers in prehistoric times, in the same way that planting different seeds may look similar to us when we consider the technique, but actually people planted different species for different needs. We should therefore be cautious in over interpreting both standardization and range of use of tools from one site, which are significant to reveal some processes, but are still limiting in revealing how they affected daily life.

In Lipari obsidian was produced in massive quantities largely for export, and the only distinctive trait from the region in which Lipari obsidian is distributed is the larger number of types of lithic tools in obsidian found there. It is not possible to explain Lipari obsidian tools without considering the exchange network that carried them far away, because their function and typology was most likely determined by needs originating across the whole region of distribution. The farming needs in Lipari were likely so modest not to warrant any kind of selection or differentiation from the mainstream production of blades, and other tools were produced in the brittle and less efficient obsidian only because of familiarity in working obsidian and the easy availability of the raw product. Only accounting for the profound effect in the life in Lipari and the Aeolian Islands we can explain such a high number of blades, bladelets and sharp flakes in our sample, and the high degree of standardization in their production.

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