Intra-site Obsidian Subsource Patterns at Contraguda, Sardinia (Italy)

R.H. Tykot, L. Lai, and C. Tozzi

1 Introduction

Obsidian sourcing studies have been done in the Mediterranean for more than 40 years, while in the last decade the importance of attributing artifacts to specific subsources has been demonstrated, as it reveals geographic and chronological patterns of obsidian usage. In particular, changes in the usage of the Monte Arci (Sardinia) subsources have raised questions about quality, quantity, access, and socioeconomic factors involved in the acquisition, production, trade, and use of obsidian during the Early, Middle, and Late Neolithic periods (ca. 6000–3000 BC).

In this study, nearly 250 obsidian artifacts from the Late Neolithic site of Contraguda in northern Sardinia were chemically analyzed by LA-ICP-MS and pXRF and attributed to specific Monte Arci subsources. This large number of analyses, at present the most done for a single site in Sardinia or Corsica, allows testing for subsource usage patterns from different contexts within the site, and provides some interpretations about obsidian selection and use.

2 Contraguda

The open-air site of Contraguda sits on a hill in the Coghinas Valley of northern Sardinia (Fig. 1). Used during the Late Neolithic, or the Ozieri period, this site extends over several hectares and is the largest Ozieri settlement known on Sardinia. Not only is the site one of the largest open-air sites from this time, but it is also one of the only open-air sites with obsidian artifacts.

This site was identified in 1980 during an archaeological survey that was conducted to identify and catalog archaeological features in the region. In 1992,

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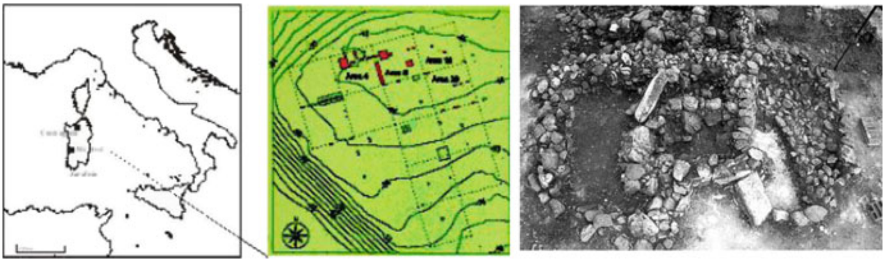

Fig. 1 Regional map showing location of Contraguda in northern Sardinia (*left*); detailed grid map showing the open-air archaeological site and the areas with obsidian artifacts tested (*center*); and a photograph of Structure A–B (*right*)

Boschian et al. (2000–2001) conducted a systematic investigation of Contraguda, with radiocarbon dates placing it in the fourth millennium BC, ca. 4050–3770 BC. The context of the obsidian tools are mainly later in the Ozieri period. Much of the obsidian was found outside of a feature, called Structure A–B, composed of a series of small, interrelated walls, which are of unknown function.

3 Monte Arci Obsidian

Previous work has identified many obsidian subsources on Monte Arci, with differences in their quantity, quality, and accessibility, while these subsources may be chemically distinguished using a variety of analytical methods (Tykot 1997; 2002). Chronological changes in the usage of the respective subsources has also been demonstrated for many sites in Sardinia and Corsica (Tykot 1996; 2004).

The main subsources are identified as SA, SB1, SB2, and SC, while SB1 and SC may be further subdivided into further subgroups. The SA and SB2 subsources, located on the southwest and west side of Monte Arci, respectively, have the glassiest, most transparent obsidian; the SC subsource is located on the northeast side of Monte Arci, is opaque and less brittle than the SA and SB2 obsidian, and appears to have been the major subsource used in the Late Neolithic. Type SB1 obsidian, from the west-central part of Monte Arci, was rarely used in any time period, most likely because it exists only in modest quantities and in small blocks. Besides primary source localities, it is also important to note that unworked raw material may be found in secondary natural deposits, especially SC obsidian to the south of Monte Arci (Lugliè et al. 2006).

4 Analytical Methods and Results

For the Contraguda project, samples were initially categorized based on visual examination and density testing. This was followed by trace element analyses on a mostly random selection of 93 artifacts using laser ablation inductively coupled

Table 1 Portable XRF data for Contraguda obsidian artifacts tested, with assigned Monte Arci subsources. All elemental data are in ppm

USF#	Source	Fe	Rb	Sr	Y	Zr	Nb	USF#	Source	Fe	Rb	Sr	Y	Zr	Nb	USF#	Source	Fe	Rb	Sr	Y	Zr	Nb
2944	SA	8,006	190	25	29	77	33	3007	SA	8,690	201	24	29	78	35	3082	SA	8,653	198	25	29	82	37
2945	SC	10,225	124	99	19	190	20	3008	SC	11,904	134	111	21	192	20	3083	SC	12,467	142	133	18	214	20
2946	SA	7,707	185	24	24	71	31	3010	SC	11,487	142	115	21	213	24	3084	SC	11,791	138	116	20	211	23
2947	SC	10,808	139	106	21	204	19	3011	SC	11,716	142	121	22	219	23	3085	SC	12,132	144	124	21	217	24
2948	SA	7,425	176	24	29	76	35	3013	SC	11,599	139	110	22	216	21	3086	SC	12,366	152	121	20	220	24
2949	SC	11,573	137	116	20	201	21	3015	SA	8,801	201	24	27	81	35	3087	SC	11,556	144	116	22	218	25
2950	SA	9,099	210	25	27	84	37	3017	SC	10,783	130	111	20	198	22	3088	SC	11,505	149	113	22	213	23
2951	SC	11,649	142	109	18	207	22	3018	SA	8,043	191	26	24	77	32	3090	SC	13,562	144	118	18	200	20
2952	SC	10,796	134	109	20	196	21	3020	SA	9,064	214	26	28	81	36	3091	SC	12,139	143	113	20	204	20
2953	SA	8,440	200	27	27	86	34	3022	SC	11,557	148	114	17	206	23	3092	SC	11,328	139	116	22	209	24
2954	SC	11,365	140	110	19	203	21	3024	SA	9,781	218	28	29	80	34	3093	SC	10,834	136	103	19	196	20
2955	SA	9,147	210	27	30	84	37	3026	SC	11,485	138	112	21	206	22	3095	SC	12,223	146	115	19	223	22
2956	SC	11,372	131	113	21	198	20	3027	SC	10,907	134	108	20	199	21	3096	SC	11,669	140	120	21	214	21
2957	SC	11,494	137	112	21	204	23	3029	SB2	8,565	181	40	18	103	20	3097	SC	11,537	142	109	21	203	22
2958	SA	9,708	212	28	27	83	36	3030	SC	13,197	157	124	20	214	22	3098	SA	10,005	226	26	26	81	35
2959	SC	12,165	144	119	23	212	22	3032	SB2	8,168	189	39	16	119	20	3100	SC	11,747	143	118	21	222	22
2960	SC	11,265	137	111	22	208	25	3033	SC	12,273	140	117	20	203	19	3101	SC	13,846	167	123	19	213	20
2961	SA	8,681	200	25	27	83	35	3034	SC	11,489	140	108	21	193	22	3103	SA	8,196	215	27	29	78	36
2962	SC	8,669	114	92	17	160	17	3035	SB2	6,551	155	25	14	77	18	3104	SC	13,236	156	121	20	213	22
2963	SC	11,942	136	125	21	203	21	3036	SC	12,178	144	111	22	209	23	3105	SC	12,039	143	116	21	211	22
2964	SC	11,557	141	116	22	209	22	3037	SC	10,012	124	102	20	197	20	3107	SC	11,069	139	108	19	194	22
2965	SA	7,868	188	23	28	73	33	3038	SC	10,453	126	97	21	184	21	3108	SA	9,491	211	28	29	86	36
2966	SA	7,824	185	23	26	80	36	3039	SC	11,759	144	117	21	207	23	3109	SA	12,840	256	28	26	89	35
2967	SC	10,841	126	105	18	188	19	3040	SC	12,219	153	113	19	201	22	3110	SC	11,087	140	117	19	212	21
2968	SC	11,206	135	110	22	198	22	3041	SC	10,937	136	108	20	205	21	3112	SC	12,118	145	118	19	201	22
2969	SC	11,687	132	116	21	200	22	3043	SC	11,094	134	107	19	203	22	3113	SA	8,740	203	25	26	80	33
2970	SA	8,487	201	27	31	85	35	3044	SA	9,165	215	27	28	83	37	3114	SA	10,043	224	30	28	79	37
2971	SC	11,148	135	105	21	196	22	3046	SC	11,933	140	117	21	195	20	3115	SC	10,913	136	110	20	200	19
2972	SA	8,225	195	23	24	76	34	3048	SB2	7,691	174	26	15	78	18	3116	SC	10,996	131	108	22	194	22
2973	SC	12,274	145	121	21	219	23	3049	SA	8,344	201	25	27	77	34	3118	SC	11,454	132	118	21	198	19

(*continued*)

Table 1 (continued)

USF#	Source	Fe	Rb	Sr	Y	Zr	Nb	USF#	Source	Fe	Rb	Sr	Y	Zr	Nb	USF#	Source	Fe	Rb	Sr	Y	Zr	Nb
2976	SA	7,342	171	21	24	74	31	3050	SC	12,199	145	113	22	219	24	3119	SB2	10,193	229	27	19	95	23
2977	SC	13,178	147	130	20	212	21	3052	SC	11,699	138	112	19	197	21	3120	SA	8,419	198	23	26	82	32
2978	SC	13,512	141	134	19	209	21	3053	SA	8,033	191	24	25	82	34	3122	SC	12,356	144	121	21	212	22
2979	SC	12,420	142	115	21	211	23	3055	SC	11,607	117	132	18	188	19	3123	SA	9,239	210	26	28	81	36
2981	SC	10,803	130	108	18	192	22	3056	SC	12,257	141	117	23	212	23	5823	SA	9,069	202	24	30	80	34
2983	SA	8,432	194	26	27	76	32	3058	SC	11,246	134	113	20	203	23	5824	SC	12,677	140	107	21	203	22
2984	SC	11,402	141	114	21	209	23	3059	SA	8,962	211	26	26	79	33	5825	SC	11,618	121	104	19	185	19
2986	SC	12,294	143	114	20	192	20	3061	SC	13,711	155	123	22	213	20	5826	SA	9,707	197	26	24	88	36
2989	SB2	9,287	210	30	15	101	22	3062	SA	8,896	206	27	29	86	37	5827	SA	20,427	190	26	30	87	35
2991	SC	10,683	130	101	21	189	20	3064	SC	12,165	148	123	20	215	23	5829	SC	10,311	135	113	20	196	20
2993	SC	11,310	131	116	23	206	21	3065	SC	11,279	143	118	21	213	22	5830	SC	13,037	143	116	21	199	21
2994	SC	14,047	158	130	21	210	23	3067	SC	10,080	121	94	20	178	19	5831	SC	12,810	146	119	21	215	24
2995	SC	15,179	146	120	18	195	19	3068	SC	12,668	136	156	17	204	20	5832	SA	8,663	197	27	26	85	37
2996	SA	8,834	196	25	25	71	34	3069	SA	8,910	213	30	29	96	39	5833	SC	11,959	143	112	23	204	23
2998	SC	11,314	133	113	18	200	23	3070	SC	11,409	136	109	22	208	24	5834	SC	10,350	132	104	19	193	20
2999	SA	8,590	199	26	27	78	34	3072	SA	8,861	203	27	28	82	36	5835	SA	8,055	185	24	27	76	33
3000	SC	11,240	141	112	19	203	18	3073	SC	12,408	142	118	21	209	22	5836	SC	9,798	123	98	19	181	21
3001	SC	11,648	144	117	19	206	22	3074	SC	11,543	147	121	19	209	23	5857	SA	8,575	188	26	25	77	34
3002	SA	8,232	189	23	29	79	36	3077	SC	12,343	130	146	20	205	22	5858	SA	9,826	207	27	25	82	30
3003	SC	10,904	136	109	21	198	19	3079	SC	12,178	136	111	23	207	22	5859	SB2	9,409	205	30	15	100	19
3004	SA	9,864	209	25	24	73	31	3080	SA	8,824	203	26	28	79	35	5860	SC	11,428	135	107	21	196	23
3006	SC	11,536	143	120	22	206	21	3081	SA	8,890	201	24	26	80	36								

plasma mass spectrometry (LA-ICP-MS), at the University of Missouri Research Reactor (Lai et al. 2006; Speakman et al. 2007).

In this study, an additional 155 artifacts were tested using a Bruker Tracer III–V portable X-ray fluorescence spectrometer. This instrument, which is entirely non-destructive, was previously tested on geological samples to demonstrate that it could differentiate all of the Mediterranean sources and subsources. A specific "obsidian" filter (12 mil Al + 1 mil Ti + 6 mil Cu) was used to enhance results for certain elements known to be useful for sourcing obsidian, while the analysis settings chosen were 40.00 kV, 10.00 μA, and 300 s. The results were calibrated against known obsidian samples used in multiple laboratories, including the Missouri University Research Reactor and the Smithsonian Institution (Table 1). Geological samples from all of the Monte Arci subsources were also tested with the exact same instrument.

It is fairly straightforward to distinguish chemically between the Monte Arci subsources, by LA-ICP-MS and pXRF, using simple X–Y plots of a few elements (Fig. 2).

The results clearly indicate that type SC obsidian is the most represented, while type SB2 is barely present (seven samples), and thus match with studies done for other Late Neolithic sites in Sardinia and Corsica (Fig. 3).

5 Discussion

The study of such a large collection of obsidian artifacts at the open-air Late Neolithic site of Contraguda is significant both for the methodological approaches used, which are non-destructive and of modest cost, and for the archaeological

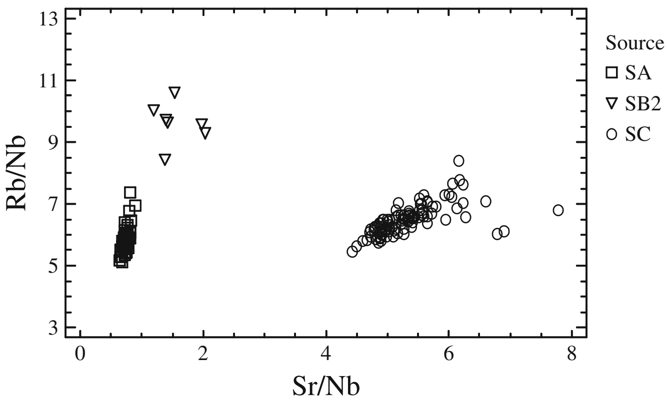

Fig. 2 Simple X–Y plot of rubidium/niobium (Rb/Nb) vs. strontium/niobium (Sr/Nb) for all of the Contraguda obsidian artifacts tested by pXRF, distinguishing between the three Monte Arci obsidian subsources (SA, SB2, SC)

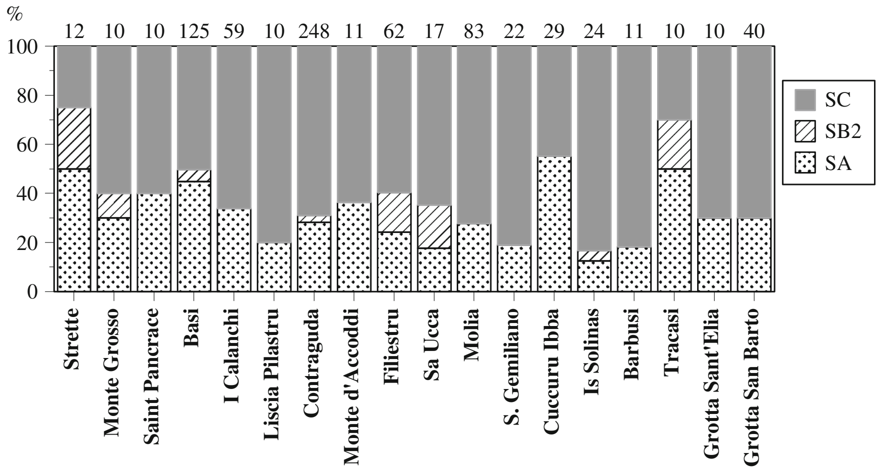

Fig. 3 Monte Arci subsource frequency at Late Neolithic sites in Corsica and Sardinia with ten or more chemical analyses done (number of samples on *top* of each bar)

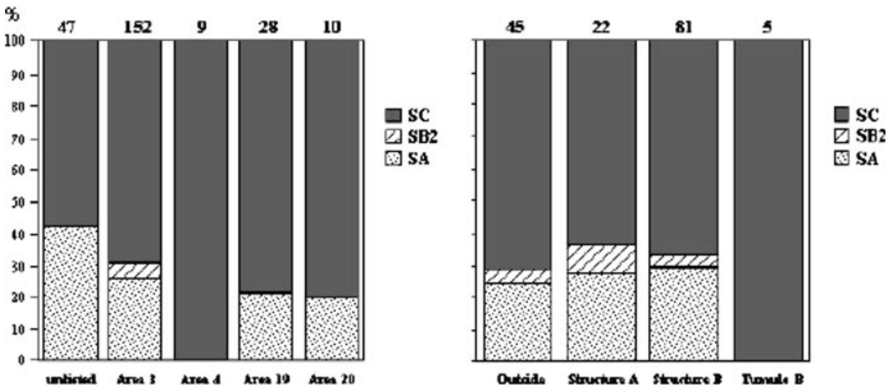

Fig. 4 Comparison of obsidian subsources present in different areas of the Contraguda site (*left*), and within Area 3 (*right*). The number of samples tested is at the top of each bar

significance of the findings. First, it is clear that a statistically significant number of samples should always be tested in order to reveal any patterns in obsidian acquisition, use, and discard. Use-wear studies on many of the obsidian samples tested already suggest that type SC obsidian was used for processing more hard inorganic materials than type SA, while SA was used to process more medium hard inorganic materials (Setzer et al. 2004). It has also been shown that density measurements and visual examination by experienced individuals can potentially provide a reasonable overview of Monte Arci obsidian subsource usage, especially the percentages of the SA and SC subsources. More significantly, the analysis of obsidian artifacts from different areas of the Contraguda site show some variation in subsource usage (Fig. 4). While the 47 general finds (from localities outside Areas 3, 4, 19 and 20) from the site are approximately 42% SA and 58% SC, the four excavated Areas have much greater percentages of SC, especially Area 4 (albeit only nine artifacts tested).

The importance of selecting samples from specific site features is quite clear when we focus on Area 3, where there is the one structure found at Contraguda. Within Area 3, at the tumulus, there is a modest cluster (five pieces) of entirely type SC obsidian, comparable to the similar cluster in Area 4, while found within the other parts of Area 3 were all of the SB2 obsidian artifacts. The proportions of SA and SC are quite similar between all parts of Area 3 except for the tumulus, and have more SA represented than in Areas 19 and 20.

6 Conclusion

The analyses of such a large number of artifacts from specific contexts at a single site provide statistically significant data about obsidian subsource selection and use, which may be combined with lithic technology, use-wear studies, and other contextual information to reconstruct the chaîne opératoire for this important period in Sardinian prehistory. This type of detailed sourcing study, using non-destructive portable XRF analysis, may also make major contributions in other areas of Italy and beyond.

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