X-Ray Fluorescence Analysis and Obsidian Hydration Measurement of Artifact Obsidian from Several Sites in the Mojave National Preserve, San Bernardino County, California

Craig E. Skinner and Jennifer J. Thatcher
Northwest Research Obsidian Studies Laboratory

Thirty-two obsidian artifacts from 15 archaeological sites located within the Mojave National Preserve, San Bernardino County, California, were submitted for energy dispersive X-ray fluorescence trace element provenance analysis. The specimens were also processed for hydration rim measurements. The samples were prepared and analyzed at the Northwest Research Obsidian Studies Laboratory under the accession number 2006-116.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the samples was completed using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area 30 mm^2. Signals from the spectrometer are amplified and filtered by a time variant pulse processor and sent to a 100 MHZ Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a rhodium target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 4 to 50 kV. For the elements Zn, Rb, Sr, Y, Zr, Nb, and Pb that are reported in Table A-1, we analyzed the collection with a collimator installed and used a 45 kV tube voltage setting and 0.60 mA tube current setting.

The diagnostic trace element values used to characterize the samples are compared directly to those for known obsidian sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2006a). Artifacts are correlated to a parent obsidian source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Obsidian Hydration Analysis. An appropriate section of each artifact is selected for hydration slide preparation. Two parallel cuts are made into the edge of the artifact using a lapidary saw equipped with 4-inch diameter diamond-impregnated .004" thick blades. The resultant cross-section of the artifact (approximately one millimeter thick) is removed and mounted on a petrographic microscope slide with Lakeside thermoplastic cement and is then ground to a final thickness of 30-50 microns.

The prepared slide is measured using an Olympus BHT petrographic microscope fitted with a video micrometer unit and a digital imaging video camera. When a clearly defined hydration layer is identified, the section is centered in the field of view to minimize parallax effects. Four rim measurements are typically recorded for each artifact or examined surface. Hydration rinds smaller than

one micron often cannot be resolved by optical microscopy. Hydration thicknesses are reported to the nearest 0.1 μm and represent the mean value for all readings. Standard deviation values for each measured surface indicate the variability for hydration thickness measurements recorded for each specimen. It is important to note that these values reflect only the reading uncertainty of the rim values and do not take into account the resolution limitations of the microscope or other sources of uncertainty that enter into the formation of hydration rims.

Additional details about specific analytical methods and procedures used for the analysis of the elements reported in Table A-1 and the preparation and measurement of hydration rims are available at the Northwest Research Obsidian Studies Laboratory World Wide Web site at *www.obsidianlab.com* (Northwest Research 2006a).

Results of Analysis

X-Ray Fluorescence Analysis. Thirteen geochemical groups, 12 of which were correlated with known obsidian sources, were identified among the 32 obsidian artifacts that were characterized by X-ray fluorescence analysis. The locations of the sites and the identified obsidian sources are shown in Figure 1. Analytical results are presented in Table A-1 in the Appendix and are summarized in Table 1 and Figure 2.

Figure 1. Locations of the sites and the sources of the artifacts.

Table 1. Summary of results of trace element studies of artifacts from the sites. Table is continued on next page.

Project Site	Obsidian Sources							
	Bodie Hills	Bristol Mountains	Castle Mountain	Coso (Joshua Ridge)	Coso (Sugarloaf Mountain)?	Coso (West Sugarloaf)	Coso Volcanic Field	Hackberry Mountain
Budweiser Spring (BUD a1)	–	1	–	–	–	–	–	–
CA-SBR-388	–	–	–	–	1	–	–	–
CA-SBR-395	–	–	–	–	–	–	1	–
CA-SBR-1241 (MOJA 869)	–	–	–	1	–	–	–	–
CA-SBR-2011 (MOJA 642)	–	–	1	–	–	–	–	–
CA-SBR-2032	–	–	–	–	–	–	–	–
CA-SBR-2696	–	–	–	–	–	1	–	1
CA-SBR-8271	–	1	–	–	–	–	–	–
CA-SBR-11445	–	1	–	–	–	–	–	–
Castle Peaks Area	–	–	7	–	–	–	–	–
Cave Shelter Site	–	–	–	–	–	–	–	1
DC-01	–	–	–	–	–	–	–	–
Ford Lake (ROC A10)	–	–	–	–	–	–	–	1
Rock Spring (ROC A7)	–	–	–	–	–	–	–	1
Silver Buddy Mine	3	–	–	–	–	2	–	–
Total	**3**	**3**	**8**	**1**	**1**	**3**	**1**	**4**

Table 1 (continued). Summary of results of trace element studies of artifacts from the sites.

Project Site	Obsidian Sources					Total
	Kane Springs Wash Caldera Variety 1	Mt. Hicks	Queen	Unknown 1	Wild Horse Canyon	
Budweiser Spring (BUD a1)	–	–	–	–	–	1
CA-SBR-388	–	–	–	–	–	1
CA-SBR-395	–	–	–	–	–	1
CA-SBR-1241 (MOJA 869)	–	–	–	–	–	1
CA-SBR-2011 (MOJA 642)	–	–	–	–	–	1
CA-SBR-2032	–	–	–	–	3	3
CA-SBR-2696	–	–	–	–	–	2
CA-SBR-8271	–	–	–	–	–	1
CA-SBR-11445	–	–	–	–	–	1
Castle Peaks Area	–	–	–	–	–	7
Cave Shelter Site	–	–	–	2	–	3
DC-01	1	–	–	–	–	1
Ford Lake (ROC A10)	–	–	–	–	–	1
Rock Spring (ROC A7)	–	–	–	–	–	1
Silver Buddy Mine	–	1	1	–	–	7
Total	**1**	**1**	**1**	**2**	**3**	**32**

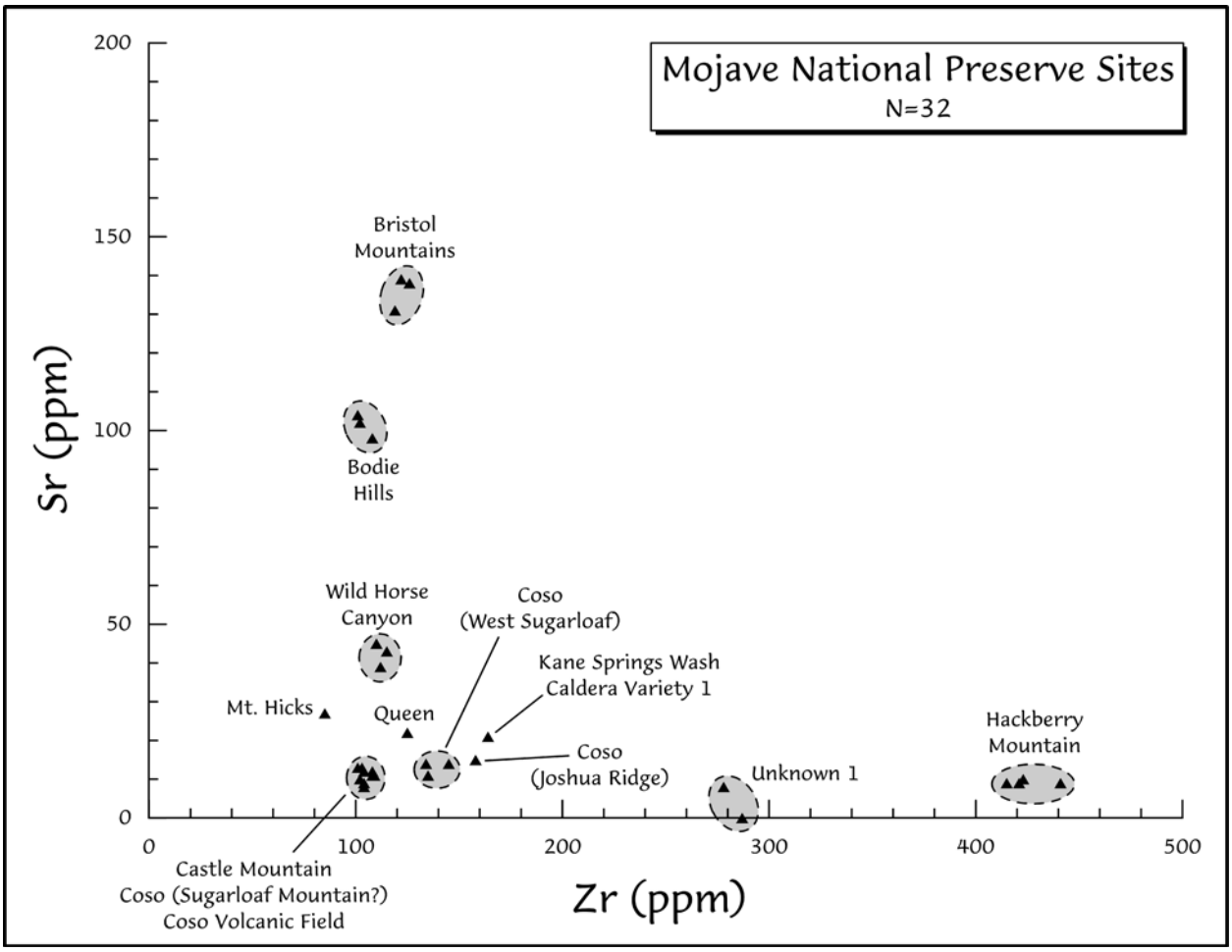

Figure 2. Scatterplot of zirconium (Zr) plotted versus strontium (Sr) for all analyzed artifacts.

The local Castle Mountain, Hackberry Mountain, and Bristol Mountains obsidian sources are described by Christensen et al. (2001), Hewett (1956), Shackley (1994), Torres (1998), and Wilke and Schroth (1989). The majority of the remaining obsidian sources identified in the current investigation are covered by Ericson (1981), Ericson et al. (1976), Gilreath and Hildebrandt (1997), Haarklau et al. (2005), Hughes (1988), and Moore (1997).

Additional descriptive information about the obsidian sources identified in the current investigation may be found at *www.sourcecatalog.com* (Northwest Research 2006b).

Obsidian Hydration Analysis. The 32 obsidian artifacts that were characterized by X-ray fluorescence analysis were prepared for obsidian hydration analysis and yielded 25 measurable rims. The specimen slides are curated at the Northwest Research Obsidian Studies Laboratory under accession number 2006-116. The results are reported in Table B-1 in the Appendix and are summarized in Table 2.

Table 2. Summary of results of obsidian hydration analysis of artifacts. Table is continued on next page.

Project Site	Hydration Rim Measurements (microns)							
	Bodie Hills	**Bristol Mountains**	**Castle Mountain**	**Coso (Joshua Ridge)**	**Coso (Sugarloaf Mountain)?**	**Coso (West Sugarloaf)**	**Coso Volcanic Field**	**Hackberry Mountain**
Budweiser Spring (BUD a1)	–	1.9	–	–	–	–	–	–
CA-SBR-388	–	–	–	–	4.1	–	–	–
CA-SBR-395	–	–	–	–	–	–	5.0	–
CA-SBR-1241 (MOJA 869)	–	–	–	7.0, 11.1	–	–	–	–
CA-SBR-2011 (MOJA 642)	–	–	2.1	–	–	–	–	–
CA-SBR-2032	–	–	–	–	–	–	–	–
CA-SBR-2696	–	–	–	–	–	7.5	–	4.3
CA-SBR-8271	–	2.4	–	–	–	–	–	–
CA-SBR-11445	–	1.5	–	–	–	–	–	–
Castle Peaks Area	–	–	3.2, 4.0, 4.1, 4.2 5.3, 5.4, 7.7	–	–	–	–	–
Cave Shelter Site	–	–	–	–	–	–	–	3.5
DC-01	–	–	–	–	–	–	–	–
Ford Lake (ROC A10)	–	–	–	–	–	–	–	6.2
Rock Spring (ROC A7)	–	–	–	–	–	–	–	7.6
Silver Buddy Mine	0	–	–	–	–	4.4, 6.7	–	–
Total	**0**	**3**	**8**	**2**	**1**	**3**	**1**	**4**

Table 2 (continued). Summary of results of obsidian hydration analysis of artifacts.

Project Site	Hydration Rim Measurements (microns)					Total
	Kane Springs Wash Caldera Variety 1	Mt. Hicks	Queen	Unknown 1	Wild Horse Canyon	
Budweiser Spring (BUD a1)	–	–	–	–	–	1
CA-SBR-388	–	–	–	–	–	1
CA-SBR-395	–	–	–	–	–	2
CA-SBR-1241 (MOJA 869)	–	–	–	–	–	1
CA-SBR-2011 (MOJA 642)	–	–	–	–	–	1
CA-SBR-2032	–	–	–	–	0	0
CA-SBR-2696	–	–	–	–	–	2
CA-SBR-8271	–	–	–	–	–	1
CA-SBR-11445	–	–	–	–	–	1
Castle Peaks Area	–	–	–	–	–	7
Cave Shelter Site	–	–	–	2.2, 7.1	–	3
DC-01	9.1	–	–	–	–	1
Ford Lake (ROC A10)	–	–	–	–	–	1
Rock Spring (ROC A7)	–	–	–	–	–	1
Silver Buddy Mine	–	0	0	–	–	2
Total	**1**	**0**	**0**	**2**	**0**	**25**

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Appendix

Results of X-Ray Fluorescence and Obsidian Hydration Analysis

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Table A-1. Results of XRF Studies: Several Sites in the Mojave National Preserve, San Bernardino County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^2O^{3T}	Fe:Mn	Fe:Ti	
Cave Shelter Site	1	MOJA-1	93	30	170	9	49	441	38	1226	701	0	1.30	15.7	36.0	Hackberry Mountain
			± 12	6	5	11	3	10	2	90	28	31	0.11			
Cave Shelter Site	2	MOJA-2	88	35	165	8	45	278	31	1216	560	0	0.98	15.1	27.8	Unknown 1
			± 11	5	5	28	3	10	2	90	28	31	0.11			
Cave Shelter Site	3	MOJA-3	62	25	158	ND	44	287	37	681	402	0	0.74	16.2	37.3	Unknown 1
			± 12	6	5	ND	3	10	2	89	28	31	0.11			
CA-SBr-388	4	MOJA-4	25	36	251	8	42	104	36	NM	NM	NM	NM	13.1	69.7	Coso (Sugarloaf Mountain)? *
			± 13	5	5	15	3	10	2	NM	NM	NM	NM			
CA-SBr-2032	5	MOJA-5	23	30	191	45	24	110	22	NM	NM	NM	NM	19.7	34.9	Wild Horse Canyon *
			± 13	5	5	9	3	10	2	NM	NM	NM	NM			
CA-SBr-2032	6	MOJA-6	17	36	185	39	20	112	20	NM	NM	NM	NM	19.7	34.9	Wild Horse Canyon *
			± 16	5	5	9	3	10	2	NM	NM	NM	NM			
CA-SBr-2032	7	MOJA-7	39	34	196	43	21	115	24	NM	NM	NM	NM	21.1	34.3	Wild Horse Canyon *
			± 11	5	5	9	3	10	2	NM	NM	NM	NM			
CA-SBr-395	8	MOJA-8	27	28	270	9	39	104	33	NM	NM	NM	NM	14.1	54.1	Coso Volcanic Field *
			± 14	6	5	11	3	10	2	NM	NM	NM	NM			
CA-SBr-2696	9	MOJA-9	97	28	158	10	51	423	38	NM	NM	NM	NM	16.6	33.0	Hackberry Mountain *
			± 11	5	5	10	3	10	2	NM	NM	NM	NM			
CA-SBr-2696	10	MOJA-10	58	24	254	14	48	145	43	NM	NM	NM	NM	44.6	94.6	Coso (West Sugarloaf) *
			± 11	6	5	9	3	10	2	NM	NM	NM	NM			
CA-SBr-8271	11	MOJA-11	66	29	183	139	20	122	21	959	294	667	0.66	20.1	24.2	Bristol Mountains
			± 10	5	5	9	3	10	2	90	27	32	0.11			
CA-SBr-11445	12	MOJA-12	31	20	178	138	22	126	20	958	293	688	0.77	23.4	28.1	Bristol Mountains
			± 12	6	5	9	3	10	2	90	27	32	0.11			
DC-01	13	MOJA-13	53	23	178	21	48	164	33	788	169	43	1.00	52.0	43.0	Kane Springs Wash Caldera Variety 1
			± 11	5	5	9	3	10	2	89	27	33	0.11			
CA-SBr-2011	14	MOJA-14	30	25	192	13	31	103	26	747	391	0	0.65	14.8	30.4	Castle Mountain
			± 12	5	5	9	3	10	2	89	28	31	0.11			
CA-SBr-1241	15	MOJA-15	57	25	214	15	43	158	40	886	332	41	1.56	39.7	58.5	Coso (Joshua Ridge)
			± 10	5	5	9	3	10	2	90	28	33	0.11			
Castle Peaks Area	16	MOJA-16	36	24	192	11	31	108	25	NM	NM	NM	NM	17.5	52.6	Castle Mountain *
			± 11	5	5	10	3	10	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table A-1. Results of XRF Studies: Several Sites in the Mojave National Preserve, San Bernardino County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^2O^{3T}	Fe:Mn	Fe:Ti	
Castle Peaks Area	17	MOJA-17	30	20	211	12	31	108	26	NM	NM	29	NM	26.8	41.0	Castle Mountain *
			± 11	5	5	9	3	10	2	NM	NM	41	NM			
Castle Peaks Area	18	MOJA-18	32	22	181	13	29	101	26	NM	NM	16	NM	19.8	24.3	Castle Mountain *
			± 12	5	5	9	3	10	2	NM	NM	31	NM			
Castle Peaks Area	19	MOJA-19	40	22	201	11	31	109	26	NM	NM	17	NM	19.0	21.6	Castle Mountain *
			± 10	5	5	10	3	10	2	NM	NM	31	NM			
Castle Peaks Area	20	MOJA-20	14	20	189	10	32	102	25	NM	NM	NM	NM	19.8	50.3	Castle Mountain *
			± 19	5	5	10	3	10	2	NM	NM	NM	NM			
Castle Peaks Area	21	MOJA-21	32	14	186	12	30	104	21	438	382	20	0.65	15.2	50.4	Castle Mountain
			± 12	6	5	10	3	10	2	88	28	31	0.11			
Castle Peaks Area	22	MOJA-22	38	19	180	10	30	102	25	NM	NM	NM	NM	17.4	46.1	Castle Mountain *
			± 11	5	5	10	3	10	2	NM	NM	NM	NM			
Budweiser Spring	23	MOJA-23	31	19	167	131	24	119	19	NM	NM	NM	NM	22.4	42.6	Bristol Mountains *
			± 12	6	5	9	3	10	2	NM	NM	NM	NM			
Ford Lake	24	MOJA-24	87	34	162	9	52	415	38	NM	NM	NM	NM	15.4	36.4	Hackberry Mountain *
			± 11	5	5	10	3	10	2	NM	NM	NM	NM			
Rock Spring	25	MOJA-25	109	30	166	9	52	421	35	NM	NM	15	NM	17.3	25.9	Hackberry Mountain *
			± 10	5	5	10	3	10	2	NM	NM	31	NM			
Silver Buddy Mine	26	MOJA-26	30	33	179	98	12	108	13	518	448	559	0.60	12.2	40.5	Bodie Hills
			± 12	5	5	9	3	10	2	89	28	32	0.11			
Silver Buddy Mine	27	MOJA-27	50	28	160	22	23	125	34	683	657	34	0.78	10.4	39.1	Queen
			± 11	5	5	9	3	10	2	89	28	35	0.11			
Silver Buddy Mine	28	MOJA-28	20	23	256	11	53	135	42	334	285	7	1.04	31.8	100.5	Coso (West Sugarloaf)
			± 14	5	5	10	3	10	2	88	27	31	0.11			
Silver Buddy Mine	29	MOJA-29	22	32	190	104	14	101	16	NM	NM	528	NM	12.2	18.1	Bodie Hills *
			± 13	5	5	9	3	10	2	NM	NM	33	NM			
Silver Buddy Mine	30	MOJA-30	55	34	279	14	52	134	46	268	207	29	0.95	40.5	112.5	Coso (West Sugarloaf)
			± 10	5	5	9	3	10	2	88	27	41	0.11			
Silver Buddy Mine	31	MOJA-31	34	34	182	102	13	102	18	654	399	536	0.62	14.0	33.2	Bodie Hills
			± 11	5	5	9	3	10	2	89	28	32	0.11			
Silver Buddy Mine	32	MOJA-32	23	33	152	27	14	85	16	NM	NM	NM	NM	13.2	16.5	Mt. Hicks *
			± 13	5	5	9	3	10	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table A-1. Results of XRF Studies: Several Sites in the Mojave National Preserve, San Bernardino County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe^{2}O^{3T}$	Fe:Mn	Fe:Ti	
NA	RGM-1	RGM-1	35	18	144	101	24	216	8	1601	371	786	1.76	40.0	37.0	RGM-1 Reference Standard
			± 12	5	5	9	3	10	2	92	28	32	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table B-1. Obsidian Hydration Results and Sample Provenience: Several Sites in the Mojave National Preserve, California

Site	Specimen No.	Catalog No.	Unit	Depth	Artifact Type[A]	Artifact Source	Hydration Rims		Comments[B]
							Rim 1	Rim 2	
Cave Shelter Site	1	MOJA-1	--	Surface	DEB	Hackberry Mountain	3.5 ± 0.0	NM ± NM	--
Cave Shelter Site	2	MOJA-2	--	Surface	DEB	Unknown 1	2.2 ± 0.1	NM ± NM	--
Cave Shelter Site	3	MOJA-3	--	Surface	DEB	Unknown 1	7.1 ± 0.1	NM ± NM	DFV
CA-SBr-388	4	MOJA-4	--	Surface	DEB	Coso (Sugarloaf Mountain)? *	4.1 ± 0.1	NM ± NM	--
CA-SBr-2032	5	MOJA-5	--	Surface	DEB	Wild Horse Canyon *	NA ± NA	NM ± NM	NVH
CA-SBr-2032	6	MOJA-6	--	Surface	DEB	Wild Horse Canyon *	NA ± NA	NM ± NM	NVH
CA-SBr-2032	7	MOJA-7	--	Surface	DEB	Wild Horse Canyon *	NA ± NA	NM ± NM	REC; NVH
CA-SBr-395	8	MOJA-8	--	Surface	DEB	Coso Volcanic Field *	5.0 ± 0.1	NM ± NM	REC
CA-SBr-2696	9	MOJA-9	--	Surface	DEB	Hackberry Mountain *	4.3 ± 0.0	NM ± NM	DFV
CA-SBr-2696	10	MOJA-10	--	Surface	DEB	Coso (West Sugarloaf) *	7.5 ± 0.1	NM ± NM	WEA, DFV
CA-SBr-8271	11	MOJA-11	--	Surface	DEB	Bristol Mountains	2.4 ± 0.0	NM ± NM	--
CA-SBr-11445	12	MOJA-12	--	--	DEB	Bristol Mountains	1.5 ± 0.1	NM ± NM	--
DC-01	13	MOJA-13	--	Surface	BIF	Kane Springs Wash Caldera Variety 1	9.1 ± 0.1	NM ± NM	Same rim on BRE
CA-SBr-2011	14	MOJA-14	--	Surface	DEB	Castle Mountain	2.1 ± 0.1	NM ± NM	--
CA-SBr-1241	15	MOJA-15	--	Surface	UNI	Coso (Joshua Ridge)	7.0 ± 0.1	11.1 ± 0.1	REC; small rim on dorsal margin
Castle Peaks Area	16	MOJA-16	--	Surface	DEB	Castle Mountain *	4.2 ± 0.0	NM ± NM	--
Castle Peaks Area	17	MOJA-17	--	Surface	DEB	Castle Mountain *	4.1 ± 0.1	NM ± NM	--
Castle Peaks Area	18	MOJA-18	--	Surface	DEB	Castle Mountain *	7.7 ± 0.1	NM ± NM	--
Castle Peaks Area	19	MOJA-19	--	Surface	DEB	Castle Mountain *	5.3 ± 0.1	NM ± NM	--
Castle Peaks Area	20	MOJA-20	--	Surface	DEB	Castle Mountain *	5.4 ± 0.1	NM ± NM	NVH on dorsal
Castle Peaks Area	21	MOJA-21	--	Surface	DEB	Castle Mountain	3.2 ± 0.1	NM ± NM	--
Castle Peaks Area	22	MOJA-22	--	Surface	DEB	Castle Mountain *	4.0 ± 0.1	NM ± NM	--
Budweiser Spring	23	MOJA-23	--	Surface	DEB	Bristol Mountains *	1.9 ± 0.1	NM ± NM	--

[A] BIF = Biface; DEB = Debitage; UNI = Uniface

[B] See text for explanation of comment abbreviations

NA = Not Available; NM = Not Measured; * = Small sample

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Table B-1. Obsidian Hydration Results and Sample Provenience: Several Sites in the Mojave National Preserve, California

Site	Specimen No.	Catalog No.	Unit	Depth	Artifact Type[A]	Artifact Source	Hydration Rims		Comments[B]
							Rim 1	Rim 2	
Ford Lake	24	MOJA-24	--	Surface	DEB	Hackberry Mountain *	6.2 ± 0.1	NM ± NM	REC; DFV
Rock Spring	25	MOJA-25	--	Surface	DEB	Hackberry Mountain *	7.6 ± 0.1	NM ± NM	--
Silver Buddy Mine	26	MOJA-26	--	Surface	BIF	Bodie Hills	NA ± NA	NM ± NM	REC; NVH (possibly burnt)
Silver Buddy Mine	27	MOJA-27	--	Surface	BIF	Queen	NA ± NA	NM ± NM	UNR (possibly burnt)
Silver Buddy Mine	28	MOJA-28	--	Surface	BIF	Coso (West Sugarloaf)	4.4 ± 0.1	NM ± NM	--
Silver Buddy Mine	29	MOJA-29	--	Surface	BIF	Bodie Hills *	NA ± NA	NM ± NM	NVH (possibly burnt)
Silver Buddy Mine	30	MOJA-30	--	Surface	BIF	Coso (West Sugarloaf)	6.7 ± 0.1	NM ± NM	--
Silver Buddy Mine	31	MOJA-31	--	Surface	BIF	Bodie Hills	NA ± NA	NM ± NM	UNR (crystalline)
Silver Buddy Mine	32	MOJA-32	--	Surface	BIF	Mt. Hicks *	NA ± NA	NM ± NM	UNR (possibly burnt)

[A] BIF = Biface; DEB = Debitage; UNI = Uniface

[B] See text for explanation of comment abbreviations
NA = Not Available; NM = Not Measured; * = Small sample

Abbreviations and Definitions Used in the Comments Column

All hydration rim measurements are recorded in microns.

BEV - (Beveled). Artifact morphology or cut configuration resulted in a beveled thin section edge.

BRE - (BREak). The thin section cut was made across a broken edge of the artifact. Resulting hydration measurements may reveal when the artifact was broken, relative to its time of manufacture.

DES - (DEStroyed). The artifact or flake was destroyed in the process of thin section preparation. This sometimes occurs during the preparation of extremely small items, such as pressure flakes.

DFV - (Diffusion Front Vague). The diffusion front, or the visual boundary between hydrated and unhydrated portions of the specimen, are poorly defined. This can result in less precise measurements than can be obtained from sharply demarcated diffusion fronts. The technician must often estimate the hydration boundary because a vague diffusion front often appears as a relatively thick, dark line or a gradation in color or brightness between hydrated and unhydrated layers.

DIS - (DIScontinuous). A discontinuous or interrupted hydration rind was observed on the thin section.

HV - (Highly Variable). The hydration rind exhibits variable thickness along continuous surfaces. This variability can occur with very well- defined bands as well as those with irregular or vague diffusion fronts.

IRR - (IRRegular). The surfaces of the thin section (the outer surfaces of the artifact) are uneven and measurement is difficult.

1SO - (1 Surface Only). Hydration was observed on only one surface or side of the thin section.

NOT - (NOT obsidian). Petrographic characteristics of the artifact or obsidian specimen indicate that the specimen is not obsidian.

NVH - (No Visible Hydration). No hydration rind was observed on one or more surfaces of the specimen. This does not mean that hydration is absent, only that hydration was not observed. Hydration rinds smaller than one micron often are not birefringent and thus cannot be seen by optical microscopy. "NVH" may be reported for the manufacture surface of a tool while a hydration measurement is reported for another surface, e.g. a remnant ventral flake surface.

OPA - (OPAque). The specimen is too opaque for measurement and cannot be further reduced in thickness.

PAT - (PATinated). This description is usually noted when there is a problem in measuring the thickness of the hydration rind, and refers to the unmagnified surface characteristics of the artifact, possibly indicating the source of the measurement problem. Only extreme patination is normally noted.

REC - (RECut). More than one thin section was prepared from an archaeological specimen. Multiple thin sections are made if preparation quality on the initial specimen is suspect or obviously poor. Additional thin sections may also be prepared if it is perceived that more information concerning an artifact's manufacture or use can be obtained.

UNR - (UNReadable). The optical quality of the hydration rind is so poor that accurate measurement is not possible. Poor thin section preparation is not a cause.

WEA - (WEAthered). The artifact surface appears to be damaged by wind erosion or other mechanical action.