5

Elemental Analysis of Obsidian Samples from Pacific Nicaragua and from Northwest Costa Rica

FRED STROSS, FRANK ASARO,
HELEN MICHEL

Lawrence Berkeley Laboratory
(with comments by Payson Sheets and Fred Lange)

X-ray fluorescence (XRF) and neutron activation (NAA) analyses of 14 selected Nicaraguan obsidian samples (received from P. Sheets; Figures 5.1, 5.2, and 5.3) and four selected Costa Rican samples (received from F. Lange; Figure 5.4) were carried out at the Lawrence Berkeley Laboratory at the University of California (Table 5.1). Nine of the Nicaraguan obsidian specimens were artifacts, and the other 5 were source, or probable source, samples. Three of the Costa Rican samples were artifacts and one was a suspected source sample.

The Nicaraguan Samples

The nine Nicaraguan artifacts fell into two homogeneous groups. NICA–9, –10, and –12 (all prismatic blade fragments) match the Ixtepeque (Guatemala) source on the basis of X-ray fluorescence analysis (Table 5.2). This assignment for NICA–9 was confirmed by an "abbreviated" neutron activation analysis (Table 5.3). We consider a confirmation by NAA of the provenience assignment of one member of a group defined by XRF measurement as a confirmation of the entire group. The other six artifacts fell into a group of matching compositions that on the basis of XRF matches the newly discovered Güinope source in southeastern Honduras (Table 5.2). In order to obtain a better chemical description of the source, we completed our neutron activation measurements on two of three samples (NICA–6 and NICA–8) and carried out an additional "abbreviated" NAA on another one (NICA–11). These are shown with the newly developed Güinope reference values, also from a completed NAA run, in Table 5.4.

The five non-artifactual samples all appeared to be chemically different from each other (Table 5.2) and from any other samples we had measured before. The two pebbles from the northeast shore of Lake Nicaragua appear to be obsidian, but the three pebbles from Luisitio have compositions much different from obsidian (Table 5.2). Although peralkaline obsidian could have greatly enhanced abundances of iron and other elements, such obsidian would also be likely to have much higher cerium abundances than measured. The observed compositions in NICA–3, –4, and –5 are closer to expectations for compositions typical of basalts rather than those of obsidian.

The two nodules found on the eastern shore of Lake Nicaragua may be from two different sources near there (Table 5.2). Because these nodules were likely to be source samples, a detailed NAA study was useful (Table 5.5).

The Costa Rican Samples

After the Pacific Nicaraguan obsidian samples had been run, two obsidian samples from the Río Sapoa/Bay of Salinas area of northwest Costa Rica, and two others from the Vidor site on the Bay of Culebra were received from Lange. Distribution of obsidian in the southern sector of Greater Nicoya is limited almost exclusively to the Nicaraguan-Costa Rican border area, and the potential relationships between the northern sector (Nicaraguan) and southern sector (Costa Rican) samples were of interest.

The four artifacts (Figure 5.4) were analyzed by XRF (Table 5.6). Three were found to correlate tentatively with obsidian sources or possible sources having compositions previously known to us, i.e., Ixtepeque and Río Pixcaya (Guatemala), and a possible source near the northeast shore of Lake Nicaragua (collected by Sheets on the 1983 Nicaraguan survey). The fourth artifact had a composition matching the Güinope source. Abbreviated NAA measurements were made on the Costa Rican samples (Tables 5.4, 5.5, and 5.7). The assignment of COST–4 to the Río Pixcaya, Guatemala source was also confirmed. An NAA run on COST–1 was completed.

The source of Costa Rica no. 86 (COST–2) and NICA–6, –7, –8, –11, –13, and –14 is now known to be Güinope. Figure 5.5 shows the locations of the different obsidian sources currently associated with Greater Nicoya sites.

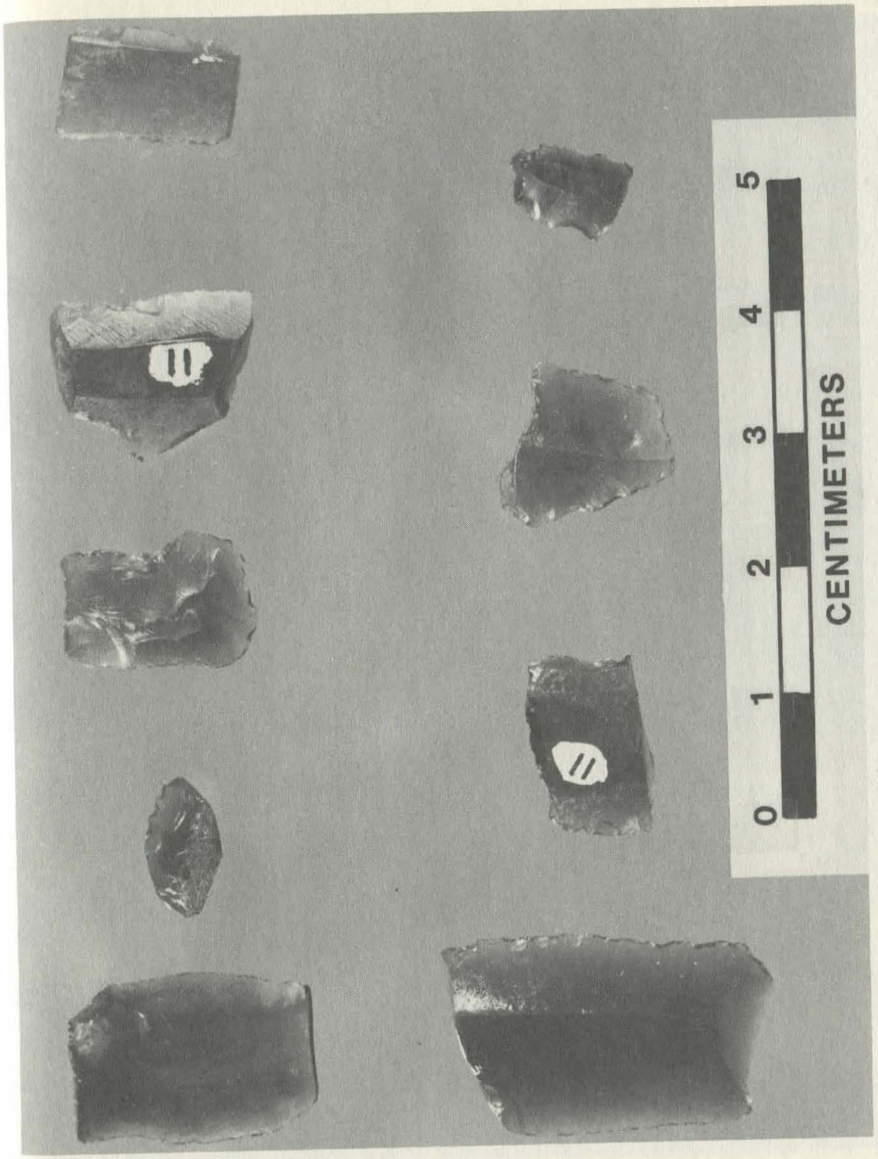

Figure 5.1. La Ceiba Sur, prismatic obsidian blades, closeup views. Top row, second from left is platform.

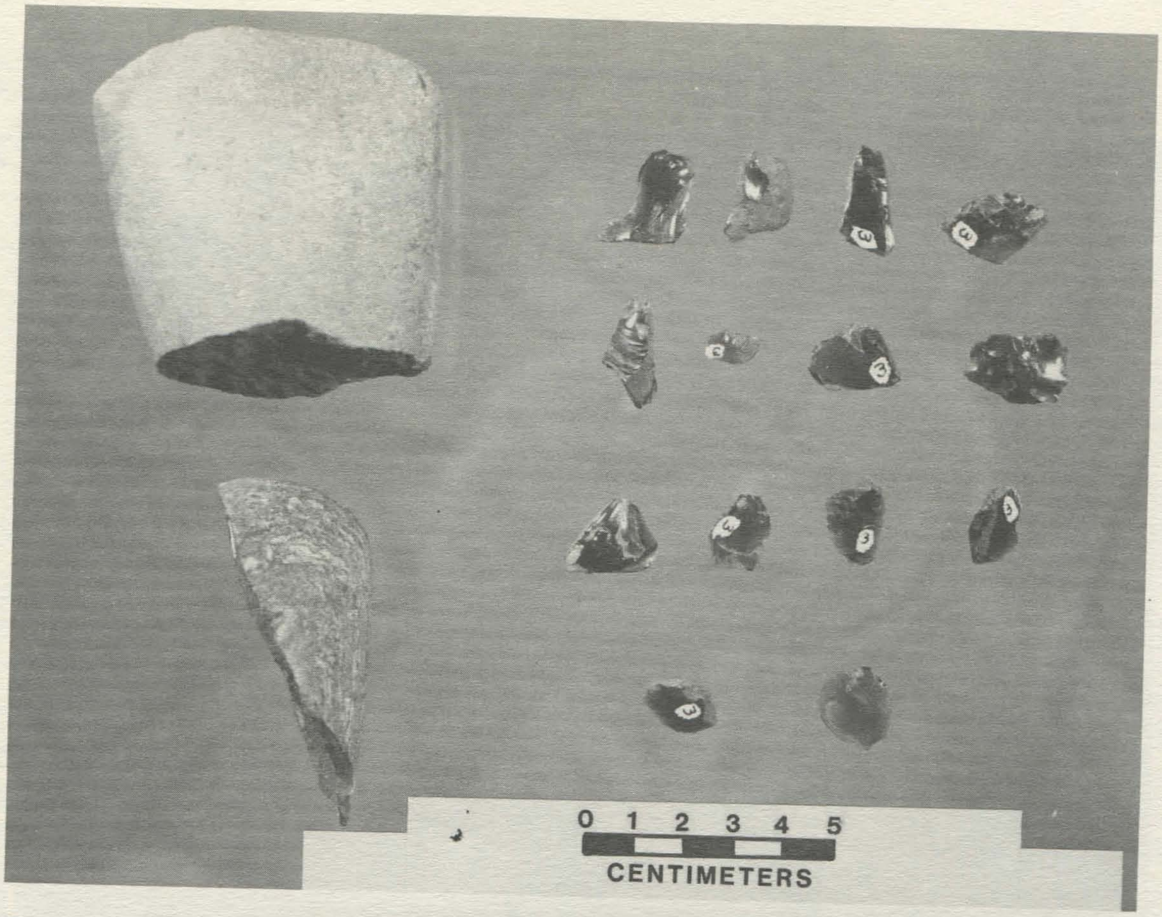

Figure 5.2. San Antonio. Two groundstone celts, 14 obsidian percussion flakes shown with dorsal side up, platforms at the top.

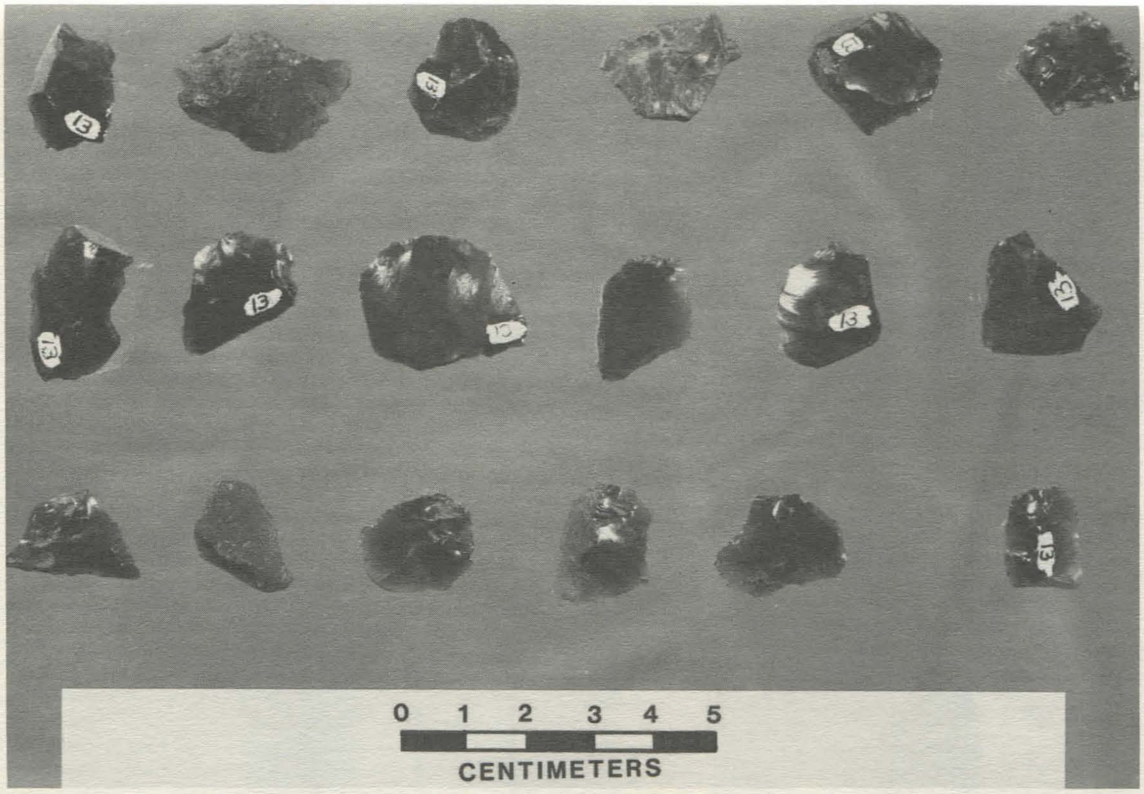

Figure 5.3. Luisitio, representative obsidian. Top: percussion flake cores; note cortex on first, second, and fifth. Middle: percussion flakes, ventral sides showing with platforms at top; note cortex platform on first. Bottom: Percussion flakes, dorsal sides shown; note cortex on second and fourth. The last item (extreme bottom right) is a prismatic blade, dorsal view.

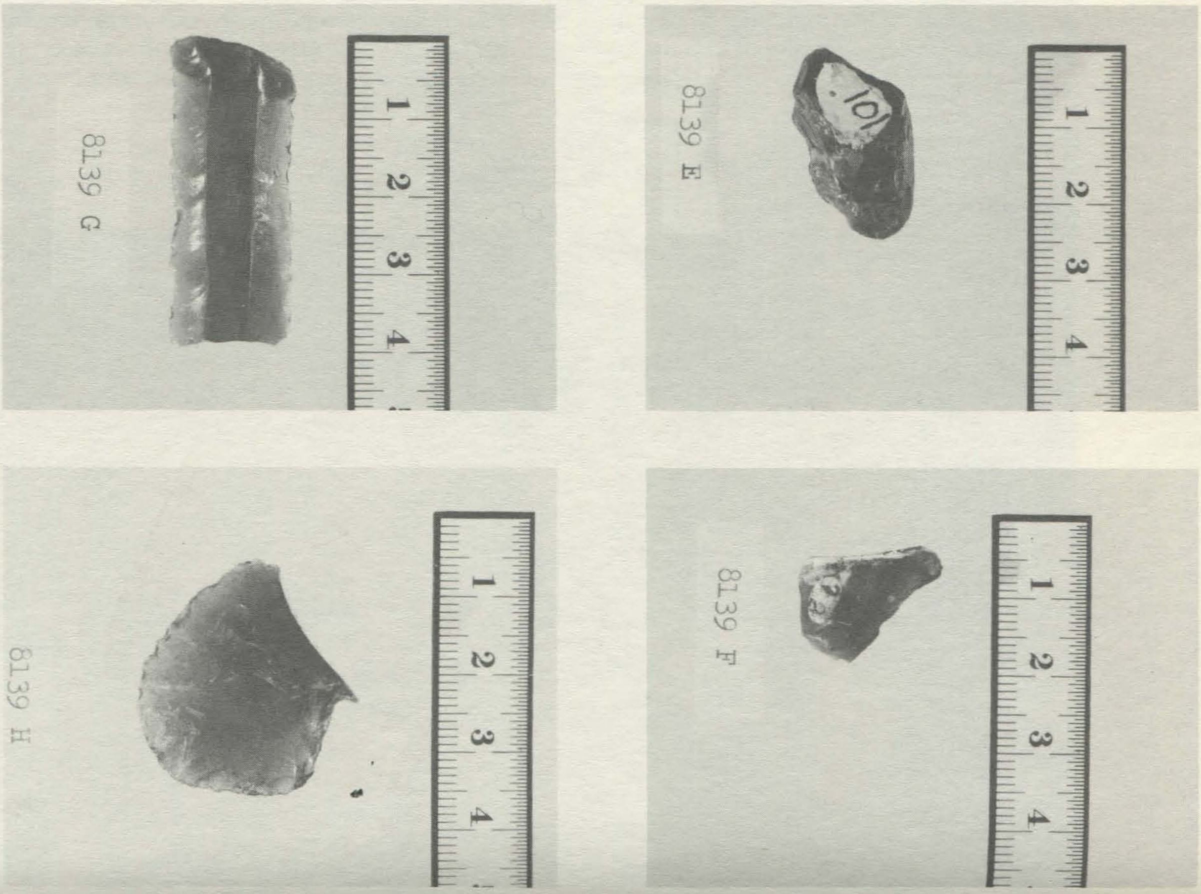

Figure 5.4. Costa Rican obsidian samples, Río Sapoa (8139F) and Bay of Culebra (8139G and 8139H). (Courtesy Lawrence Berkeley Laboratory.)

Table 5.1. Concordance of Nicaraguan and Costa Rican Obsidian Samples.

CONCORDANCE				
Description	LBL Sample	NAA Pill	XRF	Provenience
Payson Sheets, Nodule from NE Shore Lake Nicaragua	NICA-1	2208 J	8134-4	(possible source)
Payson Sheets, Nodule from NE Shore Lake Nicaragua	NICA-2	2208 K	8134-5	(possible source)
Payson Sheets, Luisitio Pebbles	NICA-3,-4,-5		8134-6,7,8	not obsidian
Payson Sheets, Nindiri Artifact	NICA-6	2121 W 2147 M	8134-9	Guinope
Payson Sheets, Nindiri Artifact	NICA-7		8134-+	Guinope
Payson Sheets, Nindiri Artifact	NICA-8	2161 T	8134-—	Guinope
Payson Sheets, Nindiri Artifact	NICA-9	2121 Y	8134-*	Ixtepeque
Payson Sheets, Nindiri Artifact	NICA-10		8134-1	Ixtepeque
Payson Sheets, Nindiri Artifact	NICA-11	2121 Z	8134-(	Guinope
Payson Sheets, Nindiri Artifact	NICA-12		8134-$	Ixtepeque
Payson Sheets, Nindiri Artifact	NICA-13		8134-.	Guinope
Payson Sheets, Nindiri Artifact	NICA-14		8134-]	Guinope
Fred Lange, #101 Bay of Salinas	COST-1	2188 J 2218-2	8139-E	like NICA-2
Fred Lange, #86 Rio Sapoa Valley	COST-2	2188 K 2207 W	8139-F	Guinope
Fred Lange, #3047 I-1-14 Vidor Site	COST-3	2188 M	8139-G	Ixtepeque
Fred Lange, #3047 I-1-3 Vidor Site	COST-4	2215 Z	8139-H	Rio Pixcaya
Honduras Source	LESP-5,-7	2237 X,Y	8150-E,F	La Esperanza
Honduras Source	GUIN-1	2237-Z	8150-G	Guinope

Table 5.2. Elemental Abundances and Ratios of Obsidian Artifacts and Pebbles from Nicaragua by X-Ray Fluorescence (XRF).

ELEMENTAL ABUNDANCES AND RATIOS, OF OBSIDIAN ARTIFACTS AND PEBBLES FROM NICARAGUA, BY X-RAY FLUORESCENCE

	Ba[a] (ppm)	Zr[a] (ppm)	Rb/Zr	Sr/Zr
Nindiri Artifacts				
Ixtepeque Provenience				
NICA-9	1127	216	.53	.88
NICA-10	1198	214	.54	.87
NICA-12	1229	204	.50	.81
Mean	1185	211	.52	.85
RMSD			.02	.04
Ixtepeque Reference[b]				
Abundance or ratio	1030	176	.57	.90
Error	27	6	.01	.02
Nindiri Artifacts				
Guinope Provenience				
NICA-6	1070	120	1.43	1.61
NICA-7	1038	128	1.39	1.64
NICA-8	1094	154	1.46	1.72
NICA-11	1173	138	1.38	1.60
NICA-13	1233	141	1.39	1.65
NICA-14	1082	138	1.42	1.69
Mean	1115	136	1.41	1.65
RMSD	73	12	.03	.05
Guinope Reference				
Abundance or ratio	1070	134	1.39	1.53
Error	44		.09	.09
N.E. Shore Lake Nicaragua Obsidian pebbles				
NICA-1	1629	191	.30	1.31
NICA-2	1848	256	.26	.48
Other pebbles[c] (Luisitio)				
NICA-3	1185	219	.23	2.5
NICA-4	1212	230	.4	2.2
NICA-5	1294	229	.26	1.9

[a] The abundance levels of these elements depend on the shapes and thickness of the samples and are only approximate. The use of ratios (Rb/Zr and Sr/Zr) of abundances largely compensates for these variations.

[b] See Asaro et al., 1978 and Stross et al., 1983.

[c] The three pebbles from Luisitio have similar unusual compositions, with iron abundances at ~6.5–8.5%, calcium ~5–7%, titanium ~1.2%, and cerium ~30 ppm. These pebbles are probably not obsidian, as their compositions are closer to that of basalt.

Table 5.3. Elemental Abundances of an Obsidian Artifact from Nindirí, Nicaragua, and Guatemala Reference, by Abbreviated NAA[a].

ELEMENTAL ABUNDANCES OF AN OBSIDIAN ARTIFACT FROM NINDIRI, NICARAGUA, AND GUATEMALA REFERENCE, BY ABBREVIATED NAA

	NICA-9 (Nindiri Artifact)	Ixtepeque reference[a]
Al,%	7.15 ± .10[b]	7.24 ± .20[c]
Ba, ppm	1041 ± 36	1030 ± 27
Dy, ppm	2.43 ± .12	2.30 ± .11
K, %	3.60 ± .29	3.61 ± .26
Mn, ppm	454 ± 9	449 ± 9
Na, %	3.13 ± .06	3.05 ± .06

[a] See Asaro et al., 1978, and Stross et al., 1983.

[b] Error is typical counting error.

[c] Error is root mean square deviation.

Table 5.4. Elemental Abundances of Obsidian Artifacts from Nindirí, Nicaragua, and from Río Sapoa, Costa Rica, and Güinope, Honduras, by NAA[a].

	NICA-6		NICA-8		NICA-11		COST-2		Reference: GUINOPE	
	Abund.	Error	Abund.	Error	Abund.	Error	Abund.	Error	Abund.	Error
% Al	6.92	.08	7.03	.09	6.92	.12			6.87	.17
Ba	1031	24	1010	34	1063	38	994	45	1000	20
Ce	51.2	.5	50.0	.9			50.2	.7	50.8	.8
Co	.51	.05	.46	.05			.53	.07	.59	.05
Cs	8.02	.11	7.98	.12			7.91	.13	7.88	.10
Dy	2.53	.12	2.61	.12	2.56	.12	2.40	.12	2.52	.10
Eu	.526	.009	.504	.009			.513	.008	.504	.008
% Fe	.878	.013	.875	.012			.872	.012	.872	.016
Hf	3.31	.06	3.16	.06			3.26	.06	3.28	.06
% K	3.59	.24	3.54	.29	3.36	.28	3.71	.26	4.09	.25
La	28.4	.5	28.0	.5			27.2	.7	28.3	.6
Mn	520	10	514	10	518	10	510	10	519	10
% Na	2.73	.05	2.73	.05	2.69	.05	2.71	.05	2.70	.05
Rb	181	11	168	7			163	6	161	20
Sb	.43	.07	.30	.05			.43	.06	.48	.07
Sc	2.14	.02	2.12	.02			2.19	.02	2.13	.02
Sm	3.05	.03	3.04	.03			3.07	.03	2.98	.03
Ta	.873	.009	.862	.009			.899	.009	.894	.009
Th	12.00	.12	12.02	.12			12.08	.12	12.06	.13
U	3.99	.04	3.95	.04			3.96	.04	3.93	.04
Yb	1.79	.03	1.78	.04			1.81	.03	1.82	.03

[a] In ppm except where otherwise indicated.

Table 5.5. Elemental abundances of obsidian artifacts from the N.E. shore of Lake Nicaragua and artifact from Costa Rica, by NAA[a].

Elements	NICA-1		NICA-2		COST-1	
	Abund.	Error	Abund.	Error	Abund.	Error
%Al	6.51	.15	6.15	.07		
Ba	1624	40	1873	47	1837	30
Ce	26.0	.45	39.9	.5	39.2	.07
Co	1.10	.06	.59	.08	.49	.07
Cs	1.76	.07	2.34	.12	2.32	.08
Dy	2.87	.14	7.69	.14	7.61	.15
Eu	.739	.010	1.137	.015	1.158	.016
%Fe	1.080	.012	1.175	.013	1.204	.014
Hf	4.35	.06	6.43	.08	6.36	.09
%K	2.54	.33	2.99	.31	3.61	.26
La	12.3	.5	17.1	.6	17.1	.4
Mn	640	13	611	12	591	12
%Na	3.27	.06	3.16	.06	3.10	.06
Rb	62.9	2.7	67.3	3.0	70.5	3.7
Sb	.38	.06	.79	.09	.55	.08
Sc	3.24	.03	9.13	.09	9.34	.09
Sm	2.71	.03	6.35	.06	6.43	.06
Ta	.268	.003	.280	.003	.284	.003
Th	3.13	.03	3.50	.04	3.51	.05
U	1.37	.02	1.50	.02	1.53	.03
Yb	2.58	.03	5.60	.05	5.48	.06

[a] In ppm except where otherwise indicated; errors are the 1σ uncertainties in counting x-rays.

Table 5.6. Elemental Abundances and Ratios of Obsidian Samples from Costa Rica, by XRF.

	Ba[a] (ppm)	Zr[a] (ppm)	Rb/Zr	Sr/Zr
Lake Nicaragua Provenience				
COST-1	1703	247	.27	.48
Error			.01	.01
Reference N.E. Shore Lake Nicaragua[b]	1848	256	.26	.48
Error			.02	.02
Guinope Provenience				
COST-2	996	123	1.27	1.52
Error			.03	.03
Reference Guinope[b]	1070	129	1.38	1.55
Error	44		.09	.09
Ixtepeque Provenience				
COST-3	996	193	.54	.88
Error			.01	.01
Reference Ixtepeque[c]	1030	176	.57	.90
Error	27	6	.02	.02
Rio Pixcaya Provenience				
COST-4	1044	123	.94	1.59
Error			.02	.02
Reference Rio Pixcaya[c]	1105	115	1.01	1.65
Error	32	3	.05	.06

[a] See note[a], Table 5.2.

[b] See Table 5.2.

[c] Stross, et al. 1983.

Table 5.7. Elemental Abundances of Obsidian Samples from Costa Rica, by Abbreviated NAA[a].

	Ba, ppm	Dy, ppm	K, %	Mn, ppm	Na, %
COST-3	1001	2.36	3.54	444	2.99
Error	28	.07	.16	9	.06
Reference Ixtepeque[b]	1030	2.30	3.61	449	3.05
Error	27	.11	.26	9	.06
COST-4	1078	2.22	3.91	513	2.93
Error	43	.11	.26	10	.06
Reference Rio Pixcaya[c]	1105	2.03	3.54	521	2.94
Error	32	.10	.25	10	.06

[a] See Tables 5.4 and 5.5 for COST-1 and COST-2 values.

[b] See Asaro et al., 1978, and Stross et al., 1983.

[c] Stross, et al. 1983.

Comments on the Nicaraguan Samples
(Payson Sheets)

Five of the samples subjected to elemental analysis by Stross, Asaro and Michel were natural, unworked, non-artifact source samples; the other nine were artifacts. It was hoped that some of the non-artifact source samples would match some of the artifact samples, and that a source to site exploitation model could be developed on the basis of solid analytical evidence. This attempt was largely successful.

As can be seen in Table 5.1, the unworked samples were obtained from the northeast shore of Lake Nicaragua and from a stream cut at the edge of Luisitio. Two specimens of non-artifact obsidian were found by a Juigalpa resident along the northeast shore of Lake Nicaragua in the "La Mesa" or "Puerto Díaz" area, approximately 20 km from Juigalpa. Chemically, these two nodules are sufficiently different from each other, and from the three collected near Luisitio (which do not appear to be obsidian), to indicate that two different sources lie somewhere to the north of Lake Nicaragua. One of these sources contributed an obsidian nodule that made its way into Costa Rica. The diversity shown in these non-artifact samples emphasizes the complexity of obsidian sources in Nicaragua and the amount of chemical analyses needed to distinguish sources and to attribute artifacts from sites to particular sources. Jaime Incer (personal communication 1983) stated

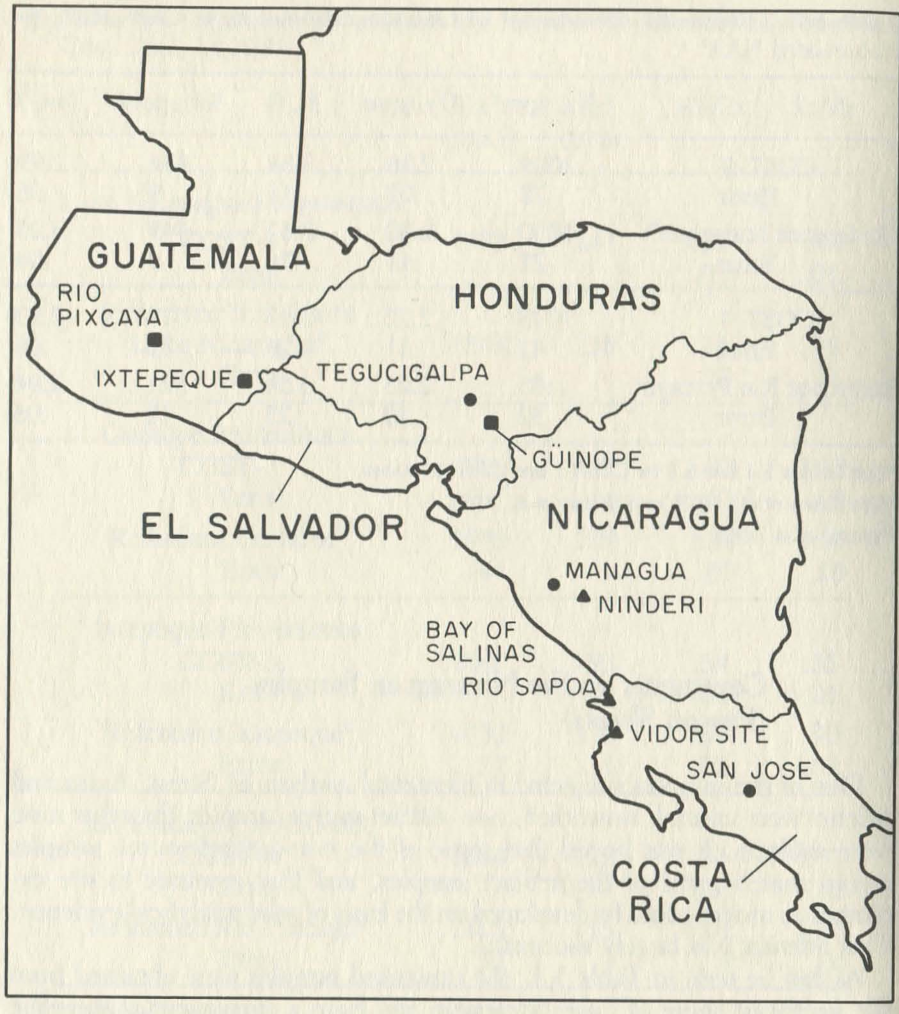

Figure 5.5. Obsidian source and artifact locations for Nicaraguan and Costa Rican samples.

that he had observed a natural deposit of obsidian in a road cut along Highway 26 in the El Horno region about 40 km north of the north shore of Lake Managua. He stated that all nodules were small, ranging from 6 cm to less than 1 cm in diameter. A systematic survey for obsidian sources in Pacific Nicaragua probably would locate more sources.

Three prismatic blades from the Nindirí area, donated by the Museo Tendirí (samples NICA–9, –10, and –12) are successful matches with Ixtepeque, and the XRF data were confirmed by an "abbreviated" NAA run. Ixtepeque is located north of Lake Guija, just inside Guatemala, a straight-line distance of 465 km away from Omtepe Island. This confirms a direct connection with Mesoamerica, particularly the Maya zone. The Museo Tendirí samples did not have chronological context, but circumstantial evidence suggests that the trade took place during late Period V or early Period VI (Lange and Stone 1984: 7). The prismatic blades collected during 1983 consistently came from later sites, and when they had platforms, they were large, with minimal overhang removal, and highly pecked and ground. Such platform surface and edge preparation is characteristic of the Late Classic and particularly the Postclassic in Mesoamerica.

The elemental analyses indicated that the four prismatic blades (NICA–8, –11, –13, and –14) and two artifact flakes from Nindirí came from the Güinope source in southeastern Honduras. This indicates a significant level of local working of obsidian imported from 225 km away. These flakes are primary working flakes, rather than resharpening flakes. The cortex on them is also indicative of primary percussion technology. However, the flakes are too fragmentary to allow definite identification as part of a core-blade, household percussion flake, or other manufacturing system.

Comments on the Costa Rican Samples (Fred Lange)

The samples from northwestern Costa Rica have interesting correlations with, and one distinct difference from, the Pacific Nicaraguan results. As with the Nicaraguan samples, all objects were subjected to XRF and three were subsequently given "abbreviated" NAA treatment. Both the prismatic blade fragment (COST–3) and tool fragment (COST–4) were matched with Guatemalan source material. The small primary waste-flake from the Sapoa Valley (COST–2) correlates with the Güinope source, while the small nodule (COST–1) correlates with sample NICA–2 from the northeast shore of Lake Nicaragua.

The limited northwestern Costa Rican sample shows a second Guatemalan source area, Río Pixcaya, which was not represented in the Nicaraguan sample. The latter sample also was small, and Río Pixcaya material might be expected in subsequent analyses of Nicaraguan obsidian artifacts.

The contexts of the northwestern Costa Rican materials are all late Middle Polychrome/Late Polychrome period (A.D. 1200–1520) and this also correlates well with the temporal placements assigned to the Nicaraguan specimens, and with the La Virgen phase (Middle Polychrome) placement given by Healy (1980: 285) for "three, and probably four" of the obsidian chips that he reported on from Norweb's testing. Only one fragment of a blade was reported from the same excavations. The low frequency of obsidian reported by Healy is comparable to the results obtained from the 1983 survey.

6

Compositional Characterization of the Nicaraguan Ceramic Sample

RONALD L. BISHOP
FREDERICK W. LANGE
SUZANNE ABEL-VIDOR
PETER C. LANGE

Chemical characterization of Nicaraguan ceramics is based on instrumental neutron activation analysis (INAA) of 51 specimens from the 1983 Nicaraguan survey and other Nicaraguan ceramics that are part of the 1,238 samples in the Greater Nicoya ceramic data base (Bishop, Lange, and Lange 1988; Bonilla et al. 1987). Recent survey, excavation, and intensive ceramic analysis allow us to refine ceramic data interpretations, both in terms of the evolution of the local ceramic production traditions and in terms of the impact of foreign influences on forms and designs. This has been particularly important in allowing us to characterize Greater Nicoya in terms of northern and southern sectors (Figure 1.10). As noted elsewhere in this volume, some ceramic types or varieties have a distribution limited primarily to one sector or the other, while others are found in both, or are "pan-regional."

In addition to the characterization of locally produced ceramics, the ceramic-based subdivisions of Greater Nicoya also permit the stylistic and analytical assessment of ceramic specimens suspected of being imported from external sources. Our ability to quantify analytically previously intuitive speculations regarding ceramic trade has been one of the most significant results of the ceramic analysis program.

A ceramic paste analytical perspective for some of these interpretations,