Obsidian Sources in Ontario Prehistory

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ABSTRACT

Several obsidian artifacts recovered from archaeological sites in northwestern Ontario were subjected to X-ray fluorescence analysis. The results of the analysis indicate that these specimens come from Obsidian Cliff in Yellowstone Park, Wyoming, and from a second source which is yet to be identified but is likely located near the Yellowstone source.

INTRODUCTION

Among the exotic artifacts recovered from archaeological sites in northwestern Ontario are those made of obsidian. In North America this natural volcanic glass occurs only in igneous contexts within and west of the Rocky Mountains, and known sources range from Alaska to Mexico. Due to its noncrystalline, amorphous structure, superior flaking qualities and extreme sharpness along fresh fracture edges, obsidian was a preferred material for the manufacture of certain types of stone tools throughout the world in prehistoric times, and was widely traded. The obsidian found in Ontario is generally believed to have originated in Yellowstone Park, Wyoming. It was probably brought to Ontario in association with the Laurel Culture which is dated from 150 BC to AD 1100 in the vicinity of D1Kp-1 (Fig. 1), and from AD 100 to AD 800 in the areas north of Lake Superior (Rajnovich, Reid and Shay 1982:174).

To date, only a small number of these obsidian artifacts have been found in northwestern Ontario. Eight are surface finds, five were excavated, one was discovered in the backdirt during an excavation, and an unspecified number come from unknown contexts along the Rainy River (Wright 1967:32).

The surface finds consist of a projectile point from Lac Seul (G. Rajnovich, personal communication), two flakes and two scrapers from Quetico Park, a projectile point from a beach on Lake Superior south of Thunder Bay (McLeod 1982), a side scraper from Black Sturgeon Lake (W. Dutchak, personal communication), and a side scraper from the Poplar Point Lodge site on Lake Nipigon (Dawson 1976:51). The excavated material consists of: two flakes found in a disturbed deposit at the Fisk site near the Winnipeg River (Rajnovich, Reid and Shay 1982:96), *a* small flake found in association with Laurel pottery at the McKenzie site located at the mouth of the McKenzie River on Lake Superior (McLeod 1982:6), and an end scraper and a flake from the Heron Bay site on the north shore of Lake Superior also in association with Laurel pottery and lithics. Additionally, an obsidian flake was recovered from the backdirt during an excavation at the Manitou Mounds near the Rainy River (D. Arthurs, personal communication).

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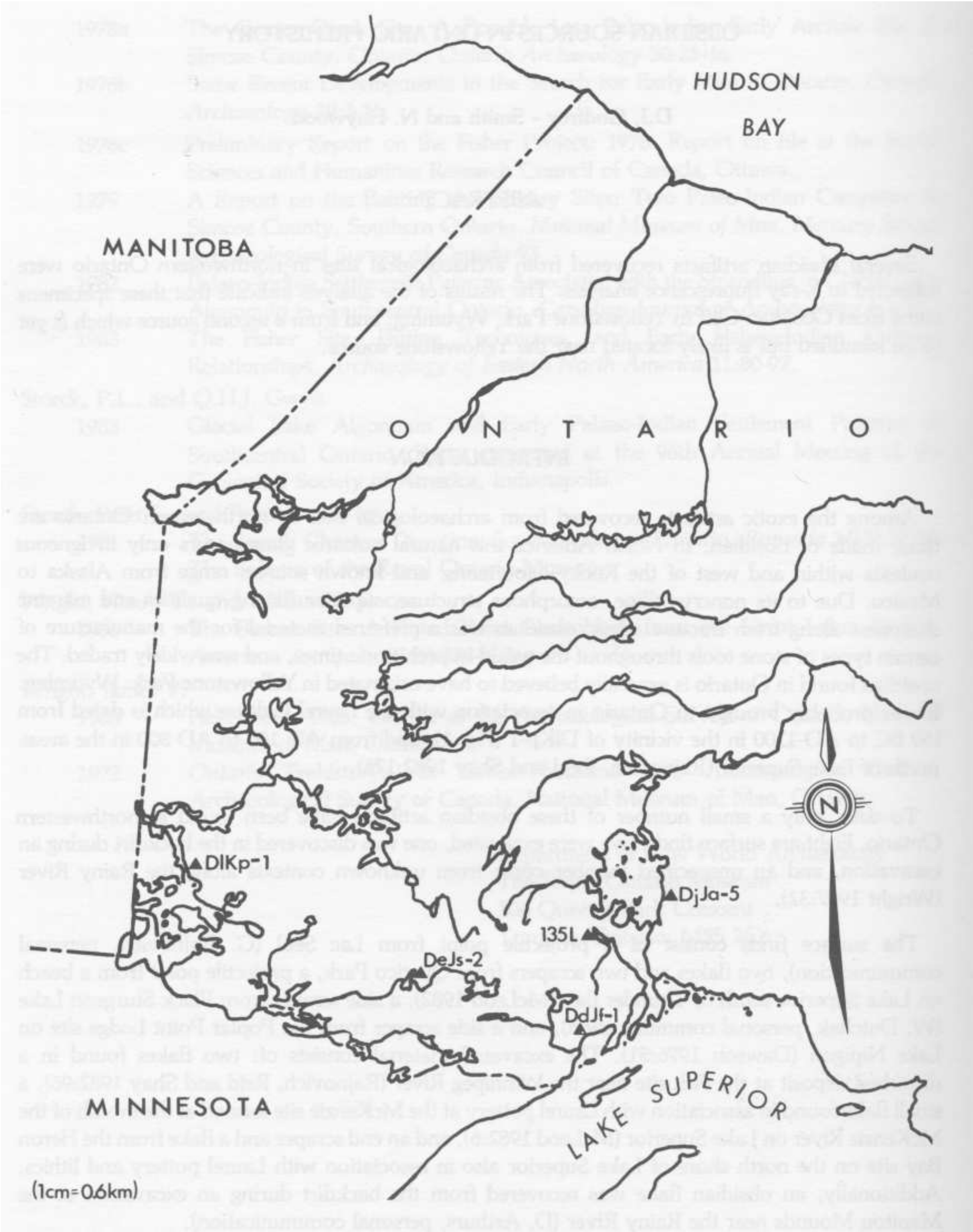

Fig. 1: Location of obsidian finds in northwestern Ontario.

ARTIFACTS EXAMINED

In an attempt to determine origins, five artifacts from northwestern Ontario were analyzed at Simon Fraser University by means of energy-dispersive X-ray fluorescence spectroscopy (XRF). They are: a flake (DIKp-1:221) from the Fisk site, a small scraper (DeJs-2:562) from Quetico Park, a flake (DdJf-1:S20/W29) from the McKenzie site, a scraper (DjJa-5:18) from the Poplar Point Lodge site, and a scraper (135L) from Black Sturgeon Lake. Locations of these sites are shown in Fig. 1.

METHODOLOGY

XRF is a method of analysis which can easily be used to obtain a "fingerprint" which is characteristic of a particular material (Nelson, D'Auria and Bennett 1975). This so-called fingerprint actually represents the relative amounts of several elements present in the material. To obtain an XRF spectrum the sample is bombarded with high energy radiation (X-rays, gamma rays, or protons) which interacts with atomic electrons so violently that one or more electrons are removed from some of the atoms. In each of these atoms the remaining electrons undergo transitions from one state to another and in doing so emit (ie. fluoresce) X-rays. The X-rays have energies which are characteristic of the emitting element. Thus the presence of certain X-rays determines the presence of certain elements. In the case of obsidian, the relevant elements are present only in very small quantities; these are called trace elements. The relative quantities of various trace elements in an artifact are compared to the spectra of obsidians from known sources. If an artifact's fingerprint falls within the statistically expected range of one of the source spectra, then the origin of the artifact is identified (Nelson, D'Auria and Bennett 1975).

This method of analysis is well established in the study of obsidian sources and of obsidian exchange networks throughout the world. It has been successfully used in many other identification studies in archaeology as well, on materials such as ancient marbles, bronze, and man-made glass. Other recent applications include work on pottery sherds to correlate the elemental variations of the clay and slip with stylistic differences (Snow et al 1983) and on tephra (volcanic ash) to determine which of many volcanic eruptions through time was responsible for a given ash deposit (Cormie 1981).

The advantage of using XRF analysis over other methods (such as neutron activation analysis) is that it is completely nondestructive, and can be repeated as many times as is necessary on any sample. The system used here has been developed in the Department of Chemistry at Simon Fraser University. It consists of Kevex Corporation instrumentation and electronics, with a Si(Li) (silicon-lithium) detector, and a silver (Ag) secondary target and filter. The silver target was chosen because the analysis is then relatively insensitive to the lighter elements which are abundant in obsidian, and highly sensitive to the heavier, more characteristic elements such as Rb, Zr, and Nb. The analysis time was 5 minutes per sample. The data were transferred to an IBM 370-165 computer and analyzed for peak energies and intensities with the Gamanal spectrum-stripping program. This method obtained relative concentrations for 13 elements ranging from potassium (K) to niobium (Nb) and also including lead (Pb).

RESULTS

The data for the five artifacts analyzed are shown in Table 1. The computer-obtained peak areas have been normalized to the element zirconium (Zr), by dividing the peak area for each element by that sample's value of Zr x 100. All other elements are thus expressed as a ratio with respect to Zr. The advantage of normalization is that it adjusts for the variability of raw counts in a spectrum, which depend on sample geometry and thickness, and yields meaningful fingerprints. After a spectrum is normalized it can easily be compared to previously acquired data for other artifacts and known source material.

TABLE 1

NORMALIZED XRF RESULTS OF FIVE OBSIDIAN ARTIFACTS

(background noise has been subtracted from all peak areas)

		Yellowstone Park				BCSIA
Energy (KeV)	Element	DIKp-1 :221	DdJf-1 S20/W29	DeJs-2 :562	DjJa-5 :18	135L
3.31	K	6.2	4.7	5.1	4.4	3.3
6.40	Fe (K-alpha)	82.0	101.9	75.7	80.0	59.1
7.06	Fe (K-beta)	15.8	19.1	15.0	14.5	10.5
8.64	Zn	2.3	3.1	3.1	3.4	1.6
10.55	Pb	2.2	tr	1.8	2.7	1.1
13.39	Rb	75.7	81.1	71.1	72.2	32.6
14.16	Sr	0	0	0	0	8.6
14.96	Y	49.7	52.8	49.8	49.6	16.9
15.77	Zr	100	100	100	100	100
16.61	Nb	31.8	36.5	34.4	30.5	20.0
	Compton*	834	783	789	784	462
22.17	Rayleigh*	629	602	600	604	365

* Incoherent (Compton) and coherent (Rayleigh) scatter of incident silver K-alpha rays.

In this case, the spectra for four of the five artifacts examined are not significantly different from each other. Although the elemental concentrations for the McKenzie site artifact (DdJf-1:S20/W29) are slightly high, this can be attributed to the thinness of the flake. The spectrum represented by these four artifacts (Fig. 2a) is known to be an obsidian from Obsidian Cliff in Yellowstone Park, Wyoming.

A different spectrum is presented by the scraper from Black Sturgeon Lake (135L). This spectrum is identical to the fingerprints of several artifacts from sites in western Canada. It does not however correspond to any of the known Canadian or American obsidian sources, over 40 of which have so far been characterized by the SW obsidian study (E. Nelson, personal communication). Because its fingerprint (Fig. 2b) has initially been noted in artifacts from sites of the Kootenay region of British Columbia, this unknown source has been assigned an interim designation of British Columbia Southern Interior Type A (BCSIA).

The BCSIA type of obsidian has frequently been found in association with Yellowstone obsidian in archaeological sites of western Canada. An analysis of six artifacts from DjPp-8 (the Crowsnest Pass) has demonstrated that three artifacts were of the Yellowstone obsidian and three of the BCSIA type (Godfrey-Smith and D'Auria 1984). This trend is reflected in other sites as well. It seems likely that the source of this obsidian is located not far from the Yellowstone source (E. Nelson, personal communication).

Frison et al (1968) have reported two other, minor sources within the Yellowstone rhyolite plateau. They are the Teton Pass source and the FMY/Canyon Junction/Willow Creek composite source. They are distinguished from the Obsidian Cliff Yellowstone source on the basis of Na/Mn activation ratios. However, these results were obtained through neutron activation analysis and thus are not comparable with our XRF work.

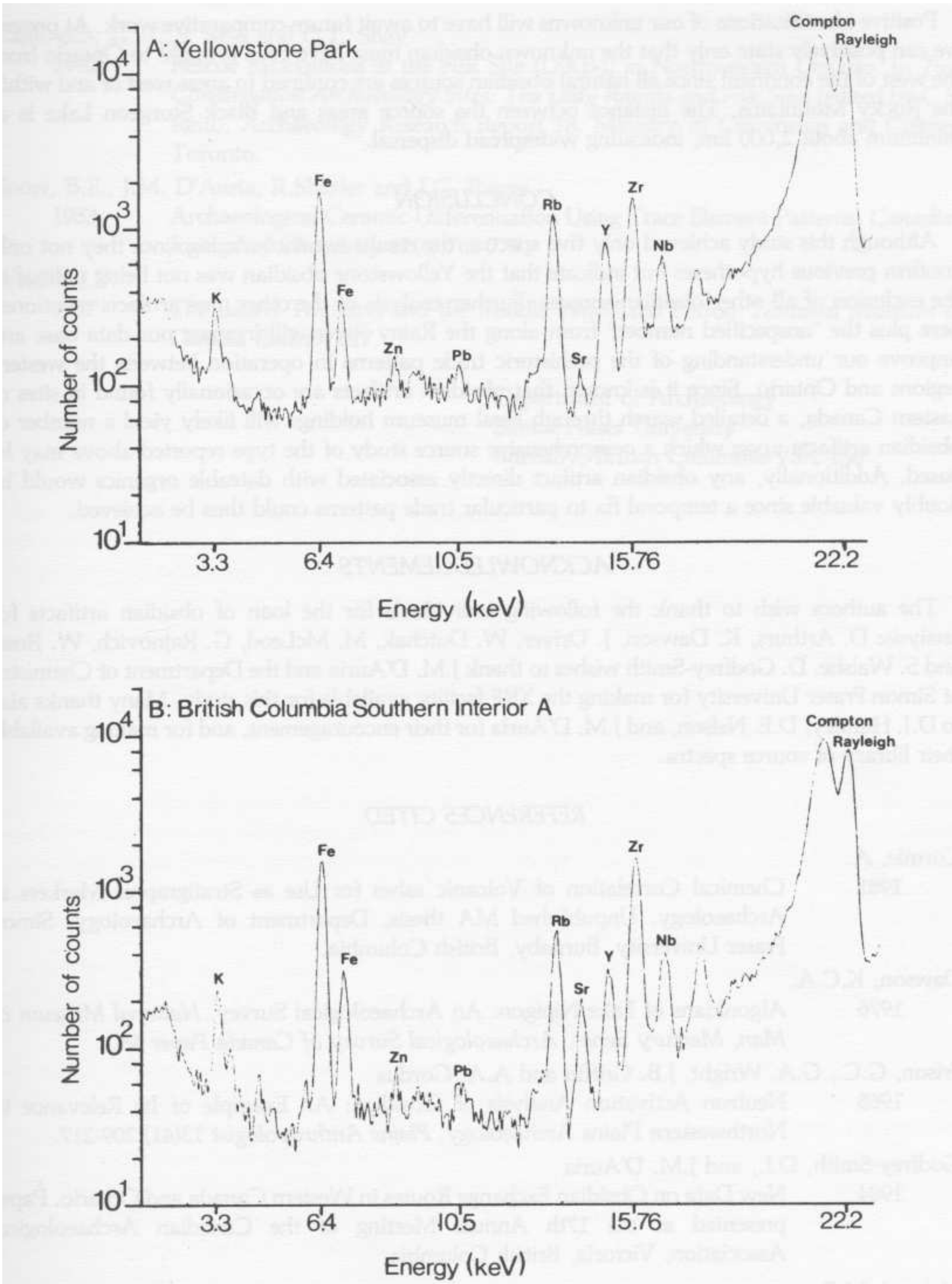

Fig. 2: XRF spectra of the artifacts analyzed.

a: Yellowstone Park.

b: British Columbia Southern Interior Type A.

Positive identifications of our unknowns will have to await future comparative work. At present we can positively state only that the unknown obsidian must have been brought to Ontario from the west of the continent since all natural obsidian sources are confined to areas west of and within the Rocky Mountains. The distance between the source areas and Black Sturgeon Lake is at minimum about 2,000 km, indicating widespread dispersal.

CONCLUSION

Although this study achieved only five spectra, the results are encouraging since they not only confirm previous hypotheses but indicate that the Yellowstone obsidian was not being utilized to the exclusion of all other obsidian sources. Further analysis of the other nine artifacts mentioned here plus the "unspecified number" from along the Rainy River will increase our data base and improve our understanding of the prehistoric trade patterns in operation between the western regions and Ontario. Since it is known that obsidian artifacts are occasionally found in sites of eastern Canada, a detailed search through local museum holdings will likely yield a number of obsidian artifacts upon which a comprehensive source study of the type reported above may be based. Additionally, any obsidian artifact directly associated with dateable organics would be doubly valuable since a temporal fix to particular trade patterns could thus be achieved.

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