Lithic Sourcing and Prehistoric Cultural Geography in the Champlain Valley

by Adrian Burke

Introduction

The purpose of this paper is to demonstrate the usefulness and the necessity of analytical techniques developed in physics and chemistry in studying prehistoric cultural geography. My primary interest is understanding the nature and extent of interactions between aboriginal groups prior to European contact. This in turn provides insight into various prehistoric processes and in some cases to historic processes in the Northeast.

The question I will be tackling here is modest in scope; basically I wish to accurately identify the geographic and geological sources of lithic materials found on a small Woodland period site near Montreal (Figure 1). This site was found during CRM work conducted by the Ministry of Transportation of Quebec (Arkeos 1994). The lithic materials used by the occupants of site BiFi-10 to make their tools can not be found in the immediate vicinity of the site. By identifying the potential sources of these lithic materials, we will be in a better position to describe the group's territory and cultural affiliations. This is particularly significant since lithics were the only cultural materials recovered from BiFi-10.

There are numerous potential sources of lithic material for the manufacture of stone tools in the Northeast. I proceeded in a systematic way, looking at progressive procurement areas of 50 kilometers radius around site BiFi-10 in order to identify the most likely sources. This first step consists of macroscopic comparison of archaeological materials with samples from known geological sources that were used prehistorically. I identified similarities between the lithics from BiFi-10 and three different geological sources in Vermont. Four color variants of chert debitage resemble macroscopically the Hathaway and Clarendon Springs cherts of western Vermont, while one biface and a few flakes in a coarse grained, greyish-green quartzite resemble the Cheshire quartzite of south-central Vermont.

Even though certain lithic materials that were used prehistorically in the Northeast can be identified macroscopically with some ease by experienced archaeologists (e.g. Western Onondaga chert or Ramah quartzite), the majority of materials can be confused and misidentified because of their macroscopic similarities (Calogero 1992). This is especially true for the most common lithic material used prehistorically in the Northeast - chert. Geographically distant sources of chert can often resemble one another in color, luster, and texture. This is in part due to their similar geological genesis. In order to differentiate among these cherts archaeologists are increasingly turning to physico-chemical analyses (Luedtke 1992; Leute 1987). I will discuss here one of these techniques called X-ray fluorescence or XRF.

The BiFi-10 Site

The BiFi-10 site is a small site covering less than 200 square meters (CRAPH 1995:78). Detailed analysis by Eric Chalifoux of the horizontal and vertical distribution of artifacts suggests a single, brief occupation of the site by a small group (CRAPH 1995:78). A total of seven stone tools and tool fragments, and 799 pieces of lithic debitage were recovered from the BiFi-10 site. The site has been interpreted as dating from the Middle to Late Woodland period (CRAPH 1995:83-4). BiFi-10 was probably a brief stopover for a group making the portage from the Richelieu River, along the St. Jacques River to the La Prairie Basin and the St. Lawrence River (Figure 1).

Chert Sources in Vermont

Two known sources of chert from Vermont resemble macroscopically the chert found on BiFi-10; they are Hathaway and Clarendon Springs. These two raw materials are found regularly on archaeological sites throughout Vermont and were economically important to the prehistoric occupants of Vermont. Geological samples were obtained from both of these sources for analysis. The samples cover the known variability of the sources in terms of color, mottling, luster, translucence, and texture.

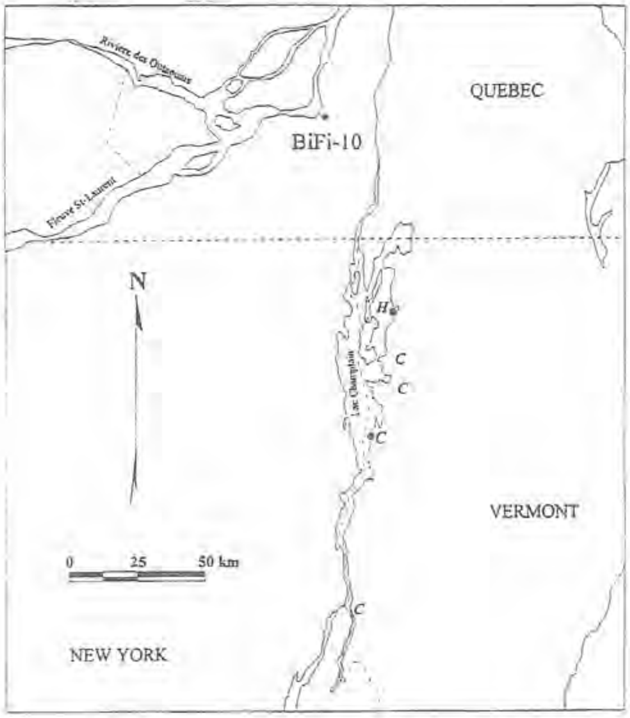

Figure 1. *Location of the BiFi-10 site and known Hathaway (H) and Clarendon Springs (C) chert sources.*

Hathaway chert samples come from Brook's Quarry and Hathaway Point near St. Albans (•**H** on Figure 1). These locales are known to have been used prehistorically to extract chert. The Hathaway "formation" as described by Hawley in 1957 is found within the shales of the Iberville formation which date to the Middle Ordovician (Hawley 1957 calls it the Hathaway formation, but Fisher 1977 refers to Hathaway breccia or melange). Hathaway chert outcrops in a relatively restricted area of northwestern Vermont along Lake Champlain and on some small islands (Hawley 1957).

Hathaway chert varies in color from a uniform olive green to green with black mottling to a uniform black. It is opaque and has a microcrystalline structure. In fresh fracture the surface has a slightly waxy luster, but once weathered it becomes matte. All of these variants of chert can be found in the collections of BiFi-10.

Clarendon Springs chert comes from several known geological sources in western Vermont. We know of at least four locations that were used as prehistoric quarry sites shown on Figure 1 by a **C** (Milton, Essex-Williston, Thompson's Point-Charlotte, and Mount Independence-Orwell). The Clarendon Springs formation is composed of dolostone and dates to the Late Cambrian (Cady 1945). It can be correlated with the Ticonderoga formation

Table 1. *Integrated peak area values in counts for analyzed samples.*
Counts reflect element concentrations but are not equivalent to ppm or % values and are therefore not comparable between elements.

Sample	Chert	Source	Fe	Rb	Sr	Y	Zr
13	green	BiFi-10	11872	955	1775	206	2042
14	green	BiFi-10	21271	555	2846	75	2248
15	green	BiFi-10	10875	834	2294	50	2031
16	green & black	BiFi-10	15628	1164	2238	0	2395
17	green & black	BiFi-10	10989	1017	2082	320	2469
18	green & black	BiFi-10	17564	1160	2048	282	2855
6	black	BiFi-10	10928	951	2226	200	2435
12	black-aberrant?	BiFi-10	2410	184	4477	5	1121
19	black	BiFi-10	11583	1109	1850	172	2462
8	green & black	Hathaway	17580	701	1525	235	2359
9	green	Hathaway	30925	798	1071	339	2583
10	black	Hathaway	28544	537	1551	41	1898
11	black vitreous	BiFi-10	3387	590	497	62	2127
5	black vitreous	BiFi-10	4507	469	839	31	3187
7	black vitreous	Clarendon Springs	5417	864	652	132	3524
20	black	LeRay	3312	278	3946	44	1194

(Beekmantown group) of New York (Fisher 1968, 1977; Welby 1961).

The geological samples we have obtained are from Thompson's Point near Charlotte, indicated in Figure 1 by a dot next to the C (•C). The chert is black and slightly vitreous and translucent. It has a microcrystalline structure with visible phenocrysts of calcite, and pyrite inclusions. Debitage resembling this chert has also been found in the collections from BiFi-10.

Analysis by X-ray Fluorescence

The X-ray fluorescence apparatus allows the archaeologist to characterize lithic raw materials based on their elemental chemical components, such as Calcium, Iron, Rubidium, etc. The method is non-destructive, which makes it particularly attractive to the archaeologist. The apparatus used for this analysis is located at the Accelerator Laboratory of the University at Albany-SUNY.

The XRF apparatus uses a radioactive source, in this case americium 243, to excite a metal plaque called a target. This target can be changed depending on which elements the analyst wishes to focus on within the raw material. I have used tin for this analysis after experimenting with molybdenum, dysprosium, tantalum, and tin. When the target is excited, it emits X-rays which are directed at a small area less than 5 millimeters in diameter on the sample. Some of these X-rays penetrate the surface of the sample at the atomic level. The elements that are present in the material, in this case a siliceous rock, are excited by the X-rays. These excited elements release characteristic energies which are recorded by a Si/Li detector (see Kuhn and Lanford 1987 for further description of the SUNY Albany XRF apparatus).

The XRF apparatus produces a spectrum of these energies which gives a general idea of which elements are present in the material (Figure 2). Typically each element is represented by a pair of peaks, a large one and a smaller one to its right, called K-alpha and K-beta (Ka & Kb). We can identify which element the peak represents by its characteristic energy in electron volts, identified as channel number on the spectrum's horizontal axis. The height of the peaks is proportional to the amount of each element in the

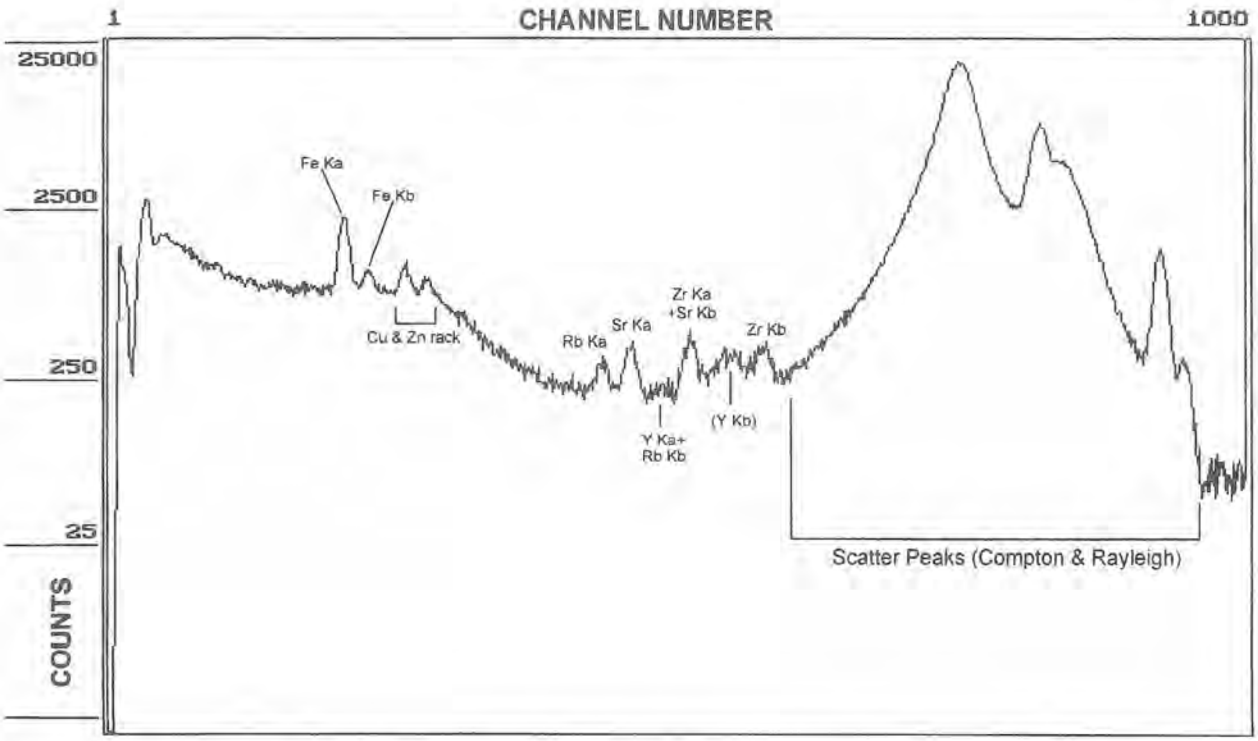

Figure 2. *XRF spectrum of a chert flake from BiFi-10 showing the peaks for the five elements used in this analysis, as well as the false peaks created by the sample holder (Cu-Zn) and the scatter peaks from the target.*

material. Each sample is usually analyzed for 60 minutes. For comparative purposes all samples must be analyzed the same amount of time since the counts are time dependent. Using the tin target, the Albany XRF apparatus is most sensitive to the elements between calcium (Ca 20) and zirconium (Zr 40), especially the metals. Aluminum (Al 13) and silicon (Si 14), which are important components of knappable stone, unfortunately can not be detected. Figure 2 indicates the elements which are present in significant amounts in all of the study samples and which will help in linking the archaeological material to the geological source. These are: iron (Fe 26), rubidium (Rb 37), strontium (Sr 38), yttrium (Y 39), and zirconium (Zr 40).

A couple of caveats regarding the XRF apparatus and its sensitivity should be mentioned before proceeding with this discussion. First, the target produces such a large amount of X-rays that many are reflected back and registered by the detector, producing a group of large scatter peaks (Compton and Rayleigh) (Figure 2). In addition, all the spectra are composed of background X-ray energies. If the apparatus did not produce or detect such a background, then the base of the peaks would start at zero counts. This point is important since certain elements may be lost in the background "noise". Cherts, for example, may contain certain elements in extremely small amounts – only a few parts per million. These rarer elements like Yttrium can be useful to characterize a chert and differentiate it from another. If the XRF technique is not sensitive enough to pick up these elements, then it may be necessary to try neutron activation analysis or another more sensitive technique.

Applying XRF Analysis to the materials from BiFi-10

Uniform olive green, green with black mottling, and uniform black chert

The first objective is to see whether the different variants of archaeological chert – olive green, green with black mottling, and black chert – are similar from a chemical viewpoint. This is important because we want to know first if these three variants can come from the same source. The three spectra shown in Figures 3, 4, and 5 show the general similarities among three flakes of olive green chert, three flakes of green chert with black mottling, and three flakes of black chert (see Table 1 for peak area counts). The three flakes of olive green chert (sample # 13-15) and the three flakes of green chert with black mottling (# 16-18) have very similar chemical profiles (Figures 3 & 4). The three flakes of black chert are less consistent (# 6, 12, & 19, figure 5). Two flakes are very similar, but a third is slightly different due in part to a high peak of strontium (Sr).

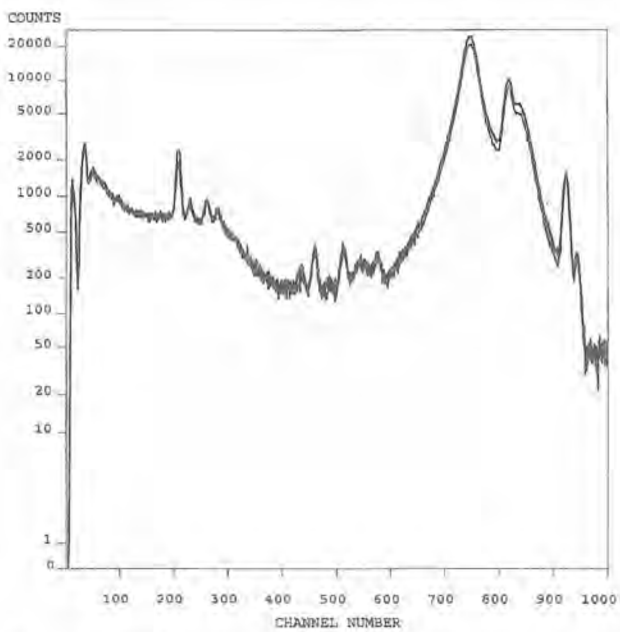

Figure 3. *XRF spectra of three green chert flakes from BiFi-10 (samples #13-15).*

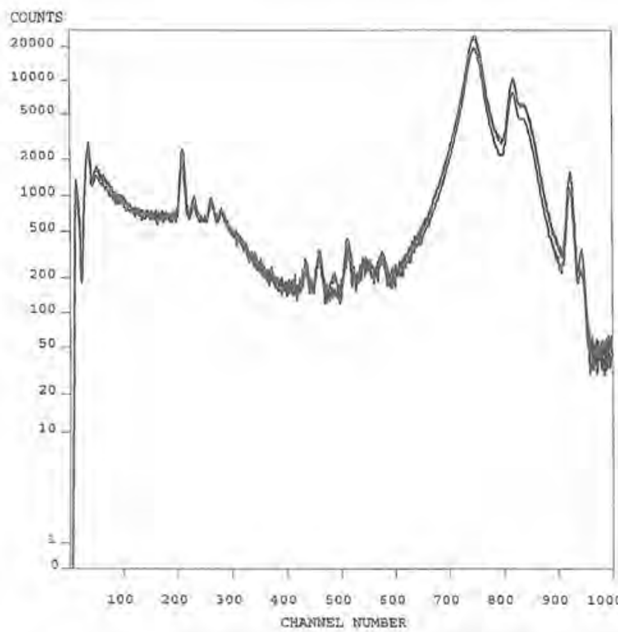

Figure 4. *XRF spectra of three green with black mottling chert flakes from BiFi-10 (samples #16-18).*

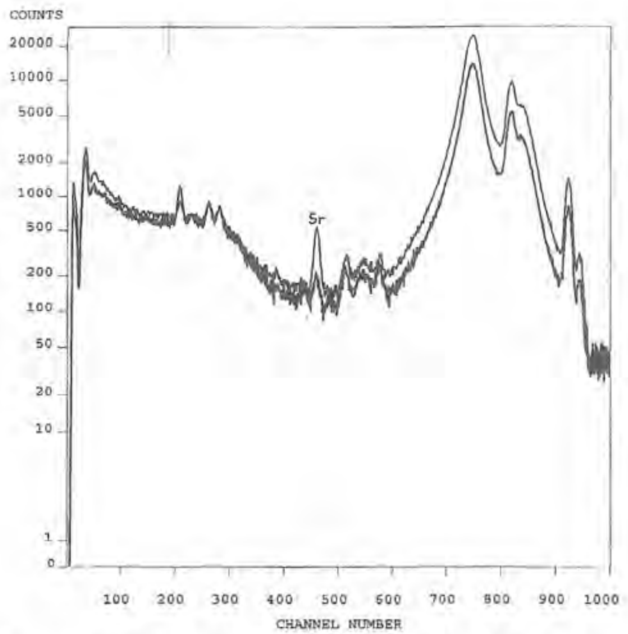

Figure 5. *XRF spectra of three black chert flakes from BiFi-10 (samples #6, 12 & 19).*

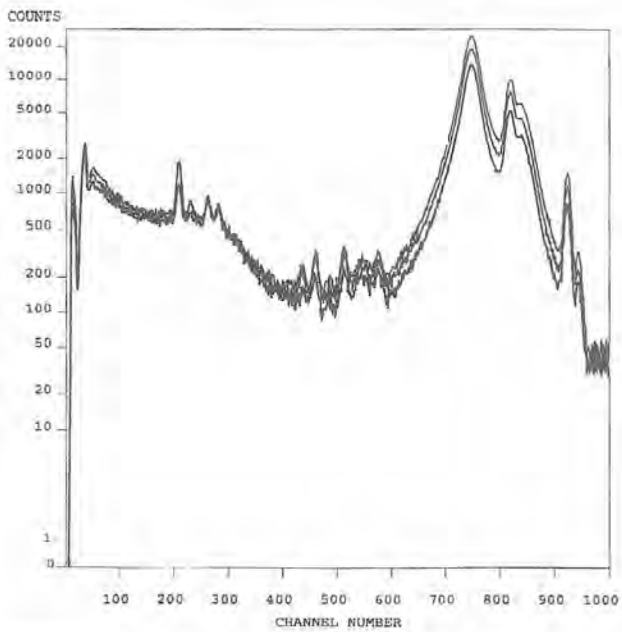

Figure 6. *XRF spectra of three chert flakes from BiFi-10: #13 green, #16 green with black mottling, and #6 black.*

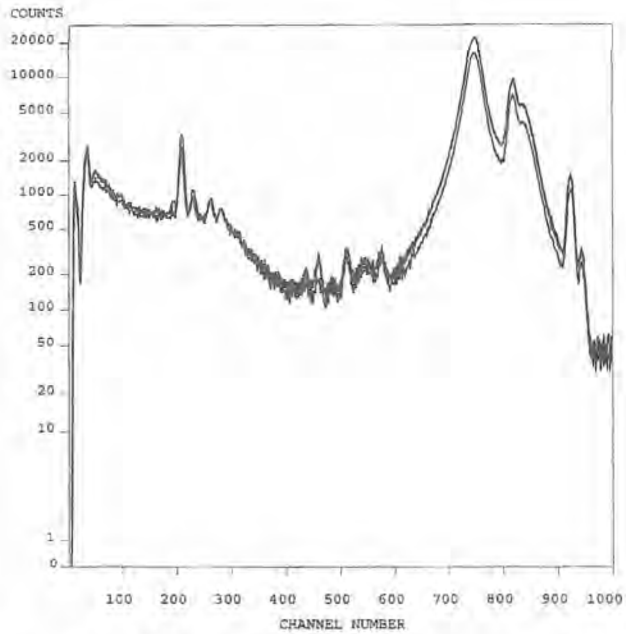

Figure 7. *XRF spectra of three geological samples of Hathaway chert: #9 green, #8 green with black mottling, and #10 black.*

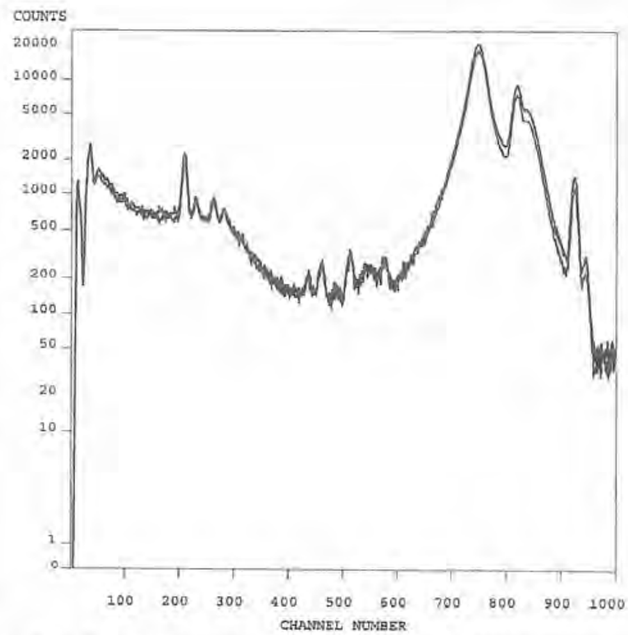

Figure 8. *XRF spectra of two green with black mottling chert flakes: #8 Hathaway formation, and #16 BiFi-10.*

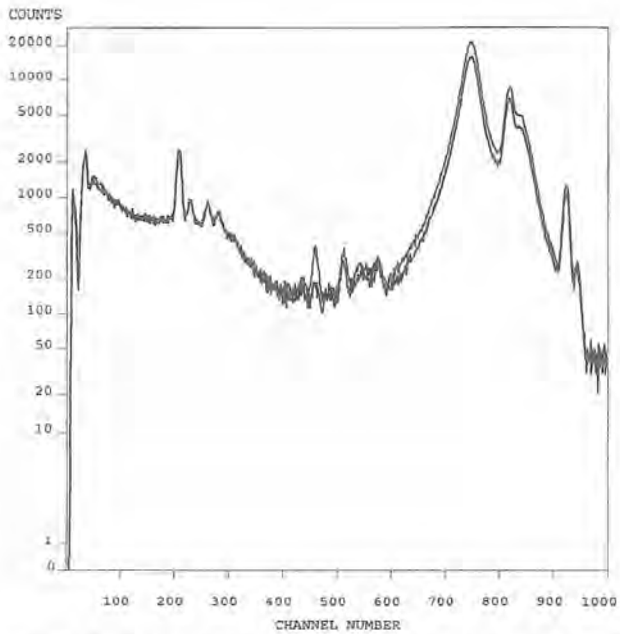

Figure 9. *XRF spectra of two green chert flakes: #9 Hathaway formation, and #14 BiFi-10.*

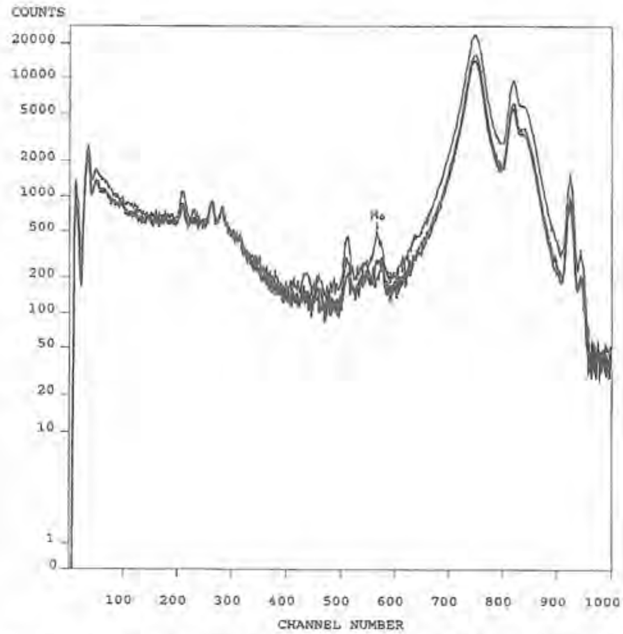

Figure 11. *XRF spectra of three black, slightly vitreous and translucent chert flakes. Two archaeological flakes from BiFi-10 (#5 & 11) are compared to a geological sample of Clarendon Springs chert from Thompson's Point, Charlotte, Vermont (# 7).*

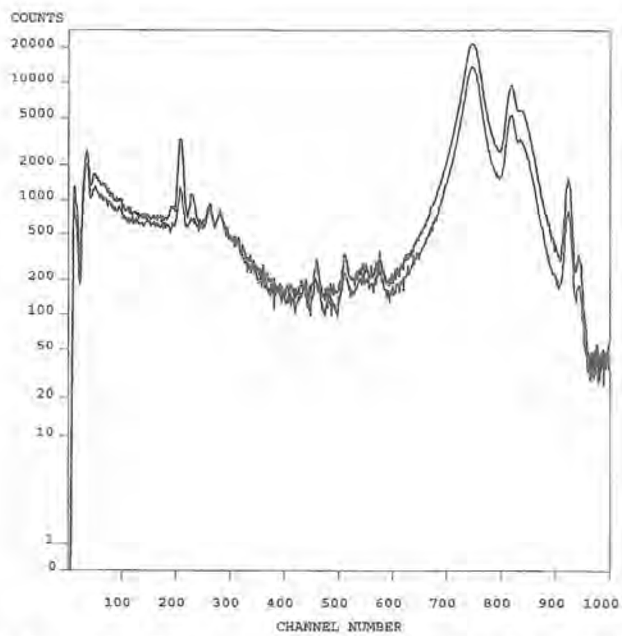

Figure 10. *XRF spectra of two black chert flakes: #10 Hathaway formation, and #19 BiFi-10.*

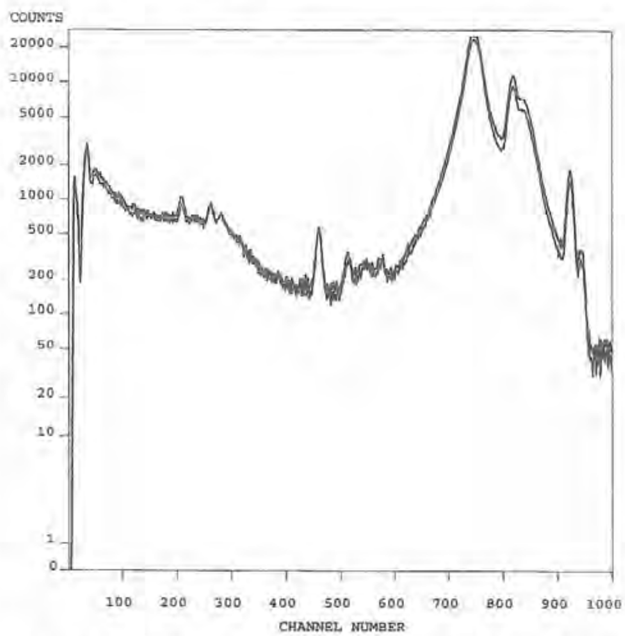

Figure 12. *XRF spectra of two black chert flakes. Sample #12 from BiFi-10 is compared to a flake of "LeRay" chert (#20-Chaumont formation, Jefferson County, New York) from the collections of the New York State Museum.*

Figure 6 compares an olive green flake, a green with black mottling flake, and a black chert flake from the archaeological collection (# 6, 13, & 16). Excluding the one aberrant black chert flake mentioned above, the three colors of chert show general similarities, but there are clear differences in the concentrations of the five elements. We can tentatively conclude that the three variants of the chert – uniform olive green, green with black mottling, and uniform black chert – are chemically similar and therefore come from the same source.

The next step is to see whether the three color varieties of the Hathaway chert geological samples also show a similar chemical profile. Figure 7 shows the three spectra for the three geological samples (# 8-10), showing that even as the colors and mottling vary, the chemical profiles are virtually identical.

Finally, let's compare the chert flakes from the site collection to the geological samples of Hathaway chert (Figures 8, 9, & 10). The best chemical match is between the green chert with black mottling (# 8 & 16, Figure 8), followed by the olive green chert with some variation in the strontium values (# 9 & 14, Figure 9). The black chert shows the greatest differences (# 10 & 19, Figure 10). These differences may be attributable to the chemical variability within the formation, or to the fact that there are several distinct sources of black chert present in the archaeological assemblage.

We can conclude that the XRF spectra demonstrate a strong similarity between the two chert groups, geological and archaeological, and suggest that the olive green, green with black mottling, as well as some of the black chert found on site BiFi-10 come from the Hathaway formation in northwestern Vermont.

Black, slightly vitreous and translucent chert

Two flakes of a black, slightly vitreous and translucent chert from site BiFi-10 were analyzed by XRF. This chert resembles macroscopically a black, vitreous variety of Clarendon Springs formation chert. The spectrum plot in Figure 11 compares the two archaeological flakes with a geological sample of Clarendon Springs chert from Thompson's Point, Charlotte, Vermont (# 5, 7, & 11). The three flakes show some similarities in their chemical profiles, but the elemental concentrations vary. Generally these cherts are low in iron, rubidium, and strontium, high in zirconium, and appear to contain molybdenum (Table 1). The variability that we see may be due to the fact that we have not found the correct archaeological source within this geographically extensive formation. These similarities tentatively support the macroscopic visual ID as well as the idea of a group procuring its lithic material from the Champlain basin of western Vermont.

Alternative sources of cherts found on BiFi-10

I have looked at potential alternative sources for the black chert which showed a different elemental profile - sample # 12 with the high strontium peak in Figure 5. There are several geological formations which contain black chert in adjacent areas of northern New York, southeastern Ontario, and southern Quebec (Table 2). These formations are all related, and date to the Early and Middle Ordovician. Two prehistoric quarry areas are known at present from these formations, one in the Chaumont formation of Jefferson County, New York (a.k.a. LeRay chert, Wray 1948; Tim Abel 1996 personal communication) and the other nearby in the related Gull River and Bobcaygeon formations on Simcoe Island (Thousand Islands), Ontario (Eley & von Bitter 1989:32). In the rest of the Saint Lawrence lowlands, these formations are covered by extensive glacio-fluvial deposits, making them less accessible, and the chert nodules are often not large enough to be useful (Codere 1995).

I obtained two chert samples from Jefferson County from the New York State Museum identified as LeRay chert (Figure 12). The XRF spectra show a close match between the New York LeRay chert and the aberrant flake of black chert from BiFi-10. Both samples show very low values for iron, rubidium, and zirconium, and high values for strontium (Table 1). This could suggest that the occupants of BiFi-10 also frequented or had access to chert from the Upper Saint Lawrence, but we should be cautious as this is based on only one archaeological flake sample.

Conclusion

The XRF analyses have supported some of our visual identifications of the geological and geographical sources of the chert found on site BiFi-10 near Montreal, and suggested alternate sources as well from a larger region. The tools and debitage made of olive green, green with black mottling, and black chert probably originate from the Hathaway formation which outcrops in the Saint Albans area. A thin section petrographic analysis of these cherts by Annie Morin confirms this origin (CRAPH 1995: 7-31). While the Hathaway source seems to be the most parsimonious hypothesis, Normanskill chert from the Hudson Valley in New York (Hammer 1976) which resembles geologically and macroscopically the Hathaway chert was also

Table 2. *Late Cambrian to Middle Ordovician bedrock geology sequence and potential chert sources in northern New York, western Vermont, southern Quebec, and southeastern Ontario.*

Formations in bold italic are known to contain chert.

Group	**New York** *Formation*	**Ontario**	**Quebec**	**Vermont**
TRENTON	Iberville Stony Point			(Hathaway) within Iberville
	Cumberland Head Glens Falls	***Bobcaygeon***	***Deschambault***	
BLACK RIVER	***Chaumont or Isle la Motte*** Lowville Pamelia	***Gull River***	***Leray***	
CHAZY	Valcour Crown Point Day Point			
Middle Ordovician				
Early Ordovician				
BEEKMANTOWN	Fort Cassin Fort Ann ***Great Meadows or Cutting*** ***Whitehall***			
Cambrian	Ticonderoga or Theresa Potsdam			***Clarendon Springs***

Compiled from Cady 1945, Codere 1995, Eley & von Bitter 1989, Fisher 1968, 1977, 1984, Globensky 1987, Hammer 1976, Hawley 1957, Johnsen 1971, Rogers et al 1990, Sabina 1986, Van Diver 1985, and Wray 1948.

analyzed by XRF and thin-section petrography as a control test. Both techniques rejected this source as the origin of the archaeological materials from BiFi-10 (CRAPH 1995).

Based on the XRF analysis, we can also conclude that the vitreous black chert probably comes from the Clarendon Springs formation which outcrops in several locations in western Vermont. Some of the tools and flakes made in black chert may originate from the Chaumont formation of northwestern New York, although it is equally possible that we have yet to find a closer geologic and prehistoric source on the northern Champlain basin of New York or southern Quebec and Ontario (cf. Codere 1995).

Based on the XRF analyses it is possible to suggest an affiliation of the occupants of BiFi-10 with the aboriginal groups of the Lake Champlain basin. The large amounts of debitage on BiFi-10 seem to suggest a direct access to the Vermont sources. These groups may have been relatively mobile and moved throughout a large region which included the upper Richelieu, northern Lake Champlain, and the Montreal region of the St. Lawrence Valley. Alternatively, it is possible that the material was obtained through exchange. Both hypotheses carry implications for the understanding of the cultural geography of the northern Champlain Valley and the adjacent Saint Lawrence Valley. The demonstration of relations between these two areas during the Woodland period is particularly interesting since historically these were home to the Abenaki and Saint Lawrence Iroquoian people, respectively. Additional archaeological evidence will be needed before we can understand the dynamic prehistoric cultural sequence for this region (Chapdelaine et al 1996).

Sources of lithic material like the Hathaway formation outcrops were used over long periods of prehistory, often to the exclusion of other sources nearby. To a large extent this seems to be linked to the accessibility of the lithic material and its visibility. Many of the sources in western Vermont would have been visible in the form of cobbles on the lake shore or on rivers, and the parent bedrock formations would have been located easily this way. Raw material quality was also important. Many of the Early and Middle Ordovician limestone replacement cherts in the region are not as massive or homogeneous as the Hathaway chert or Normanskill chert of New York. This may explain the presence and preference of the Hathaway chert on the site of BiFi-10. Not surprisingly, Missisquoi Bay at the northern end of Lake Champlain is translated from Abenaki as "flint bay" or "flint water," implying that this area was known for generations as an important lithic source (Missisquoi County Historical Society 1906: 37-61, 1907: 26-28). Once again, the archaeologist, armed with modern analytical tools, is reminded and humbled by the sophisticated knowledge of the land and its resources that Indian groups accumulated over centuries.

Acknowledgments

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