CHAPTER 4

Chert Artifact-Material Correlation at Keatley Creek Using Geochemical Techniques

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Indigenous use of toolstone deposits has long intrigued archaeologists. Questions about lithic material type, procurement strategies, and toolstone deposit locations can be addressed through geoarchaeological and archaeometric applications such as macroscopic, microscopic, and geochemical material analyses. Our research uses instrumental neutron activation analysis (INAA) and X-ray fluorescence (XRF) to assess variation between chert toolstone deposits in the mid-Fraser region of British Columbia. With these data, we then explore the relationship between toolstone deposits and chert debitage excavated from Structure 109 (ST 109), a semi-subterranean dwelling (also referred to as housepit in an archaeological context) located at the Keatley Creek site (EeRl-7), in the mid-Fraser region of British Columbia (Figure 4-1).

The relative abundance of chert in archaeological contexts and its prevalence in Quaternary deposits indicates its importance as a toolstone material for ancient populations and, as such, it can provide information on hunter-gatherer toolstone exploitation in prehistory. For example, the location of these toolstone deposits and their proximity to settlements provides information about exchange between communities. Thus, the goal of our research is to investigate the geographic relationship between chert toolstone deposits and chert materials in archaeological contexts, and how archaeologists can use this information to expand the current understanding of the procurement and movement of siliceous toolstone materials in the mid-Fraser region (for additional details see Kendall 2014).

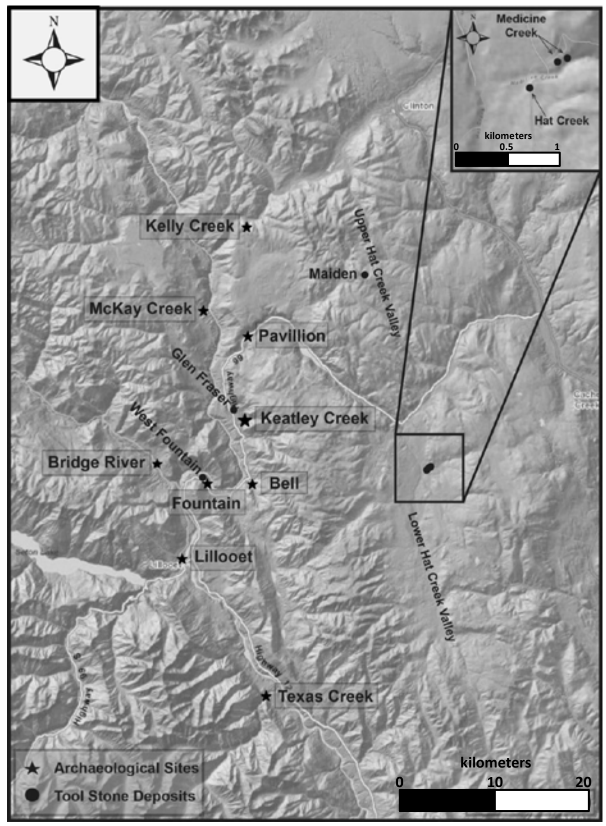

Figure 4-1. Siliceous toolstone deposits of the mid-Fraser Region (Kendall 2014:18).

Background

To effectively link chert artifacts to toolstone

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deposits, we collected samples from both the lithic assemblage of ST 109 and chert toolstone deposits. Deposits were identified using Geologic Survey of Canada maps (British Columbia Geological Survey 2008; Duffel and McTaggart 1951), geologic literature, and a previous study by Rousseau (2000). The majority of the toolstone deposits are within reasonable travelling distance (20 km), or a few days travel from the Keatley Creek site. Reasonable travelling distance was determined by the deposits' accessibility. For example, the deposit being located on or near major water corridors, or along frequently used hunting/gathering trails for expedient collection.

The Keatley Creek Archaeological Site (EeRl-7) and Structure 109

Keatley Creek is one of the largest documented archaeological sites in the Interior Plateau, covering 19 hectares with over 120 semi-subterranean structures (Hayden and Adams 2004). Human occupation of the site began ca. 7,000 B.P. and persisted into the Kamloops Horizon (1200–250 B.P.). It is generally agreed that there was a population climax at the site during the Plateau Horizon (3500–1200 B.P.), within the Plateau Pithouse Tradition (Richards and Rousseau 1987:22-23). However, see Harris (2012) and Prentiss et al. (2003) for conflicting opinions.

The study area is situated within the Interior Plateau of British Columbia, an archaeologically significant region with numerous large pithouse village sites in close proximity to one another. In terms of geology, the Interior Plateau is an elevated expanse of metamorphic bedrock overlain by a significant sedimentary environment that contains numerous Quaternary and Neogene age siliceous deposits (Ewing 1981). The materials from these types of deposits are likely to have been used for prehistoric stone tool production and were probably obtained for this purpose by the hunter-gatherer populations that inhabited the many villages in the area. The locations of some of these material deposits are known, but none have been correlated to artifacts from housepit sites using geochemical techniques as part of a provenance study; however, characterization studies have been conducted in this area on basaltic materials (e.g., Bakewell 2000; Greenough et al. 2002, 2004)

Structure 109 is located on the periphery of the Keatley Creek site on the first terrace east of the site's core. Archaeological excavations of ST 109 were first conducted in 1988, 1989, and 1998 as part of the Fraser River Investigations into Corporate Group Archaeology Project (Hayden 2000; 2004). Two occupations were recorded: 1) the earlier Plateau (Stratum VII); and 2) the more recent Kamloops (Stratum III) Horizon floors. Excavations revealed unprecedented amounts of chert and chalcedony debitage associated with the Kamloops deposits relative to other excavations at the site. During the 2006 Simon Fraser University Archaeology Field School, directed by Robert Muir (Muir et al. 2008), the earlier excavations of ST 109 were reopened and expanded.

The 2006 excavations of ST 109 recovered 101 tools and 2,662 pieces of debitage (Muir et al. 2008), of which 1,606 pieces were chert and chalcedony material; all of the formed tools were made from basalt. Considering all excavations at Keatley Creek, chert and chalcedony comprise less than 7 percent of the total lithic debitage (Hayden et al. 1996; Morin 2006:107), making the abundance of silicates recovered from ST 109 atypical. Based on the uncharacteristic lithic material choice, other researchers have hypothesized that these siliceous materials might be from a non-local source, brought in by trade with other contemporaneous communities outside the mid-Fraser region (Hayden and Adams 2004:96).

Geological Background

The main geologic features of the British Columbia Plateau region are the deeply incised Thompson and Fraser rivers valleys. These valleys contain dense accumulations of Quaternary and Neogene deposits left by glacial outwash. Over 12,000 years ago, the entire surface of this region was covered in a large ice sheet exceeding depths of 2000 meters (Hayden and Ryder 1991). When the Ice Age ended 11,500 years ago and the glaciers receded, they deposited boulders, cobbles, pebbles, gravel, sands, and silts on the landscape (Hayden 2005:2-3; Hayden and Ryder 1991). Using geologic classification, the bedrock of this area of the Plateau is known as the Kamloops Group, with the Cache Creek group in close proximity (Ewing 1981:1464; Rousseau 2000:166). The Kamloops group is defined as an assemblage of Lower to

Middle Eocene volcanic and sedimentary rocks found in south central British Columbia. Of particular interest is the area west of Kamloops, which runs into Lillooet and the vicinity of Keatley Creek. This area contains the basal Tranquille Formation, which consists of 500 meters of lacustrine and deltaic sediments (Ewing 1981:1464-65); common areas for silicate rocks to occur either through formation, diagenesis, or deposition.

The Cache Creek group is situated in the vicinity of Marble Canyon, which is southeast of the Keatley Creek site. According to Duffel and Taggart (1951), the bedrock is composed of chert, argillites, minor agglomerates and tuffs that are exposed along the Thompson River and Cariboo Highway from Martel to Cache Creek and north to Clinton (Rousseau 2000:166). A large component of this formation is the recrystallized limestone exposed in Marble Canyon and the Pavilion Mountains. The limestone contains inclusions of chert, argillite, and greenstone.

Methods

Our research used basic visual and advanced geochemical techniques to characterize and source the chert debitage excavated from ST 109. Due to the high propensity of inter- and intra-site variation within chert outcrops and deposits, this provenance study required a method that could test for rare earth, trace elements, and elemental density with high precision. Each chert deposit may contain the same elements, but the composition percentage of each element varies (i.e., each chert deposit has different amounts of trace elements and based on the variation detected by INAA, it is possible to identify where a specific piece was quarried). In the interests of a clear and focused research question, chalcedony materials were not included in the elemental statistical analysis.

Collection of Material: Toolstone Deposits

Toolstone deposits were selected after reviewing the extensive work done by the Geological Survey of Canada (Duffel and McTaggart 1951; Monger 1985; Monger and Price 2002), consulting with archaeologists (Austin 2007; Crossland and McKetta 2007; Rousseau 2000; Rousseau, personal communication 2009) and rockhounds (Hudson 2006), and conducting pedestrian surveys of the mid-Fraser region. Samples were collected from each area in 10-m intervals running north to south, across the extent of the deposit. Each sample was placed in a labelled paper bag within a larger plastic Ziploc freezer bag. At each deposit, two to three GPS points were recorded at the deposit boundaries and one in the centre. Five to ten digital photographs were taken of each deposit.

Chert samples were collected from six deposits in the mid-Fraser region: 1) Ashcroft Blue; 2) Glen Fraser; 3) Hat Creek chert; 4) Maiden Creek; 5) Rusty Creek Red and; 6) West Fountain deposits. These deposits are within 20 km of the Keatley Creek site and are situated on or near major rivers, or close to traditional hunting routes (Tyhurst 1992). In addition to geochemical analysis, samples taken from these deposits were analysed for their basic mechanical properties including strength, hardness, elasticity, and homogeneity (see Table 4-1).

Strength (brittle, strong) was gauged based on grain size as observed using a petrographic microscope at 30X magnification. Hardness was determined using the Mohs scale of mineral hardness. Elasticity (elastic, non-elastic) scores were based primarily on grain size and the presence/absence of pores, cracks, and fissures within the sample. Finally, homogeneity was determined by the presence/absence of inclusions, veins, and other irregularities observed using a petrographic microscope at 30X magnification.

Artifacts from ST 109

One thousand six hundred and six pieces of silicate debitage from the 2006 excavations of ST 109 were analysed for material type, weight, crystalline structure, texture, and strength. Material type was defined according to the Keatley Creek typology established by Hayden (2004), which is based in part on physical properties and on the material characterizations done by Bakewell (1995) for his graduate thesis on chert material characterization. The Keatley Creek typology categorizes lithic toolstone materials and includes various types of cherts, chalcedonies, and basalts. Included in this typology are 20 chalcedony types, nine chert types, and five forms of quartz. The Chert 2 and Chalcedony 6 types comprise the majority of the materials excavated from ST 109.

Table 4-1. Mechanical Properties of the Mid-Fraser Toolstone Deposits.

Deposit		Strength/ Tenacity	Mohs	Elasticity	Homogeneity	Colour/ Texture	Translucency/ Lustre
Glen Fraser		Brittle	5-7	Medium	Inclusions of quartz veins	Mottled; red, orange, and white/ Coarse	Opaque/ Varies – matte, some shiny
Rusty Creek Red Chert		Brittle	7	High	Homogenous; no visible inclusions, has a vitric appearance	Red / Fine	Opaque/ Matte
Blue Ridge/Moran Chalcedony		Not Brittle	7	High	Homogenous	Grey/ Fine	Translucent/ Shiny
		Not Brittle	7	High	Homogenous	White/ Fine	Translucent/ Shiny
Hat Creek Deposits	**Maiden Creek**	Brittle	7	High	Homogenous	Yellow/Fine	Opaque/ Matte
	Medicine Creek	Brittle	5-6	Medium	Inclusions; pockets of quartz	Red, yellow/ Coarse	Opaque/ Shiny
	Hat Creek	Brittle	7	Medium	Homogenous	Red/ Fine	Opaque/ Waxy Lustre/ Matte
Ashcroft Blue		Brittle	7	Medium	Homogenous; vitric appearance	Bluish green/ Fine	Opaque/ Matte

We selected debitage samples from the Kamloops floor and associated construction fill to represent this entire occupation. Samples were not taken from the earlier Plateau horizon, as all of the artifacts recovered from this occupation were produced from fine-grained basalt. Weight was measured in grams, and recorded to determine which samples exceeded 1 g, making them viable for INAA testing. Samples that did not exceed 2 mm in thickness were not considered viable for pXRF analysis.

INAA

Instrumental neutron activation analysis is capable of detecting and measuring elements with high precision, accuracy, and sensitivity and is therefore highly suited to bulk elemental characterization (Pollard et al. 2007). Basically, samples are bombarded with neutrons from a nuclear source. A number of the atoms present in the sample are then converted into radioactive isotopes that decay at known rates. These radioisotopes emit gamma energies characteristic of each element. The gamma energies were measured using a high-purity germanium (HPGe) detector and their electrical signal is diverted through an amplifier, and then sorted into channels along an electromagnetic spectrum measured in kiloelectron volts (keV). The peaks that form as a result are the spectrometric end products of elements that produce radioisotopes.

Samples were cleaned in an ultrasonic cleaner and left to dry overnight. They were then weighed to approximately 1 g and sealed in high-purity polyethylene vials. Two irradiations were performed on samples to acquire data on elements that produce short, medium, and long-lived isotopes. In total, data on 34 different elements were acquired for each sample. For this experiment, we tested for major, minor, and trace elements that are characteristic of, and routinely measured in, the analysis of chert geochemistry. Six standard reference materials (SRMs) and control samples were run with each bundle of samples. Standard reference materials used for this analysis include SRM 1632c Coal, SRM 1633b Fly Ash, SRM 688 Basalt and SRM 278 Obsidian Rock; all issued by the National Institute of Standards and Technology (NIST).

Samples were run through a pneumatic tube system and subjected to a ten second thermal irradiation at a neutron flux of 5×10^{13} n cm^{-2} s^{-1}. Each sample was left to decay for 10 minutes, and gamma emissions were measured by a hyper-pure germanium (HPGe) detector for 5 minutes. The elements measured for the short-lived procedure include Al, Ba, Br, Ca, Co, Cl, Dy, Mg, Na, Ti, U and V. Samples were left to decay for approximately 24 hours after which a second 5 minute count was performed to acquire data on Eu, K, La, Mn, Na, Sm and Sr. The samples were bundled and subjected to an in-core irradiation for another two hours at a neutron flux of 5×10^{13} n cm^{-2} s^{-1}. These samples were left to decay for 7 to 10 days, after which they were counted for 30 minutes each to measure concentrations of Au, As, Ba, Br, Fe, La, Na, Nd, Sb and Sm. Approximately 14 to 16 days after the long irradiation, samples were counted for another 30 minutes to measure concentrations of Ce, Co, Cr, Cs, Eu, Hf, Lu, Rb, Sc, Ta, Tb, Yb and Zn. The raw data in counts per second were weight corrected and calculated using PEAK software.

pXRF

Portable X-ray fluorescence (pXRF) technology was chosen as a technique in this study for its non-destructive qualities, availability, accuracy, and efficiency. Samples were tested on each side to determine the amount of intra sample variation. Using a Bruker Tracer III-V+ pXRF, we tested 48 geologic samples and 19 artifact samples for the following 18 elements: Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Rb, Sr, Y, Zr, and La. Ten samples were tested from each deposit with the exception of Ashcroft Blue, Hat Creek, and West Fountain, for which six samples were tested from each. All samples were subjected to X-rays for three minutes at 40 KV, with a vacuum and no filter. The data generated by pXRF were transferred into JMP for statistical analysis.

Results

As discussed, compositional data for artifacts and toolstone deposits were collected using INAA and pXRF. Based on previous geochemical studies by Bakewell (1995:5) and Sieveking et al. (1972), we used elements indicative of the clastic component (this component consists of silicate minerals in clay, silt, and sand) within cherts. The minerals are stoichiometrically constructed from major and minor elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, and P). The geochemical data derived from INAA and pXRF analysis included the majority of these elements, and the counts were used to calculate the mean and standard deviation of the toolstone deposits (Tables 4-2 and 4-3). These summary statistics reveal which elements are responsible for the variation between the deposits.

INAA Statistical Analysis

We used boxplots to discern patterns and identify outliers within the toolstone deposit samples. Using these plots, we identified Cr, Fe, and Zn as elements that have the potential to characterize some of the deposits. We then plotted these elements using bivariate plots for the toolstone deposits. Although the sample size was limited to one, for the Ashcroft and West Fountain deposits, we were able to separate these deposits from the rest using bivariate plots of Cr, Fe, and Zn. This pattern was replicated in the pXRF results, in which more samples were analysed. Bivariate plots and principal component analysis (PCA) results were inconclusive and could not characterize the remaining Glen Fraser, Hat Creek, Maiden Creek, and Rusty Creek Red deposits individually (See Kendall 2014 for detailed characterization of the toolstone deposits).

Table 4-2. INAA Summary Statistics for Toolstone Deposits.

Element	Glen Fraser *n= 6*	Maiden Creek *n= 6*	Hat Creek *n= 8*	Ashcroft Blue *n= 1*	Rusty Red *n= 2*	West Fountain *n= 1*
Al	4581 ± 2519	7676 ± 10937	3814 ± 3778	1558	1319 ± 208	1794
As	1 ± 2	10 ± 17	143 ± 169	44	11 ± 3	4
Au	0	0	0	2	0	0
Ba	130 ± 159	144 ± 272	299 ± 483	237	28 ± 6	34
Br	1 ± 0	17 ± 40	0	159	1	1
Ca	698 ± 682	1996 ± 2339	1503 ± 1338	2253	464 ± 27	636
Ce	6 ± 8	7 ± 12	3 ± 2	22	0	1
Cl	11 ± 8	14 ± 10	38 ± 46	4	9	1
Co	1	2 ± 1	1 ± 1	6	1	0
Cr	2 ± 2	3 ± 4	4 ± 4	6	1	11
Cs	0	0	2 ± 3	2	0	0
Dy	1±1	0	0	1	0	0
Eu	0	0	0	1	0	0
Fe	9071 ± 16670	14242 ± 18750	75216 ± 114291	24248	30294 ± 9372	25845
Hf	0	1 ± 2	0	4	0	0
K	949 ± 629	913 ± 1522	311 ± 273	1339	52 ± 10	161
La	5±4	4 ± 8	1±1	16	1	1
Lu	0	0	0	1	0	0
Mg	248 ± 145	287 ± 352	366 ± 373	848	53 ± 4	380
Mn	86 ± 129	66 ± 75	196 ± 254	191	38 ± 5	100
Na	106 ± 93	1231 ± 2997	165 ± 124	923	108 ± 2	47
Nd	3±1	4 ± 8	2 ± 1	17	1	1
Rb	0	0	0	0	0	0
Sb	0	2±1	2 ± 2	1	44±3	0
Sc	1±1	1±2	0	16	0	2
Sm	1±1	0	0	0.00	0	0
Sr	1551 ± 774	1963 ± 611	4030 ± 2740	4294	623 ± 597	1600
Ta	0	0	0	0	0	0
Tb	0	0	0	1	0	0
Ti	197 ± 117	353 ± 404	188 ± 229	767	37 ± 8	106
U	0	1 ± 1	3 ± 3	1	0	0
V	26 ± 46	21 ± 30	36 ± 37	12	58 ± 20	24
Yb	0	1 ± 2	0	3	0	0
Zn	14 ± 26	8 ± 11	9 ± 7	55	0	23

Table 4-3. pXRF Summary Statistics.

Element	Glen Fraser n= 10	Maiden Creek n= 10	Hat Creek n= 6	Ashcroft Blue n= 6	Rusty Red n= 10	West Fountain n= 6
Si	56568 ± 16182	51358 ± 24204	54720 ± 20975	41230 ± 11793	31804 ± 20144	45780 ± 21816
S	1221 ± 247	1147 ± 179	1220 ± 146	565 ± 79	1244 ± 172	1110 ± 298
K	4801 ± 1475	3927 ± 1051	3958 ± 1702	1066 ± 22	3708 ± 821	3485 ± 742
Ca	16372 ± 42387	2169 ± 1543	1947 ± 1277	12495 ± 2461	2351 ± 1182	1859 ± 1948
Ti	1586.67 ± 1330	1261 ± 1060	2296 ± 3980	7267 ± 1076	722 ± 1182	455 ± 1208
V	210 ± 176	193 ± 159	180 ± 143	292 ± 153	722 ± 408	138 ± 131
Cr	184 ± 129	200 ± 256	287 ± 579	46 ± 71	361 ± 985	2480 ± 1374
Mn	3298 ± 8683	703 ± 1234	1983 ± 3724	3042 ± 673	2100 ± 3209	364 ± 532
Fe	63508 ± 66720	120673 ± 101749	209255 ± 349046	180621 ± 26164	346914 ± 26707	187391 ± 43575
Ni	2235 ± 448	1941 ± 415	1926 ± 839	1338 ± 125	1535 ± 1395	5987 ± 1464
Cu	1022 ± 395	1092 ± 379	1346 ± 588	1338 ± 236	1107 ± 357	1067 ± 379
Zn	186 ± 112	243 ±153	248 ± 140	634 ± 98	165 ± 106	206 ± 110
As	1300 ± 397	997 ± 438	1938 ± 1950	847 ± 192	819 ± 414	816 ± 331
Rb	802 ± 203	912 ± 264	2558 ± 4534	1045 ± 231	2338 ± 3171	940 ± 177
Sr	888 ± 313	792 ± 525	841 ± 709	5442 ± 802	625 ± 167	516 ± 858
Y	434 ± 209	357 ± 185	297 ± 196	1075 ± 212	237 ± 161	285 ± 177
Zr	892 ± 1039	611 ± 375	763 ± 1284	4361 ± 671	263 ± 155	298 ± 736
La	272 ± 95	245 ± 76	228 ± 100	233 ± 113	241 ± 83	233 ± 103

Table 4-4. Principal Components Analysis of the Mid-Fraser Silicate Deposits and Artifacts Characterized by Neutron Activation at the McMaster University Reactor. Values in Bold Indicate Strong Elemental Loading.

	Prin1	Prin2	Prin3	Prin4	Prin5
%Variance	34.477	21.424	20.733	13.543	9.823
Cumulative % Variance	34.477	55.901	76.634	90.177	100
Eigenvalues	1.7238	1.0712	1.0367	0.6772	0.491
K	**0.47023**	**0.66266**	**-0.30473**	**0.48300**	-0.11669
Cr	**0.38412**	**0.53146**	**0.66600**	**-0.24869**	0.25417
Fe	**0.78985**	-0.23980	0.21137	-0.17169	**-0.49444**
As	**0.64675**	**-0.53904**	0.13919	**0.32900**	**0.34368**
Rb	**0.55947**	0.03982	**-0.66045**	**-0.44597**	0.22433

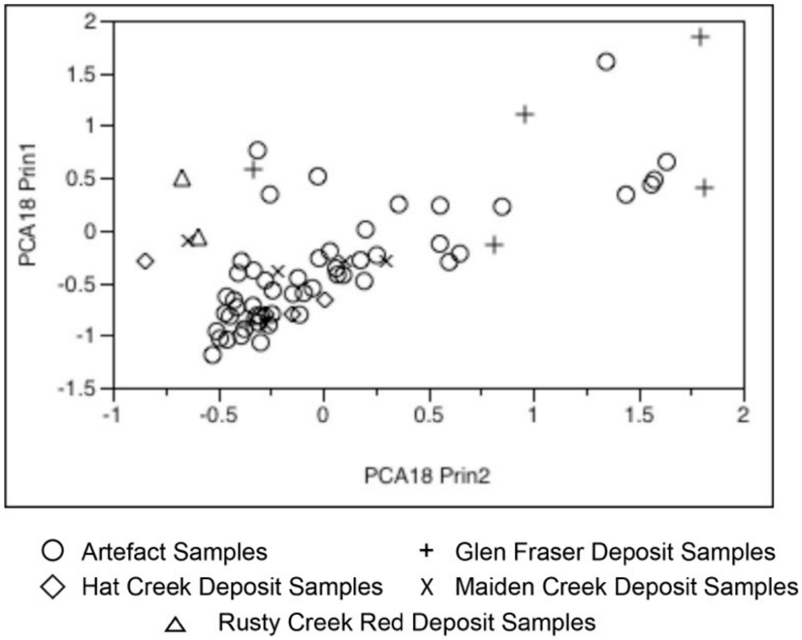

Figure 4-2. Bivariate Plot of Principal Components Analysis of the mid-Fraser Silicate Deposits and Artifacts Characterized Using INAA.

To explore the relationship between the artifacts from ST 109 and the toolstone deposits, we conducted PCA. Principal components analysis of the INAA data revealed that greater than 76 percent of the cumulative variance for the data set of the analysis is explained within the first three principal components (Figure 4-2, Table 4-4). Iron, potassium, and arsenic are responsible for most of the variation within the dataset. Scores for the first and second principal components suggest that the mid-Fraser toolstone deposits and artifacts are indistinguishable. Therefore, using the available data it is not possible to correlate the artifacts to any of the four toolstone deposits. In addition, no relationship was identified between the artifacts and the West Fountain and Ashcroft Blue deposits.

pXRF Statistical Analysis

Characterization of the toolstone deposits is detailed in Kendall (2014). We used bivariate plots of the Ashcroft Blue (Ti by Zn) and West Fountain (Cr by Ti) deposits to investigate the potential for a relationship. These plots revealed that no relationship exists between these deposits and the artifacts, based on the current dataset. Principal component analysis of the pXRF data (Figure 4-3) for the remaining four toolstone deposits and artifacts were inconclusive. This PCA represents 82.1 percent of the dataset explained within the first three principal components (Table 4-5). The majority of the variation in the dataset is caused by all of the elements within the analysis, suggesting that there is not enough variation within the group to distinguish groups of artifacts and deposits. These results suggest that the artifacts are related to the Glen Fraser, Hat Creek, Maiden Creek, and Rusty Creek Red group of deposits.

Since the pXRF dataset is more comprehensive (with a greater number of samples for each deposit than was possible for the INAA analysis), we chose to conduct additional statistical analyses. We used canonical discriminant analysis (CDA) to further explore the relationship that exists between the Glen Fraser, Hat Creek, Maiden Creek, and Rusty Creek Red group of deposits. Figure 4-4 clearly shows similar results to the PCA plots—the group of four deposits is related to the artifacts excavated from ST 109. According to Table 4-6, this CDA accounts for 99 percent of the cumulative variance of the dataset within the first three analyses. Figure 4-4 offers further insight into the toolstone deposits, and their relationship to the artifacts, in that the artifacts overlap with and are plotted closer to the Glen Fraser and Hat Creek deposits. The bivariate plot of Canonical 1 and Canonical 2 reveals that the

Table 4-5. Principal Components Analysis of mid-Fraser Silicate Deposits and Artifacts Characterized by pXRF. Values in Bold Indicate Strong Elemental Loading.

	Prin1	Prin2	Prin3	Prin4	Prin5
%Variance	43.309	21.807	16,994	16.217	1.673
Cumulative % Variance	43.309	65.115	82.109	98.327	100.00
Eigenvalues	2.1654	1.0903	0.8497	0.8109	0.0837
K	**-0.55007**	0.26156	0.08528	0.78719	0.04552
Cr	**-0.31705**	**0.65241**	**-0.30496**	**-0.30496**	-0.00537
Fe	**0.93502**	0.28086	0.05782	0.05782	0.20852
As	**-0.31817**	**0.63976**	-0.16867	-0.16867	-0.04420
Rb	**0.88704**	**0.32881**	0.25770	0.25770	-0.19508

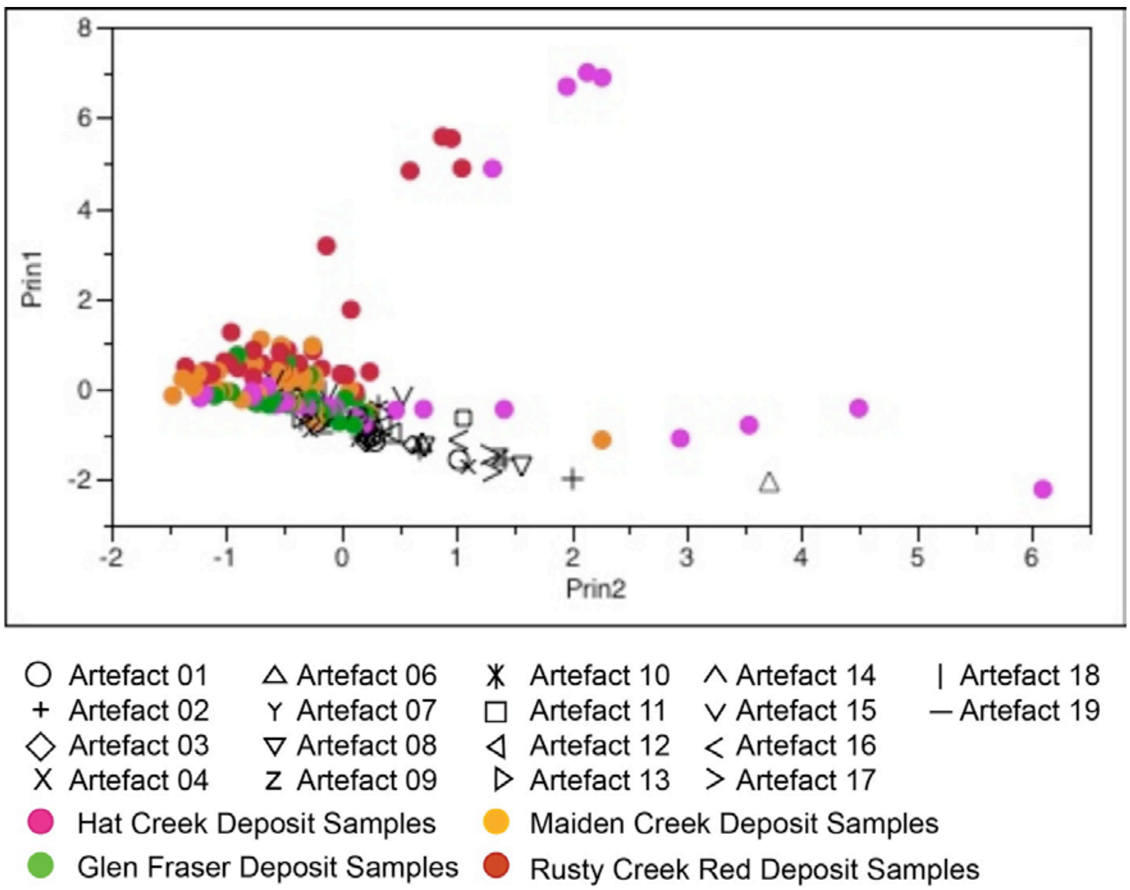

Figure 4-3. Bivariate Plot of Principal Components of the mid-Fraser Silicate Deposits and Artifacts Characterized Using pXRF.

Table 4-6. Canonical Discriminant Analysis of pXRF Data for the mid-Fraser Toolstone Deposits and Artifacts (*wilks F= 20.7357, prob<.0001*).'

	CD1	CD2	CD3	CD4
%Variance	76.29	18.99	4.58	0.12
Cumulative % Variance	76.29	95.29	99.88	100
K	**0.7464**	-0.7217	0.0001	**-0.0304**
Cr	**0.0559**	**0.0740**	**0.0986**	**1.0349**
Fe	**-1.4641**	-2.3161	0.5011	0.1897
As	**0.4197**	**0.3019**	0.5861	-0.3321
Rb	**1.4721**	**2.0840**	0.3740	-0.2209

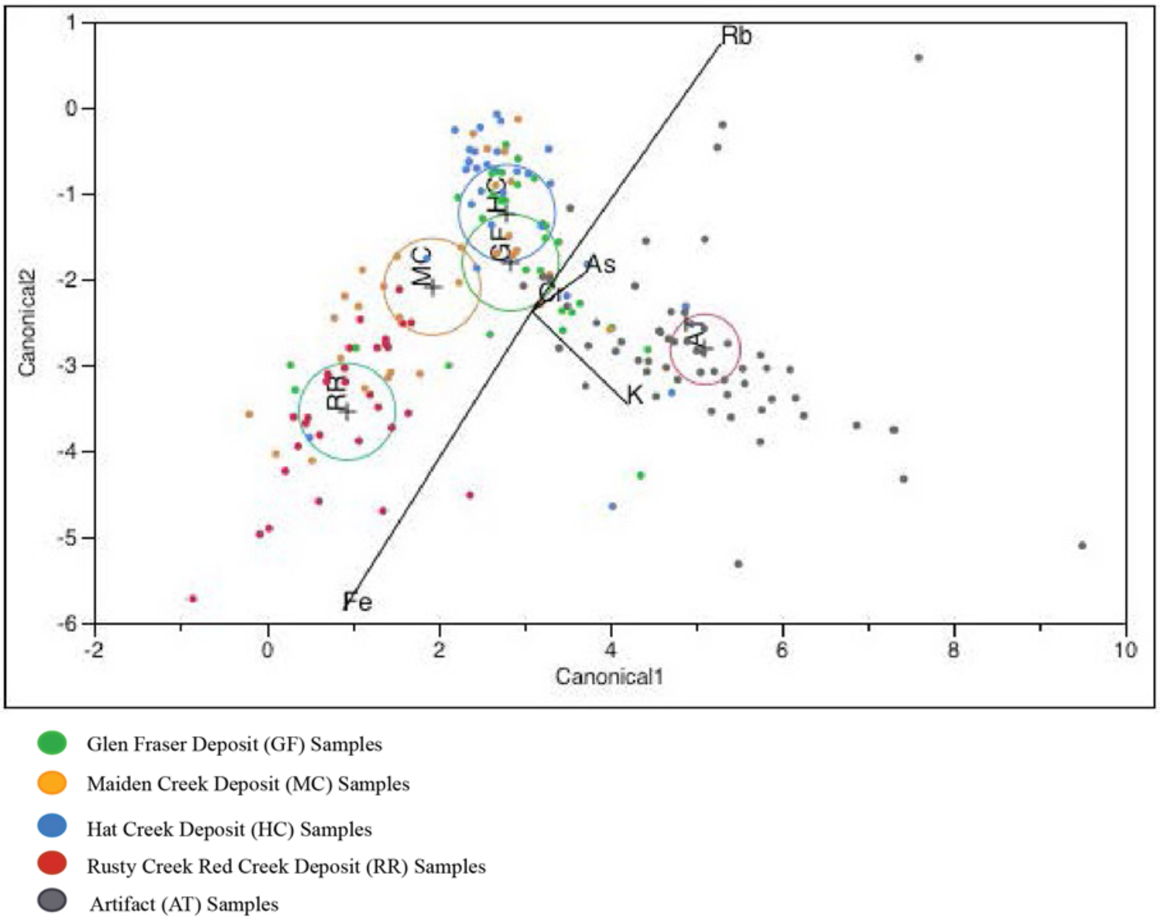

Figure 4-4. Scatterplot of canonical discriminant functions one and two showing all of the toolstone deposits in the mid-Fraser region. Ellipses represent 90 percent confidence interval of group membership. This plot explains 62 percent of the cumulative variation in the dataset.

elements Cr, K, and As are showing that association, and the elements Fe and Rb are loading Canonical 1 and Canonical 2. The CDA also reveals that the Rusty Creek Red deposit is somewhat removed from the group of deposits considering Canonical 1, but remains elementally similar to both the Hat Creek and Glen Fraser deposits (Figure 4-4; Table 4-6).

Discussion

Chert is one of the most common material types recovered from archaeological contexts. This prevalence in the archaeological record makes chert a valuable material for investigations into the use of toolstone deposits in the past. To trace toolstone deposit use, archaeologists can use geochemical techniques to establish the geochemical "fingerprint" of a particular deposit, or group of deposits. Once this unique fingerprint has been determined, archaeologists can then correlate artifacts to toolstone deposits to ascertain if the inhabitants of a site visited different deposits in an area.

Archaeologists have long considered the mid-Fraser region to be an area rich in many resources; including toolstone deposits (see Alexander 1992; Rousseau 2000; Tyhurst 1992). Generally, most of the toolstone silicate materials occur as small irregular nodules (under 30 cm) of opaque chert of varying colour and quality. The material typically appears on steep benched slopes, or at the base of hillsides. There is no evidence of tool manufacture at the deposit areas.

Our research demonstrates that the artifacts from ST 109 do not show a relationship to the West Fountain and the Ashcroft Blue deposits. Principal component analysis of pXRF and INAA data reveal that the Glen Fraser, Hat Creek, Maiden Creek, and Rusty Creek Red deposits are very similar, or closely related to the artifacts from ST 109. Both of these deposits are within 20 km from the Keatley Creek site. Additional CDA of the pXRF data showed similar results, but emphasize the similarity between the Glen Fraser and Hat Creek deposit, based on elemental composition. Interestingly, the CDA indicates that the artifacts are more closely associated with the Glen Fraser and Hat Creek deposits, while the Maiden Creek and Rusty Creek Red appear to be more closely related to each other than with the artifacts.

Conclusion

This study highlights the value of geochemical techniques for the characterization and discrimination of toolstone materials, and the applicability of such studies to queries of past resource use and movement.

Our small-scale study on toolstone deposits in the mid-Fraser region has proven that geochemical characterization is possible. Furthermore, our research suggests that the inhabitants of ST 109 were using locally derived chert toolstone materials during the Kamloops Horizon. Expanding this work to include a greater sample size from all of the deposits will improve our ability to distinguish these deposits from one another. Although our study could not pinpoint a particular deposit as the origin for the chert material present at ST 109, we have determined that the inhabitants of ST 109 were exploiting local resources within 20 km of the Keatley Creek site.

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