CHAPTER 5

Implications Between Technological Organization and Portable X-Ray Fluorescence Analysis on Lithic Material Use at Two Rockshelter Sites on the Southern Northwest Coast

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Introduction

Igneous toolstone dominates artifact assemblages along the Northwest Coast (Bakewell 1998; Kwarsick 2010; Reimer 2012). Until recently, the analysis of lithic assemblages on the Northwest Coast contributed little to our broader understanding of the ancient life ways of a dynamic range of cultures of this region. However, recent analyses by Hall (1998, 2003), Rahemtulla (1995, 2006) and Reimer (2004, 2006, 2012) show for this region a wide range of variation between lithic workshops, habitation and seasonal camps sites in different areas, time periods and associated cultures. However, many Northwest Coast archaeologists commonly assume that cores, tools and debitage at the sites they are investigating originate from local sources (typically beaches, creek and river beds), without full consideration of the variability of source materials that can exist from one assemblage to another. Another broad assumption in regional literature (Ames and Maschner 1999; Matson and Coupland 1995; Moss 2011) is that the characterizing and sourcing of dark grey to black igneous toolstone is not possible as it is with obsidian. In this paper we take these assumptions regarding the access and use of toolstone on the southern Northwest Coast to the test, and echo the sentiment of Andrefsky (2009), who considers raw materials as an organized choice when he points out that lithic raw material sources and use play an important role in technological organization. Furthermore, he points out that we must go beyond basic visual characterization of lithic materials to better understand ancient land use patterns.

In this paper we ask, can x-ray fluorescence determine the differences between igneous source materials? Moreover, can we apply these results to artifact assemblages? Likewise, what is the role of these materials at two archaeological sites in the southern Northwest Coast region of British Columbia? Characterizing and eventual sourcing of lithic materials through elemental analysis provides a robust contribution to our developing understanding of how these materials moved and circulated in and amongst cultural groups.

Geological Background

Geologically, the lithic landscape is built because of plate tectonics and the numerous volcanoes of the Pacific Ring of Fire that dominate the region (Monger 1994). Specifically, the Juan de Fuca Plate is sandwiched between the much larger Pacific Plate and North American Plate. Convergent plate subduction leads to the melting of crust material, producing abundant magma and pressure (Monger 1994). This feeds volcanoes, causing the numerous eruptions that eventually formed the lava flows that ancient peoples of the region utilized for stone tools (Reimer 2012). Physiographically, the southern Northwest Coast, near Vancouver, British Columbia, stretches from sea level to glaciated mountains over 2,000 m above sea level. Numerous rivers and lakes drain the heavy annual rainfall and snow pack down through sub-alpine meadows and parkland, past mid- and low-elevation old-growth

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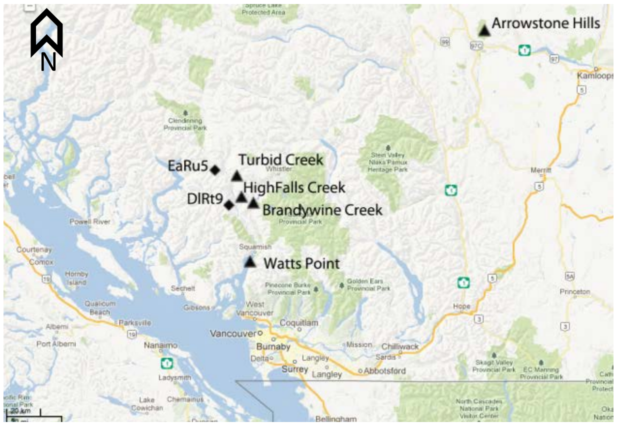

Figure 5-1. Southwestern British Columbia, lithic sources (triangles) and archaeological sites (diamonds) considered in this study.

cedar, fir, and hemlock forests, into the Salish Sea and eventually the Pacific Ocean. By comparison, the interior Plateau is dryer, with less vertical relief and a varied array of patchy environments.

Before we describe the sources included in this study, we must first define, archaeologically, what a lithic source actually is (R. Green 1998: 226-228). We use a combination of definitions provided by Glascock et al. (1998:16) and Shackley (2011) who consider both the physical and elemental nature of lithic sources. Physically, an igneous lithic source can occur as primary and secondary deposits. A primary deposit is a lava flow/outcrop or major pyroclastic field (consisting of bomblets) surrounding a volcanic cone(s). Secondary sources and deposits result from erosion activity from glaciers, streams, gravity, or other geological processes that transport material away from a primary zone. Up until now, standardized visual and elemental analysis of igneous lithic sources has been hampered by the fact that these materials are more widespread, in varying sized outcrops, and typically worked into secondary deposits by numerous geomorphological mechanisms (Reimer 2012).

Within the Squamish region, the Garibaldi volcanic belt is responsible for widely available lithic raw material (Kelman et al. 2003; Kelman 2005; Evans and Brooks 1991; Green 1991; Green et al. 1988; Mathews 1957, 1958). Eruptions in this area extend back to the Miocene and as recently as the early Holocene (Kelman 2002:197). Numerous lava flows, exposed as large outcrops at high elevation, are exposed to continual weathering, resulting in a wide range of materials being easily available in local streams and creeks, draining into Squamish River system (Reimer 2012). Notable outcrops and source areas include, Turbid Creek, High Falls Creek, Brandywine Creek and the Watts Point lava dome (Figure 5-1). On the interior Plateau, the Arrowstone Hills source is the result of 50 million year-old shield volcano eruptions (Ewing 1981a and b). Culturally, this source also has a long history of use (Baker et al. 2001, Commisso 1997, 2000; Ewing 1981b; Greenough et al. 2004) (Figure 5-1).

Archaeological Background

The archaeological record of both the Northwest Coast and Plateau spans the past 12,000-10,000 years B.P. (Carlson 1996; Pokotylo and Mitchell 1998; Reimer 2012). Regional researchers (Ames and Maschner 1999; Matson and Coupland 1995; Moss 2011) roughly define the temporal periods of each region into Early (12,000-7,000 BP), Middle (7,000-3,500 BP) and Late (3,500-European contact). Many researchers focused on the topic of complex hunting and gathering, the development of social elites, and household archaeology. A general pattern of this research shows an increase of social complexity, resource intensification, and trade and interaction on a local to regional scale (Ames and Maschner 1999; Hayden 1992, 2000a and b1999; Matson and Coupland 1995). Major regional studies have focused on the role of the range and the amount of marine and land resources utilized by local Coast Salish Indigenous peoples (Matson and Coupland 1995; Ames and Maschner 1999; Moss 2012).

The sites considered here are within Squamish Nation territory, southwestern British Columbia (Figure 5-1). Squamish Nation territory situates along the shores of the Burrard Inlet, Howe Sound and the Squamish River valley. The Squamish Nation represents one faction of the larger Coast Salish cultural-linguistic group inhabiting the region referred to as the Salish Sea. Broadly, archaeological settlement patterns on the southern Northwest Coast start at large sites that tend to be villages or primary resource locations that stretch along coastlines and the river valleys. Away from villages in less exposed locations at specific resource locales are seasonal camps that range along coastlines, river valleys extending up to mid elevation and forested areas. Finally, temporary

Table 5-1. Stratigraphic Layers and 14C Dates for DlRt9.

Layer	Description	14C Date B.P.	Lab Number
A	0-5cm partially disturbed, silt to coarse sand and rook spall, abundant charcoal	30±40	Beta 227278
B	5-10cm yellow to brown silt and sand, some roof spall, abundant charcoal	190±40	Beta 227278
C	25-40cm coarse grey sand, little charcoal	1360±40	Beta 227279
D	40-50cm coarse grey to yellow sand with cemented roof spall cobbles, sparse charcoal	1390±40	Beta 227280

hunting and gathering camps located in high elevation sub-alpine and alpine areas indicate the entire landscape was used for a wide range of uses (Reimer 2000, 2003, 2012). The two sites considered here, are mid elevation rockshelters, in forested contexts, above the confluences of major rivers (Reimer 2012; Squamish Nation 1992). They represent key locations, away and above ethnographically known villages, ranging 300-400 m above sea level and valley bottoms.

DlRt9 situates near the confluence of the Squamish and Ashlu Rivers, 22 km north of the modern town of Squamish (Figure 5-1). It is approximately 300 m above sea level on the southeastern slopes of Buck Mountain. It is a mid-sized rock-shelter, measuring 20 m east to west and 10 m north to south. A dozen pictographs mark its interior walls; depicting deer hunting, spirit animal relations (e.g. bear paws, thunderbird lightening). The surface of the site contains historical materials associated with a traditional trap line registered under the name of George Moody, who traversed the area for plant and animal resources up until the 1960's. A rusted double bladed axe head, remains of a pair of work boots and remnants of newspapers dating to the late 1930's and 1940's illustrate recent use of the shelter. Additionally, a hearth feature visible through a semi-circular ring of rocks is also visible at the site. Excavations of 2 1x1-m units, from the shelters back wall, outwards to the edge of the hearth revealed an intact stratigraphic sequence to a depth of 50 cm below surface. Within this sequence, four distinct layers associated with activities around the hearth feature. Table 5-1 summarizes these layers and ^{14}C dates. Faunal remains at the site were sparse, with deer being the likely ungulate acquired along the nearby mountain slopes, while mountain blueberry was an abundant plant gathered and brought back to the site from higher elevations, likely prepared for fall-winter storage. Two thousand eight hundred eleven artifacts were recovered from the two excavation units at this site. The majority of these were visually assessed as dacite, while the remainder included 52 obsidian, 9 quartz crystal, 8 pieces of quartzite, and a single piece of mica and slate. Technological organization focused on core-flake tool production, and a small degree of tool maintenance occurred on site (Reimer 2004).

EaRu5 situates at the top of the Elaho River canyon (Figure 5-1), 42 km north of the modern town of Squamish (ARCAS 1999). It is a strategic location as it guards access, north into the main Elaho valley, south to the Squamish-Elaho River confluence and west up and over the Coast Range into neighboring Sechelt Nation territory (Reimer 2004). The site consists of two small rockshetler boulders, one measuring 10 m in size, the other 20 m. A single excavation unit was placed in the larger shelter and revealed a stratigraphic sequence extending to 40 cm below surface (Reimer 2004). The excavation unit was placed in-between the shelters back wall and an ethnohistorical hearth feature on the site's surface. As with the DlRt9 shelter, the strata at EaRu5 are intact and illustrated seasonal (spring to fall) use over several hundreds of years (Table 5-2). Faunal remains at the site show a focus on ungulate hunting (deer and mountain goat) while botanical remains show a wide range of environments utilized for sentience (Reimer 2004). Lithic debitage analysis concluded that the people using EaRu5 likely acquired toolstone from a nearby creek or the beds of the Elaho and/or Squamish Rivers. Technology focused on an expedient cobble-core reduction strategy for basic tasks, such as cutting, scraping and sawing, while tool maintenance was minimal. Four hundred thirty two artifacts were recovered in the single excavation unit, with 418 visually assessed as dacite, 13 obsidian, and a single piece of slate. Of the 432 artifacts, only 20 are formed tools (projectile points, bifaces, knives, scrapers) and the remaining cores, flakes and debitage (Reimer 2004). Only 12 artifacts are formed tools (projectile point, bifaces, scrapers). Similar to DlRt9, the technological organization focused on core-flake tool production and a small degree of tool maintenance occurred on site (Reimer 2006).

Table 5-2. Stratigraphic Layers and 14C Dates for EaRu5.

Layer	Description	14C Date BP	Lab Number
A	0-12cm yellow to brown silt and sand, little charcoal	75±35	CAMS 111663
B	13-33cm dark brown to black hearth feature	225±25	CAMS 111664
C	34-39cm dark brown to black hearth feature grading with depth into grey sand	655±35	CAMS 111665
D	40cm coarse grey sand and cobbles	1210±35	CAMS 111666

Analytic Methods

The instrument used in this analysis is a Bruker AXS Tracer III-V+ portable EDXRF. In the lab, the instrument was mounted in a stable stand, allowing for easy maintenance of a fixed position. It is equipped with a rhodium tube that emits x-rays, a peltier cooled silicon PIN diode detector, operating at 40 kV and 13uA from an external power source. Samples ran for 180 live seconds with a filter comprised of 6 mm Cu (copper), 1 mm Ti (titanium), and 12mm Al (Aluminum). The Tracer produces an x-ray beam at a 45-degree angle from the centre of the analyzer window that measures 4 mm across. Placing it in front of the instrument with clean, flat surfaces that covered the entire instrument window ensured that each sample was exposed to x-rays. This ensured that each sample achieved an optimal count rate and minimized x-ray scatter.

X-ray counts, processed through the S1PXRF Canada program, developed by Bruker, allow the user to examine spectra live time during analysis or review afterwards. Results, converted to parts per million through another Bruker program, S1CalProcess, uses the rhodium Compton backscatter and a database of nearly 40 previously known and established values for obsidian sources around the world, as determined by the University of Missouri Nuclear Reactor. This database empirically calibrates the instrument by comparing expected values with those produced by the instrument for the following elements manganese (Mn), iron (Fe), zinc (Zn), gallium (Ga), thorium (Th), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr) and niobium (Nb).

In total, 306 samples were examined, 53 from primary geological source deposits (Table 5-3), 166 artifacts from DlRt9 (Table 5-4), and 87 artifacts from EaRu5 (Table 5-5). Selection of samples from archaeological sites came from each site's layer/level bags. Visual analysis of site assemblages concluded that a single type of raw material- dacite -dominates them. As such, only these materials were subject to analysis. From each bag, we visually examined its contents for the widest range of visual lithic raw material variation. This helped us determine if the ancient users of each site used a single or multiple sources of toolstone (e.g. coarse to fine grained material, different colour, hardness, luster, amount and density of phenocrysts).

Results

Sources

Figure 5-2 provides graphic geochemical data on the geological sources considered in this study. Separation of all the source materials is possible using pXRF and a range of mid to high range Z trace elements (Rb, Sr, Y, Zr, and Nb). The clearest separation of these source materials uses Sr and Zr, both elements abundant in each source, while the other elements illustrate less separation. Confidence

Table 5-3. Source Data for Materials Included in This Study. All Values in ppm.

Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Turbid	1045	37577	123	1	10	33	3946	15	224	5
Turbid	1151	40767	116	8	10	36	4307	18	225	4
Turbid	1246	40461	142	8	11	34	4234	16	245	5
Turbid	1014	42451	139	10	11	35	5362	19	244	4
Turbid	979	40664	119	4	8	40	4873	14	220	5
Turbid	1177	42222	109	6	8	35	5181	18	238	6
Turbid	1193	39224	144	13	8	36	4043	15	237	5
Turbid	1195	39680	124	-1	10	32	4036	16	216	4
Turbid	1097	42613	121	5	12	38	3327	17	203	5
Watts	717	26094	70	14	0	26	1032	15	154	3

Table 5-3 (continued). Source Data for Materials Included in This Study. All Values in ppm.

Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
Watts	671	27709	77	14	1	27	1014	14	145	5
Watts	595	28496	71	13	1	32	1017	13	147	5
Watts	689	26074	63	14	0	28	1052	14	148	6
Watts	713	26393	68	13	2	31	1050	13	153	6
Watts	548	25721	66	14	2	26	941	15	144	1
Watts	696	28447	69	13	3	27	1056	13	156	6
Watts	408	23697	61	14	1	24	942	12	138	5
Watts	759	27519	81	13	2	32	1089	12	166	4
Watts	680	30130	96	14	4	33	1106	12	157	5
Watts	709	29693	102	15	0	34	1067	14	151	4
Watts	635	32018	88	13	0	31	1036	13	153	4
Watts	614	25505	68	14	0	29	972	13	142	3
Watts	653	28663	81	14	2	28	1023	12	154	3
Watts	502	27239	70	14	2	29	1054	13	148	2
Watts	643	27153	74	14	1	28	1054	10	153	6
Brandywine Creek	1107	32313	95	9	3	33	1717	12	167	4
Brandywine Creek	1003	37452	116	11	5	38	1747	15	167	3
Brandywine Creek	1039	34859	93	10	7	34	1648	11	156	5
High Falls	1203	57942	143	1	2	26	3294	17	188	5
High Falls	1177	60790	148	1	10	22	3323	16	214	5
High Falls	1079	60998	150	0	9	25	3327	17	186	6
High Falls	1221	56934	133	8	6	24	2900	14	189	4
High Falls	1221	56874	140	0	8	22	3034	17	199	7
High Falls	1144	60603	144	0	10	22	3174	16	219	5
High Falls	1195	52193	144	9	10	33	2336	14	208	9
High Falls	1324	54709	131	4	11	30	2227	15	209	7
High Falls	1137	47236	122	9	8	29	2784	14	204	6
Arrowstone	470	18058	63	15	11	140	563	13	213	9
Arrowstone	609	16148	74	16	10	138	528	13	213	7
Arrowstone	317	15740	80	17	13	137	535	11	218	8
Arrowstone	537	18073	60	15	12	129	525	12	214	7
Arrowstone	320	14811	70	17	9	123	536	11	199	7
Arrowstone	324	18067	62	16	10	121	497	10	195	7
Arrowstone	481	17550	56	15	10	127	530	15	202	9
Arrowstone	483	17481	68	16	10	118	533	11	199	7
Arrowstone	463	19667	59	15	9	129	535	11	198	7
Arrowstone	412	18747	58	15	9	122	515	10	208	9
Arrowstone	441	14749	63	14	7	111	477	10	186	7
Arrowstone	355	16012	68	16	11	120	512	13	205	6
Arrowstone	436	17106	73	16	11	126	494	11	188	9
Arrowstone	382	17180	47	14	12	118	576	11	199	8
Arrowstone	526	18107	65	15	11	126	538	11	204	9
Arrowstone	529	20582	94	17	13	133	542	11	214	6

Table 5-4. XRF Data for Artifacts from DlRt 9. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
DlRt9 Unit1 LayerA-0 Tool	High Falls	685	31009	97	14	3	29	3044	14	176	5
DlRt9 Unit1 LayerA-0.10	Watts	749	27711	84	14	1	23	1310	10	132	3
DlRt9 Unit1 LayerA-0.11	Brandywine Creek	817	28951	86	14	2	24	1657	12	129	5
DlRt9 Unit1 LayerA-0.2	High Falls	720	29729	147	18	5	28	2722	13	169	3
DlRt9 Unit1 LayerA-0.6	High Falls	677	29065	96	15	3	25	2861	12	172	3
DlRt9 Unit1 LayerA-0.7	High Falls	775	29508	95	14	6	25	2912	13	171	6

Table 5-4 (continued). XRF Data for Artifacts from DlRt 9. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
DlRt9 Unit1 LayerA-0.8	High Falls	725	29598	115	16	4	23	2739	13	173	5
DlRt9 Unit1 LayerA-0.9	High Falls	684	29984	130	16	6	25	2854	12	179	4
DlRt9 Unit1 LayerA-0	High Falls	830	32118	101	14	7	30	2969	12	169	5
DlRt9 Unit1 LayerA-1 Tool	Watts	751	26900	89	15	2	43	933	13	125	4
DlRt9 Unit1 LayerA-1 Tool	High Falls	655	29278	101	14	1	30	2880	11	177	4
DlRt9 Unit1 LayerA-1.12	High Falls	970	30671	103	14	5	34	2941	11	177	3
DlRt9 Unit1 LayerA-1.2	High Falls	849	30931	108	14	5	29	2824	12	171	3
DlRt9 Unit1 LayerA-1.3	High Falls	750	29441	114	14	5	26	2752	12	173	4
DlRt9 Unit1 LayerA-1.5	High Falls	689	30556	88	14	7	26	2927	10	174	3
DlRt9 Unit1 LayerA-1.6	High Falls	806	29413	71	13	7	24	2931	13	167	4
DlRt9 Unit1 LayerA-1.7	High Falls	801	31561	126	15	5	32	3012	11	180	3
DlRt9 Unit1 LayerA-1.8	High Falls	779	33213	105	14	5	25	3725	14	195	3
DlRt9 Unit1 LayerA-1.9	High Falls	647	30365	133	17	2	26	2874	13	171	3
DlRt9 Unit1 LayerA-1	High Falls	634	31223	97	14	7	25	3047	14	176	3
DlRt9 Unit1 LayerA-2.10	Watts	829	34978	156	16	1	18	1165	13	167	6
DlRt9 Unit1 LayerA-2.11	High Falls	660	33033	103	14	8	24	3365	13	195	3
DlRt9 Unit1 LayerA-2.12	High Falls	815	36541	176	16	3	24	3188	11	187	6
DlRt9 Unit1 LayerA-2.13	High Falls	788	32092	115	15	6	38	3011	12	179	4
DlRt9 Unit1 LayerA-2.15	High Falls	831	40910	441	28	5	39	2889	10	152	5
DlRt9 Unit1 LayerA-2.2	High Falls	674	29726	87	13	4	22	2321	13	178	4
DlRt9 Unit1 LayerA-2.3	High Falls	750	34692	150	14	3	22	3364	11	185	6
DlRt9 Unit1 LayerA-2.4	Watts	585	28189	106	15	2	23	1340	12	148	2
DlRt9 Unit1 LayerA-2.5	High Falls	724	33469	123	15	5	29	3006	13	188	4
DlRt9 Unit1 LayerA-2.6	High Falls	765	29989	122	14	6	24	2799	14	179	2
DlRt9 Unit1 LayerA-2.7	High Falls	746	32475	123	15	2	24	2984	13	180	4
DlRt9 Unit1 LayerA-2.8	High Falls	790	30148	112	15	4	25	2781	9	166	3
DlRt9 Unit1 LayerA-2.9	High Falls	675	31093	98	14	5	27	2912	13	174	7
DlRt9 Unit1 LayerA-2	High Falls	638	30960	117	16	7	22	2940	15	179	4
DlRt9 Unit1 LayerB-3 Tool	High Falls	869	30622	107	14	8	23	2967	13	181	5
DlRt9 Unit1 LayerB-3.11	High Falls	943	41500	368	27	2	30	2956	10	169	5
DlRt9 Unit1 LayerB-3.3	High Falls	654	30623	114	15	3	26	2933	12	165	3
DlRt9 Unit1 LayerB-3.4	Watts	872	29510	92	14	1	20	1373	9	142	3
DlRt9 Unit1 LayerB-3.6	High Falls	645	31523	125	16	7	26	3147	12	186	5
DlRt9 Unit1 LayerB-3.8	High Falls	697	33236	114	15	2	30	3300	14	189	5
DlRt9 Unit1 LayerB-3.9	High Falls	710	30884	99	14	6	31	2387	11	170	4
DlRt9 Unit1 LayerB-4.10	Watts	920	33444	163	17	-2	16	1101	12	154	5
DlRt9 Unit1 LayerB-4.2	High Falls	713	31664	124	16	4	29	3004	11	183	4
DlRt9 Unit1 LayerB-4.3	High Falls	827	34334	169	17	6	36	3237	14	183	3
DlRt9 Unit1 LayerB-4.5	High Falls	732	31738	85	14	1	27	2988	13	164	3
DlRt9 Unit1 LayerB-4.6	High Falls	754	32975	97	14	2	28	2995	12	179	5
DlRt9 Unit1 LayerB-4.7	High Falls	756	33760	109	14	2	26	3009	13	177	3
DlRt9 Unit1 LayerB-4.9	High Falls	989	35140	171	16	4	34	2675	11	172	2
DlRt9 Unit1 LayerB-4	High Falls	649	31329	80	13	4	24	2812	12	170	4
DlRt9 Unit1 LayerBC-5.2	High Falls	789	31831	176	18	6	33	3014	10	163	3
DlRt9 Unit1 LayerBC-5.3	High Falls	734	32950	107	14	4	23	2949	12	175	4
DlRt9 Unit1 LayerBC-5.4	High Falls	773	31059	99	9	4	33	2815	11	165	5
DlRt9 Unit1 LayerBC-5.5	High Falls	699	32785	106	14	1	26	2900	14	182	5
DlRt9 Unit1 LayerBC-5.6	Watts	751	27060	140	17	0	24	896	12	138	4
DlRt9 Unit1 LayerBC-5.7	High Falls	1286	31981	180	17	1	23	2987	13	185	4
DlRt9 Unit1 LayerBC-5	Brandywine Creek	740	28624	99	14	4	26	1783	12	152	3
DlRt9 Unit1 LayerBC-6.3	High Falls	602	32661	154	17	6	28	2574	12	181	2
DlRt9 Unit1 LayerBC-6.4	Watts	707	31261	78	13	1	23	1375	14	149	4
DlRt9 Unit1 LayerBC-6.5	High Falls	702	35537	220	20	1	35	3446	12	182	4
DlRt9 Unit1 LayerBC-6.6	High Falls	764	32543	114	15	3	28	2960	14	166	2
DlRt9 Unit1 LayerBC-6	High Falls	726	29514	101	15	4	28	2735	13	170	4

Table 5-4 (continued). XRF Data for Artifacts from DlRt 9. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
DlRt9 Unit1 LayerC-7	High Falls	871	29096	108	15	3	23	2770	11	173	5
DlRt9 Unit1 Surface Tool	High Falls	710	31424	102	14	6	29	3018	15	174	6
DlRt9 Unit1 Surface	Brandywine Creek	787	26787	92	15	6	25	1743	13	149	4
DlRt9 Unit1 Surface	High Falls	721	31293	124	15	3	26	3495	14	192	3
DlRt9 Unit1 Surface	High Falls	637	33365	84	13	4	24	2963	16	182	3
DlRt9 Unit1 Surface	Watts	813	27151	93	15	4	23	1278	12	136	5
DlRt9 Unit1 Surface	High Falls	780	30797	105	15	10	28	3066	12	182	4
DlRt9 Unit2 LayerA-0.10	High Falls	509	34691	153	17	6	25	3160	12	172	8
DlRt9 Unit2 LayerA-0.11	High Falls	678	29301	114	16	3	22	2896	14	171	5
DlRt9 Unit2 LayerA-0.2	High Falls	763	32725	99	14	9	25	3042	12	177	3
DlRt9 Unit2 LayerA-0.3	High Falls	851	31942	101	14	3	32	3008	13	178	3
DlRt9 Unit2 LayerA-0.5	High Falls	816	29529	102	14	5	28	2992	14	187	4
DlRt9 Unit2 LayerA-0.6	High Falls	745	28836	90	15	3	31	2868	12	182	6
DlRt9 Unit2 LayerA-0.7	High Falls	1535	17264	153	20	2	30	2608	11	162	4
DlRt9 Unit2 LayerA-0.8	Brandywine Creek	768	31199	98	14	5	25	1900	12	149	5
DlRt9 Unit2 LayerA-0	High Falls	1023	32022	118	15	4	25	3063	13	185	5
DlRt9 Unit2 LayerA-1 Tool	Arrowstone	428	15891	65	16	9	108	489	10	174	6
DlRt9 Unit2 LayerA-1 Tool	Watts	669	28480	85	14	3	24	1351	13	139	3
DlRt9 Unit2 LayerA-1 Tool	Watts	669	28480	85	14	3	24	1351	13	139	3
DlRt9 Unit2 LayerA-1 Tool	High Falls	848	30818	101	14	5	23	2928	12	173	3
DlRt9 Unit2 LayerA-1.10	High Falls	758	30388	99	14	3	25	2984	12	180	3
DlRt9 Unit2 LayerA-1.12	High Falls	794	29772	101	14	4	33	2930	13	180	3
DlRt9 Unit2 LayerA-1.13	High Falls	724	32076	114	15	4	25	2999	14	172	3
DlRt9 Unit2 LayerA-1.15	High Falls	719	29707	120	16	4	32	2918	14	174	3
DlRt9 Unit2 LayerA-1.2	High Falls	845	29141	105	15	6	27	3050	12	176	4
DlRt9 Unit2 LayerA-1.3	High Falls	669	32458	100	14	4	30	3099	12	182	4
DlRt9 Unit2 LayerA-1.4	High Falls	880	31058	177	19	4	35	2920	11	171	4
DlRt9 Unit2 LayerA-1.5	High Falls	675	28501	91	13	5	24	2804	11	170	3
DlRt9 Unit2 LayerA-1.6	High Falls	921	31703	137	16	4	28	3047	11	184	3
DlRt9 Unit2 LayerA-1.7	High Falls	926	31864	208	20	4	25	2908	12	168	2
DlRt9 Unit2 LayerA-1.8	High Falls	913	29854	119	15	7	40	2953	13	183	6
DlRt9 Unit2 LayerA-1.9	High Falls	763	30192	122	16	4	25	2837	14	180	4
DlRt9 Unit2 LayerA-1	High Falls	601	31092	101	14	5	27	2994	11	177	8
DlRt9 Unit2 LayerA-2 Tool	High Falls	836	32736	118	13	6	23	2846	12	183	5
DlRt9 Unit2 LayerA-2 Tool	Brandywine Creek	875	31848	99	14	0	27	1887	13	161	5
DlRt9 Unit2 LayerA-2.11	High Falls	841	43532	246	19	6	33	2665	11	173	5
DlRt9 Unit2 LayerA-2.12	Watts	745	30290	508	35	16	125	909	5	172	4
DlRt9 Unit2 LayerA-2.14	High Falls	770	35969	249	22	7	31	2311	10	165	3
DlRt9 Unit2 LayerA-2.2	Watts	769	32748	96	14	1	23	1406	13	145	5
DlRt9 Unit2 LayerA-2.3	High Falls	775	33424	105	13	4	32	3065	13	179	2
DlRt9 Unit2 LayerA-2.4	Arrowstone	399	18240	97	17	12	121	549	11	199	8
DlRt9 Unit2 LayerA-2.6	High Falls	636	28044	153	17	2	27	2778	13	165	3
DlRt9 Unit2 LayerA-2.7	High Falls	971	55834	182	11	2	18	2115	11	146	4
DlRt9 Unit2 LayerA-2.8	High Falls	802	33434	148	16	3	29	3305	13	182	3
DlRt9 Unit2 LayerA-2.9	High Falls	887	38195	249	20	3	32	3412	12	167	5
DlRt9 Unit2 LayerA-2	High Falls	747	30399	101	15	2	26	2917	11	178	4
DlRt9 Unit2 LayerB-2 Tool	High Falls	762	31827	102	14	7	26	3040	14	178	4
DlRt9 Unit2 LayerB-3 Tool	High Falls	668	31640	135	16	5	25	3021	16	173	4
DlRt9 Unit2 LayerB-3 Tool	Brandywine Creek	776	36730	198	19	2	36	1777	10	146	5
DlRt9 Unit2 LayerB-3	High Falls	641	30385	91	13	1	25	3124	14	171	5
DlRt9 Unit2 LayerB-3	High Falls	794	32218	108	15	1	24	2390	10	172	4
DlRt9 Unit2 LayerB-3	High Falls	1290	32882	210	20	3	43	2432	11	168	3
DlRt9 Unit2 LayerB-3	High Falls	717	29942	101	15	6	29	2996	14	185	5
DlRt9 Unit2 LayerB-3	High Falls	803	31495	101	15	6	27	2880	14	183	4
DlRt9 Unit2 LayerB-3	High Falls	811	36439	278	23	5	27	2931	15	161	3
DlRt9 Unit2 LayerB-3	High Falls	999	30589	143	17	3	35	2891	14	184	5

Table 5-4 (continued). XRF Data for Artifacts from DlRt 9. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
DlRt9 Unit2 LayerB-3	High Falls	735	32567	90	13	5	25	3228	11	183	5
DlRt9 Unit2 LayerB-3.3	High Falls	773	33159	164	17	6	27	3181	14	187	4
DlRt9 Unit2 LayerB-3.4	High Falls	593	32110	111	15	6	40	2975	11	176	4
DlRt9 Unit2 LayerB-3.5	High Falls	690	32704	115	15	6	25	3345	16	185	5
DlRt9 Unit2 LayerB-3.6	High Falls	1002	30216	123	16	3	35	2914	13	177	4
DlRt9 Unit2 LayerB-3.7	Brandywine Creek	701	31030	88	14	2	27	1773	11	147	2
DlRt9 Unit2 LayerB-3.8	High Falls	841	31202	131	16	1	31	2855	11	177	5
DlRt9 Unit2 LayerB-3.9	High Falls	676	34336	154	17	3	26	3004	12	174	3
DlRt9 Unit2 LayerB-3	High Falls	751	30623	107	14	3	27	3099	15	189	6
DlRt9 Unit2 LayerBC-4 Tool	Watts	661	28330	85	14	1	30	1317	11	140	4
DlRt9 Unit2 LayerBC-4.2	High Falls	773	33882	113	13	5	31	2764	10	180	4
DlRt9 Unit2 LayerBC-4.3	High Falls	794	30963	112	15	4	26	2876	14	172	4
DlRt9 Unit2 LayerBC-4.4	High Falls	793	34448	178	18	3	32	2939	12	169	1
DlRt9 Unit2 LayerBC-4.5	High Falls	842	29414	101	15	4	27	2772	12	177	2
DlRt9 Unit2 LayerBC-4.6	High Falls	714	31319	147	17	5	22	3067	12	183	3
DlRt9 Unit2 LayerBC-4	Watts	600	27735	98	15	2	28	1515	10	140	3
DlRt9 Unit2 LayerBC-5 Tool	High Falls	664	30104	112	12	5	34	2995	14	180	3
DlRt9 Unit2 LayerBC-5.2	High Falls	715	32714	128	16	7	30	3076	13	176	6
DlRt9 Unit2 LayerBC-5.3	High Falls	792	34440	206	19	3	33	3234	11	179	5
DlRt9 Unit2 LayerBC-5.4	High Falls	809	30549	93	14	2	27	2745	9	166	6
DlRt9 Unit2 LayerBC-5.5	High Falls	576	30139	122	16	5	22	2697	13	174	3
DlRt9 Unit2 LayerBC-5.6	Brandywine Creek	695	31104	102	15	4	22	1806	13	150	4
DlRt9 Unit2 LayerBC-5.7	High Falls	860	31916	146	15	4	46	2746	10	172	2
DlRt9 Unit2 LayerBC-5.8	High Falls	837	34297	233	20	9	36	3304	12	176	2
DlRt9 Unit2 LayerBC-5	High Falls	736	34226	93	13	6	22	3158	13	184	4
DlRt9 Unit2 LayerC-6.2	High Falls	899	31473	125	16	6	27	3056	12	176	6
DlRt9 Unit2 LayerC-6.3	High Falls	730	32157	190	19	3	24	3082	11	174	5
DlRt9 Unit2 LayerC-6.4	High Falls	831	35253	205	18	4	29	3115	10	178	3
DlRt9 Unit2 LayerC-6.5	High Falls	973	36350	321	21	4	30	3102	10	167	4
DlRt9 Unit2 LayerC-6.6	High Falls	764	40007	327	22	6	28	3318	11	180	7
DlRt9 Unit2 LayerC-6.7	High Falls	831	34818	336	27	5	30	3253	12	178	5
DlRt9 Unit2 LayerC-6	High Falls	772	32053	115	14	6	27	3410	14	183	5
DlRt9 Unit2 Surface Tool	Arrowstone	511	16552	81	16	8	115	501	12	181	5
DlRt9 Unit2 Surface	High Falls	666	29291	112	16	2	31	2660	12	173	2
DlRt9 Unit2 Surface	Watts	673	24887	73	15	-2	22	1177	9	125	3
DlRt9 Unit2 Surface	High Falls	707	29746	79	13	4	24	2958	13	180	4
DlRt9 Unit2 Surface	High Falls	644	30333	152	18	1	25	2909	13	172	4
DlRt9 Unit2 Surface	High Falls	703	29947	92	14	6	25	3020	13	187	7
DlRt9 Unit2 Surface	High Falls	1398	21369	130	18	3	29	2840	13	181	2
DlRt9 Unit2 Surface	High Falls	783	31812	98	11	7	27	2959	13	172	4
DlRt9 Unit2	High Falls	753	31448	122	15	5	23	2883	16	180	6
DlRt9 Unit2	High Falls	689	31840	93	14	4	34	3123	14	184	4
DlRt9 Unit2	High Falls	652	31742	124	15	4	24	2999	15	183	2
DlRt9 Unit2	High Falls	662	33999	176	18	7	26	3051	10	184	3
DlRt9 Unit2	High Falls	1294	34173	237	21	5	30	2830	12	182	5
DlRt9 Unit2	High Falls	649	36162	227	19	2	30	3142	13	166	4
DlRt9 Unit2	High Falls	741	29341	112	15	5	29	2837	13	171	4
DlRt9 Unit2	High Falls	839	35516	238	20	3	23	3117	12	175	3
DlRt9 Unit2	High Falls	676	34478	175	18	3	22	3171	12	175	3
DlRt9 Unit2	High Falls	724	31252	108	15	5	27	3052	15	175	2

Table 5-5. XRF Data for Artifacts from EaRu5. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
EaRu5 Unit1 LayerA-0 Tool	Arrowstone	659	17936	190	22	13	124	512	11	194	5
EaRu5 Unit1 LayerA-0 Tool	Unknown	786	15747	72	17	6	82	620	9	157	3
EaRu5 Unit1 LayerA-0 Tool	Arrowstone	804	15939	62	16	7	113	504	9	184	9
EaRu5 Unit1 LayerA-0 Tool	Arrowstone	522	17082	143	19	10	127	531	13	186	7
EaRu5 Unit1 LayerA-0 Tool	Unknown	928	17966	118	19	7	96	767	8	181	3
EaRu5 Unit1 LayerA-0.2	High Falls	728	28331	99	13	2	36	2715	11	168	5
EaRu5 Unit1 LayerA-0.3	High Falls	1361	30249	168	18	0	46	2998	13	187	1
EaRu5 Unit1 LayerA-0.4	High Falls	1049	31769	141	16	3	38	3067	13	186	5
EaRu5 Unit1 LayerA-0.5	High Falls	2312	30130	188	19	3	36	3076	13	186	5
EaRu5 Unit1 LayerA-0.6	High Falls	1118	31190	100	14	5	28	3235	13	182	4
EaRu5 Unit1 LayerA-0	Unknown	570	17546	88	17	1	89	707	9	173	5
EaRu5 Unit1 LayerA-1 Tool	Arrowstone	689	16485	129	19	12	127	515	9	170	6
EaRu5 Unit1 LayerA-1.2	High Falls	946	30235	112	15	3	31	3168	13	181	2
EaRu5 Unit1 LayerA-1.3	High Falls	1307	34841	189	16	4	33	4069	12	209	3
EaRu5 Unit1 LayerA-1.4	Unknown	2347	16829	164	21	2	83	734	10	175	5
EaRu5 Unit1 LayerA-1.5	Unknown	2347	16829	164	21	2	83	734	10	175	5
EaRu5 Unit1 LayerA-1.6	Arrowstone	2061	19117	203	23	9	128	555	9	192	8
EaRu5 Unit1 LayerA-1.7	Unknown	2467	22637	441	38	10	118	848	8	178	5
EaRu5 Unit1 LayerA-1.9	Unknown	606	21710	291	28	5	85	761	6	171	3
EaRu5 Unit1 LayerA-1	High Falls	946	30235	112	15	3	31	3168	13	181	2
EaRu5 Unit1 LayerAB-1 Tool	Arrowstone	653	19794	221	24	11	124	546	9	198	7
EaRu5 Unit1 LayerAB-1 Tool	Arrowstone	1163	16930	157	21	11	124	536	10	190	8
EaRu5 Unit1 LayerAB-1 Tool	Unknown	472	18605	90	16	4	92	728	8	178	3
EaRu5 Unit1 LayerAB-1 Tool	Unknown	1281	16807	105	18	7	92	717	5	175	3
EaRu5 Unit1 LayerAB-1 Tool	Unknown	1042	17196	197	23	8	104	702	8	168	4
EaRu5 Unit1 LayerAB-1 Tool	Unknown	1819	15967	234	26	5	95	727	9	182	2
EaRu5 Unit1 LayerAB-1 Tool	Arrowstone	727	18207	83	16	12	126	549	12	191	8
EaRu5 Unit1 LayerAB-1.10	High Falls	575	35920	139	15	4	24	3842	14	203	5
EaRu5 Unit1 LayerAB-1.11	High Falls	854	32248	136	16	6	33	3145	12	183	4
EaRu5 Unit1 LayerAB-1.12	Arrowstone	486	18943	126	19	12	129	567	13	200	6
EaRu5 Unit1 LayerAB-1.2	Unknown	517	18642	170	22	6	92	771	8	176	1
EaRu5 Unit1 LayerAB-1.4	High Falls	732	33612	90	13	1	28	3113	10	185	5
EaRu5 Unit1 LayerAB-1.5	High Falls	1094	31536	113	15	7	28	2931	11	188	3
EaRu5 Unit1 LayerAB-1.6	High Falls	971	30790	172	18	7	35	2978	15	179	4
EaRu5 Unit1 LayerAB-1.7	High Falls	663	34266	104	14	2	27	3204	11	180	3
EaRu5 Unit1 LayerAB-1.8	High Falls	730	33708	113	15	4	28	3044	14	182	2
EaRu5 Unit1 LayerAB-1.9	High Falls	909	32939	97	13	6	31	3788	16	191	2
EaRu5 Unit1 LayerAB-1	High Falls	1073	32839	140	16	5	29	3709	13	194	2
EaRu5 Unit1 LayerB-2 Tool	Unknown	666	17044	99	18	5	91	712	8	172	3
EaRu5 Unit1 LayerB-2 Tool	Unknown	481	18553	179	22	6	93	721	5	168	4
EaRu5 Unit1 LayerB-2 Tool	Unknown	509	18116	133	19	5	83	719	10	170	4
EaRu5 Unit1 LayerB-2 Tool	Unknown	432	18502	151	20	5	90	712	11	177	4
EaRu5 Unit1 LayerB-2 Tool	Unknown	1011	18709	230	25	7	107	733	8	172	3
EaRu5 Unit1 LayerB-2 Tool	Unknown	503	16764	137	19	5	80	693	10	167	3
EaRu5 Unit1 LayerB-2 Tool	Unknown	385	17662	129	19	7	87	691	10	178	3
EaRu5 Unit1 LayerB-2 Tool	Unknown	669	17993	75	16	7	89	718	8	174	4
EaRu5 Unit1 LayerB-2.10	High Falls	949	30914	113	15	5	25	3041	11	185	5
EaRu5 Unit1 LayerB-2.11	High Falls	844	33556	106	14	6	31	3118	13	193	4
EaRu5 Unit1 LayerB-2.12	Unknown	728	15284	97	18	5	85	762	10	173	3
EaRu5 Unit1 LayerB-2.13	Unknown	505	19849	134	19	5	100	804	10	186	2
EaRu5 Unit1 LayerB-2.14	High Falls	2162	30620	109	13	3	30	3049	12	180	5
EaRu5 Unit1 LayerB-2.15	High Falls	811	31253	167	16	5	26	3051	11	173	4
EaRu5 Unit1 LayerB-2.16	Arrowstone	452	18393	76	15	12	126	548	15	198	6
EaRu5 Unit1 LayerB-2.17	High Falls	718	31395	121	16	6	26	2977	14	181	5
EaRu5 Unit1 LayerB-2.18	High Falls	647	34311	179	18	3	27	3296	14	179	2
EaRu5 Unit1 LayerB-2.19	High Falls	708	30269	164	18	4	49	3078	13	176	4

Table 5-5 (continued). XRF Data for Artifacts from EaRu5. All Values in ppm.

Context	Source	Mn	Fe	Zn	Ga	Th	Rb	Sr	Y	Zr	Nb
EaRu5 Unit1 LayerB-2.2	High Falls	804	32121	94	14	3	35	3028	12	183	5
EaRu5 Unit1 LayerB-2.20	High Falls	795	34711	141	15	4	26	3352	14	182	3
EaRu5 Unit1 LayerB-2.22	Unknown	443	17178	113	19	6	82	702	6	174	3
EaRu5 Unit1 LayerB-2.23	High Falls	776	32580	109	15	3	27	3754	13	199	4
EaRu5 Unit1 LayerB-2.24	High Falls	776	32580	109	15	3	27	3754	13	199	4
EaRu5 Unit1 LayerB-2.26	High Falls	714	29676	121	16	2	30	2872	9	171	3
EaRu5 Unit1 LayerB-2.28	Unknown	466	19867	133	19	7	92	746	8	176	4
EaRu5 Unit1 LayerB-2.3	High Falls	902	31457	101	14	2	26	3115	16	181	5
EaRu5 Unit1 LayerB-2.4	High Falls	893	32662	106	14	3	31	2820	13	176	6
EaRu5 Unit1 LayerB-2.5	Arrowstone	758	16179	84	17	9	122	516	10	185	6
EaRu5 Unit1 LayerB-2.6	High Falls	763	34051	111	14	7	31	3143	14	182	3
EaRu5 Unit1 LayerB-2.7	Unknown	699	18283	126	19	7	90	722	9	182	3
EaRu5 Unit1 LayerB-2.8	High Falls	627	31772	186	19	4	30	3019	10	174	4
EaRu5 Unit1 LayerB-2.9	High Falls	745	31088	84	14	5	27	3534	12	193	2
EaRu5 Unit1 LayerB-2	High Falls	768	31908	92	11	4	25	3124	13	178	4
EaRu5 Unit1 LayerB-3 Tool	Unknown	581	19192	183	22	7	85	721	6	168	5
EaRu5 Unit1 LayerB-3.11	High Falls	694	30004	115	15	5	23	2847	11	164	4
EaRu5 Unit1 LayerB-3.2	Unknown	375	20297	134	19	9	93	741	9	176	2
EaRu5 Unit1 LayerB-3.3	High Falls	1364	32956	112	14	4	30	3501	14	180	4
EaRu5 Unit1 LayerB-3.4	Unknown	274	24286	246	22	11	102	872	7	186	2
EaRu5 Unit1 LayerB-3.5	High Falls	1119	34125	151	16	5	31	2808	16	203	6
EaRu5 Unit1 LayerB-3.6	Unknown	391	26045	276	26	14	106	887	7	180	2
EaRu5 Unit1 LayerB-3.7	High Falls	909	32490	107	14	2	27	3030	13	186	5
EaRu5 Unit1 LayerB-3.8	High Falls	845	32345	147	17	5	26	3084	13	182	4
EaRu5 Unit1 LayerB-3.9	High Falls	640	31433	83	12	5	27	2959	12	176	4
EaRu5 Unit1 LayerB-3	High Falls	636	30616	147	17	8	40	2953	12	179	3
EaRu5 Unit1 LayerC-3.2	High Falls	799	34338	153	16	3	32	3039	11	179	7
EaRu5 Unit1 LayerC-3.3	High Falls	1060	31263	120	14	5	39	3244	14	183	4
EaRu5 Unit1 LayerC-3.4	High Falls	800	30253	87	14	4	25	2875	11	182	3
EaRu5 Unit1 LayerC-3.5	High Falls	680	30123	92	14	5	25	2848	14	178	5
EaRu5 Unit1 LayerC-3	High Falls	680	33503	97	14	3	26	3643	13	191	4

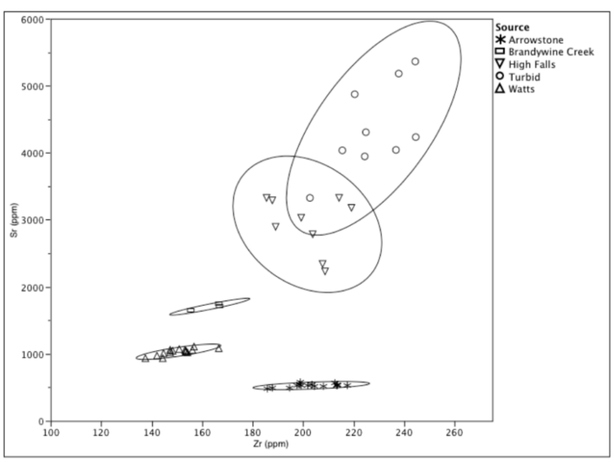

Figure 5-2. Elemental biplot of strontium and zirconium for lithic sources. Confidence ellipses are 95 percent and all values in ppm.

ellipses in Figure 5-2 are at 95 percent and all values are in parts per million (ppm). As light overlap exists between the High Falls Creek and Turbid Creek source that is due to the similar geological origin from the Mount Cayley volcanic field, however, these materials can be double checked with visual assessment- High Falls Creek is lighter in color, is coarser grained and contains more phynocrysts. What is notable is that these materials, like obsidian sources, are relatively chemically homogenous. Samples included here were collected in the widest range of localities possible to ensure that there range of variation is captured. Trace elements that are not compatible demonstrate similar results as obsidian, but this result shows that pXRF can discriminate one igneous rock source from another- be it sources proximate to each other, or separated by substantial distance.

Archaeological Sites

Of the 166 artifacts sampled from DlRt9, all were

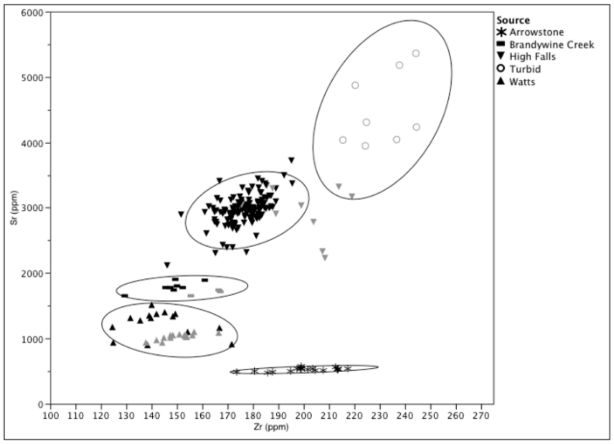

Figure 5-3. Elemental biplot of strontium and zirconium for lithic sources (lightly shaded) and artifact materials from DlRt 9. Confidence ellipses are 95 percent and all values in ppm. **Elemental biplot of strontium and zirconium for lithic sources (lightly shaded) and artifact materials from DlRt 9. Confidence ellipses are 95 percent and all values in ppm.**

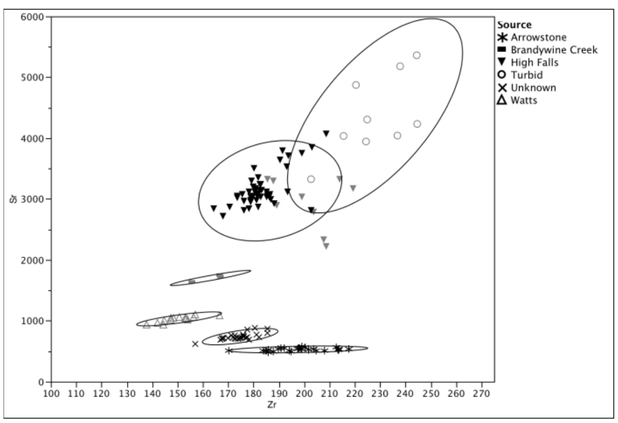

Figure 5-4. Elemental biplot of strontium and zirconium for lithic sources (lightly shaded) and artifact materials from EaRu 5. Confidence ellipses are 95 percent and all values in ppm.

assigned to a known source (Figure 5-3). Surprisingly, not one of the artifacts derives from local Turbid Creek source. This is likely due to the matching to source signatures. The next closest source, Brandywine Creek was represented by eight artifacts, followed by fifteen from Watts Point, located in northern Howe Sound. The most distant source, Arrowstone Hills, accounts for three items at this site. This and other signatures mark the first known occurrence of this material from the interior Plateau, on the Northwest Coast. Of the 87 artifacts from EaRu5, 58 assign to a known geological source and 29 originate from an unknown source (Figure 5-4). Future research will attempt to determine its geological origin and archaeological occurrence. Intriguingly, no artifacts originate from Watts Point or Brandywine Creek sources. Yet, forty-seven artifacts derive from the High Falls Creek source, 20 km south of the site in the Squamish River valley. Surprisingly, eleven artifacts come from the Arrowstone Hills source.

Discussion and Conclusion

To address the questions posed at the beginning of this paper, portable x-ray fluorescence can determine the differences between geological source materials. In this case, chemical distinction of toolstone sources from five discrete sources is possible. Trace element analysis found that these materials characterize in much the same way as obsidian sources. It can also apply these results to archaeological contexts, in this case two rock-shelter sites, in similar environmental contexts, with a very similar radiocarbon chronology. However, what is most intriguing is that these results offer new insights into the role of various lithic materials in local to regional technological organization, trade and interaction.

On the larger scale of Northwest Coast and Plateau archaeology, these results demonstrate that the peoples using these sites did not simply use local toolstone found in close proximity of these locales. Non-obsidian materials have much more dynamic role and distribution in these culture areas than previously understood. In terms of local to regional use of lithic materials, the majority of lithic material used at each site does originate from local sources on the Northwest Coast. On one hand, at DlRt9, the local High Falls Creek sources dominate the lithic assemblage, followed by Watts Point, Brandywine Creek and finally the most distant source, Arrowstone Hills. This pattern of lithic material use reflects a local use and focus of resources in and around ethnohistorically-recorded villages along the Squamish River (Bouchard and Kennedy 1986; Reimer 2012). On another, EaRu5 illustrates a different pattern, with High Falls Creek (and possibly Turbid Creek) dominating lithic material use, followed by Arrowstone Hills and Unknown source, with no use of Brandywine Creek or Watts Point materials. However, closer examination of results illuminates an interesting pattern at EaRu5 that all but one tool at EaRu5 derives from a single source- Arrowstone Hills. This is a somewhat surprising pattern, as all the other sources (except the unknown) are known to be closer. Furthermore, Arrowstone Hills is a source located on the interior Plateau, approximately 200 km distant. Access or exchange for this material crossed ethno-linguistic boundaries, and demonstrates previously undocumented occurrence of this material on the Northwest Coast. The single tool (a scraper) that does not match the Arrowstone Hills chemical signature derives from the High Falls Creek source, 20 km down river in the Squamish River. While the pattern of lithic material use at DlRt9 seems to reflect a pattern of direct procurement, a small degree of exchange, down the line, that eventually makes it way down the river systems bordering the interior Plateau onto the Northwest Coast, up into mid elevation resource use contexts, but only as curated tools. Further north, a similar pattern is observed, but amplified, with a higher number of formal tools curated and left at EaRu5. This site may reflect a trade/exchange contact point between coastal Squamish Nation and interior Plateau group as no village is located between the culturally known travel and trade route via the upper Meagher Creek over the upper Elaho River down into the Squamish valley or up and over to Jervis Inlet (Bouchard and Kennedy 2010).

The results presented here offer new ways that elemental analysis can contribute to larger issues in lithic technological analysis, by examining non-obsidian source materials using XRF, their archaeological occurrence at two similar archaeological sites, that illustrate different land use patterns over the past 1500 years on the southern Plateau and Northwest Coast. These patterns are previously undocumented, and offer a nuanced perspective to lithic materials, their geochemistry and technological organization. As a final concluding point, I would recommend that archaeologists consider the cultural value and places from which these materials derive. It is with that information that we can factually understand their occurrence and distribution. Future analysis of these materials must include those factors.

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