Aluminous Alteration at the Briton Hematite Prospect, Chilcotin Ranges (92N/14E)

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INTRODUCTION

This article describes unusual aluminous alteration associated with hematite mineralization at the Briton iron prospect (MINFILE 92N 011), Chilcotin Ranges, southwest British Columbia. Massive specular hematite occurs adjacent to argillite in a package of intermediate volcanics. The hematite is closely associated with an alteration assemblage consisting of quartz, pyrophyllite, andalusite, corundum, and nacrite.

Although this iron occurrence is itself of limited economic interest, the associated aluminous alteration assemblage is similar to advanced argillic alteration assemblages that occur around or above porphyry copper deposits, such as El Salvador, Chile, and the Empress and Equity Silver deposits in British Columbia. The potential for porphyry mineralization in the area is also supported by: anomalous Cu, F, Hg, As, Fe, Sb, As, and Co values in a stream sediment sample collected downstream to the east; vague reports of float containing high copper and gold values a few kilometres east of Briton iron at the Pin Cu prospect (92N 053); and Late Cretaceous-Tertiary intrusions that lie a few kilometres to the south. As well, the distinctive pale bluish-grey colour of the corundum-bearing alteration suggests that the potential for gem quality sapphire should be evaluated.

LOCATION, ACCESS AND CLAIM OWNERSHIP

The Briton iron prospect is located on the south side of Perkins Peak in the Chromium Creek valley at an elevation of 2280 metres (7475 feet) (Figure 1). It is 24 kilometres southwest of the village of Kleena Kleene on Highway 20. Four-wheel drive access to the site is possible in late summer and early fall via the Miner Lake Forest Service Road, the Perkins Peak mine road, and a 7-km long, rough spur

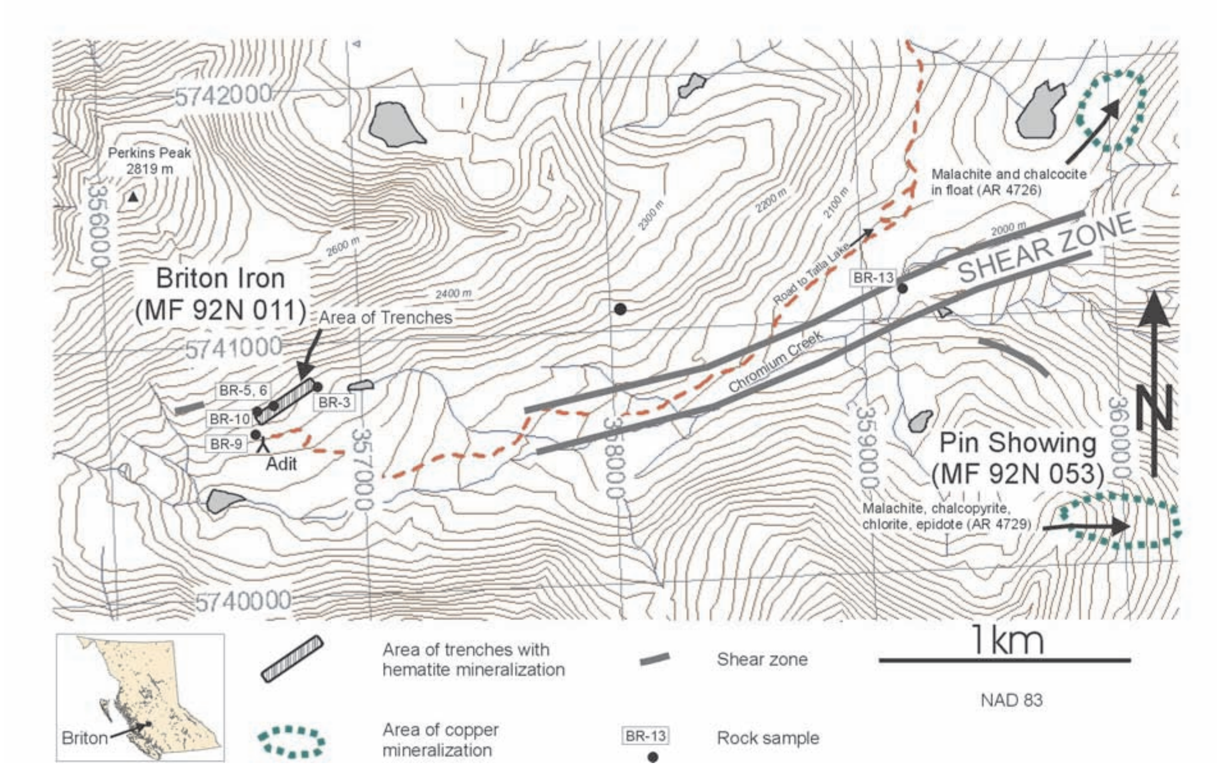

Figure 1. Map showing mineral occurrences and sample locations in the Chromium Creek valley.

TABLE 1
MAJOR AND TRACE ELEMENT ANALYSES OF OCCURRENCES AND SHEAR ZONES IN THE CHROMIUM CREEK AREA

Sample #	Element / Units / Method / Description	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Cr2O3	Ba	Sc	LOI	TOT/C	TOT/S	SUM
	Units	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	%	%	%	%
	Method	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	LMI	FUS	LCO	LCO	TOT
Sample #	Description																	
BR-3	Blue-grey alteration	61.24	29.9	3.9	0.04	0.39	0.69	0.19	1.03	0.14	< .01	0.003	135	51	2.4	0.01	< .01	99.94
BR-5	Specularite	14.19	1.24	81.69	0.03	0.53	0.01	< .02	0.73	0.42	0.01	0.002	12	5	0.5	< .01	< .01	99.36
BR-6	Blue-grey alteration	67.27	20.72	5.51	0.89	1.09	0.4	0.21	1.06	0.13	0.05	0.004	32	19	2.6	0.03	< .01	99.94
BR-9	Qtz-ser-py schist	61.82	19.71	7.19	0.06	2.13	1.2	0.91	1.2	0.09	< .01	0.003	346	26	5.6	< .01	2.01	99.96
BR-10	Specularite & alteration	61.09	2.76	31.24	0.1	0.39	0.08	< .02	3.21	0.2	0.01	0.002	32	17	0.7	0.01	< .01	99.79
BR-13	Qtz-ser-py schist	73.12	10.42	8.42	0.02	0.1	0.1	0.02	0.67	< .01	< .01	0.002	94	10	7.1	0.02	6.04	100

	Element	Au	Ag	As	Bi	Cd	Co	Cs	Cu	F	Ga	Hf	Hg	Mo	Nb	Ni	Pb	Rb	Sb	Sr	Zn
	Units	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Method	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	ION	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM
BR-3	Blue-grey alteration	< .5	< .1	2.7	< .1	< .1	1.3	0.3	6.6	930	16.9	2.4	< .01	0.9	2.1	1.1	1	2.9	0.3	164	5
BR-5	Specularite	< .5	< .1	18.8	0.1	< .1	1.2	< .1	2.5		23.9	2.3	0.01	1.5	1.6	0.1	2.3	< .5	5.6	4.3	4
BR-6	Blue-grey alteration	< .5	< .1	1.8	< .1	< .1	10	1.4	17.6	500	15.7	2.9	< .01	2.1	2.3	3.1	1.3	5	0.3	92.1	22
BR-9	Qtz-ser-py schist	3.3	0.1	2.7	0.1	0.3	6.1	2.8	55.3		13	3.2	0.04	2.4	2.4	2.1	3.1	17	0.4	165.6	7
BR-10	Specularite & alteration	1.1	< .1	14	0.3	0.1	0.9	< .1	14.3	210	22.3	10.6	0.18	1.7	7.4	0.7	1.3	< .5	3.1	25.6	8
BR-13	Qtz-ser-py schist	1.1	0.1	62.3	1.4	0.2	38.3	< .1	60.2	830	9.7	3.2	1.15	5.8	2.3	10.6	10.9	< .5	2.5	48.1	8

	Element	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Ta	Th	U	V	W	Zr
	Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Method	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM	LMM
BR-3	Blue-grey alteration	5.5	3.1	8.4	1.14	4.8	1.1	0.17	0.92	0.16	1.05	0.23	0.68	0.1	0.71	0.12	0.6	0.5	0.4	160	1	87.2
BR-5	Specularite	2.7	1.8	3.4	0.36	1.5	0.4	0.11	0.49	0.09	0.63	0.14	0.32	0.06	0.34	0.04	< .1	0.3	0.3	3619	0.8	78.2
BR-6	Blue-grey alteration	12.7	6.5	17.1	2.92	17.1	3.2	1.05	2.5	0.4	2.31	0.51	1.44	0.2	1.47	0.23	0.4	0.9	0.5	209	4.2	94.8
BR-9	Qtz-ser-py schist	17	5.2	13.6	1.93	10.9	2.6	0.86	2.61	0.47	2.63	0.6	1.76	0.27	1.99	0.27	0.1	1	0.7	182	3.6	104.4
BR-10	Specularite & alteration	12.9	12.1	29.5	4.51	21.7	4.7	1.03	3.45	0.44	2.3	0.52	1.48	0.24	1.63	0.25	0.4	1.1	1.7	1025	1.8	332.5
BR-13	Qtz-ser-py schist	13.6	4.2	10.8	1.6	7.4	1.9	0.62	1.84	0.36	2.02	0.5	1.7	0.33	2.6	0.38	< .1	0.5	1.9	78	4.3	102.7

Notes:

Preparation: Sample jaw crushed @ GSB & steel milled @ ACME. Quartz wash between each sample milled.

LMI = Lithium metaborate fusion - inductively coupled emission spectrometry

LMM = Lithium metborate fusion - inductively coupled mass spectrometry

LCO = Leco combustion

LOI = Loss on ignition @ 1100^{o}C

ION = Sodium carbonate fusion - spectifc ion electrode road into the upper Chromium Creek valley. The total distance from Highway 20 to the prospect is 32.6 km.

All prospects in the area are covered by mineral claims belonging to 397470 British Columbia Inc. and Hunter Point Explorations Ltd. Many of the claims have been held for several decades, with the oldest apparently staked in 1964.

EXPLORATION HISTORY

According to the Minister of Mines Annual Report for 1916, the Briton (or Wallace) iron prospect was discovered and staked prior to 1916. About that time the showing was developed by eight open cuts and a 600-foot long adit that apparently failed to intersect the hematite zone. Samples collected at that time by J.D. Galloway, Assistant Provincial Mineralogist, returned up to 47.6 % Fe over 2 feet in the most westerly cut, 48.4 % Fe (average of westerly dump), and 57 % Fe (selected ore from another cut). Sulphur and phosphorus values were reported as nil or trace.

Two dump samples collected in 1921 by W.M. Brewer, Resident Engineer, assayed 48.9 and 57.6 % Fe, trace and 0.24% P, trace sulphur, and 30.7 and 15.5% Si (Minister of Mines Annual Report for 1921). Both government officials remarked that despite the apparent purity of the iron, the commercial value of the deposit was low given its remote location. With the exception of an airborne geophysical survey (Smith, 1970), there is no record of further work being conducted on the Briton iron prospect.

The only recorded work on the Pin copper prospect (MINFILE 92N 053), which is located east of Briton iron, was in 1973 and 1974, when Cities Services Minerals Corp. conducted soil, geological and geophysical surveys over several areas with float boulders that carried high copper and gold values.

North of Perkins Peak, Au-Ag bearing veins and silicified zones at the Mountain Boss prospect (92N 010) were first staked between 1935 and 1938 (Minister of Mines Annual Report for 1938). Eight open cuts and an adit were dug at that time. The Bluebell prospect (92N 012) was first mentioned in 1945, when some tunneling took place. Several other adits have been driven over the years but very little technical information is available.

REGIONAL GEOLOGY

The Perkins Peak area is situated in an area of complex geology between the mid-Cretaceous Coast Belt magmatic arc to the southwest and the Tchaikazan and Yalakom dextral transcurrent faults to the northeast. A three- to eight kilometre-wide imbricate thrust zone affects Upper Triassic arc volcanic and sedimentary rocks of the Mt. Moore and Mosely Formations. These formations are interpreted to be correlative with Stikine Terrane and the thrust zone is interpreted to be part of the East Waddington thrust belt (Mustard *et al*. 1994).

To the north, the Triassic rocks are thrust over clastic sediments and felsic volcanics of the Late Cretaceous Cloud Drifter and Ottarasko Formations respectively, which are part of the Tyaughton Basin. Two kilometres south of the Briton showing, the Triassic rocks are in thrust contact with Late Cretaceous (ca. 96 Ma) tonalite that intrude Cretaceous felsic to intermediate volcanics of the Powell Creek Formation. All of these rocks are intruded by the Late Cretaceous to Tertiary (63-67 Ma) Klinaklini pluton and related stocks and dikes (Mustard *et al*., 1994).

LOCAL GEOLOGY

The Chromium Creek valley is underlain by a stacked series of east-northeast trending, south-dipping pyritic quartz-sericite shear zones that cut intermediate volcaniclastic rocks. Rocks in the immediate area of the hematite showings are mainly medium to dark green and locally maroon-weathering tuffaceous volcanic rocks, and polymictic volcanic breccia. The breccias contain fragments of green and buff volcaniclastics or sediments, dark grey argillite, and intrusive rocks. Minor dark grey argillite that is found locally in trenches and on dumps appears to be intimately associated with the hematite. Greenish intermediate volcanic breccia and tuff are the hosts to mineralization at the Pin copper showings

MINERALIZATION AND ALTERATION

Three types of mineralization are noted in the Chromium Creek valley: massive hematite bodies at the Briton occurrence; chalcopyrite-bearing veins at the Pin prospect and pyrite in quartz-sericite schist. Locations of these occurrences are shown on Figure 1 and analytical values are included in Table 1.

At the **Briton Iron Prospect** (MINFILE 92N 011), on the south slopes of Perkins Peak, massive, dark blue to black-weathering specular hematite occurs in several old trenches and pits extending northeasterly for more than 150 m in the western part of the valley. The workings are badly sloughed-in and the width of the hematite bodies cannot be ascertained, however, when they were open previous workers estimated widths of between two and nine metres. Other rock types on the dumps include dark grey to black siliceous argillite and green andesitic volcanic. In some places, hematite occurs as bands within the dark grey argillite.

Distinctive beige-orange and pale bluish grey alteration assemblages are intimately associated with the hematite in many of the trenches. The beige-orange material is variably soft and hard and fine-grained but contains local radiating masses of pyrophyllite that range up to 1 centimetre in diameter (Photo 1). X-ray diffraction (XRD) studies of this material indicates it is made up of quartz, pyrophyllite ($Al_2Si_4O_{10}(OH)_2$), minor andalusite (Al_2SiO_5) and possibly zussmanite ($(K(Fe^{2+},Mg,Mn^{2+})_{13}(Si,Al)_{18}O_{42}(OH)_{14})$). A soft light-coloured material that fills vugs in the massive hematite was identified by XRD as mainly nacrite ($Al_2Si_2O_5(OH_4)$ with possible minor pyrophyllite (J.A. McLeod, Written Communication, November 27, 2002).

The pale bluish grey alteration (Photo 2) is much harder (5 to >7 on Mohs scale) and consists of white, pale

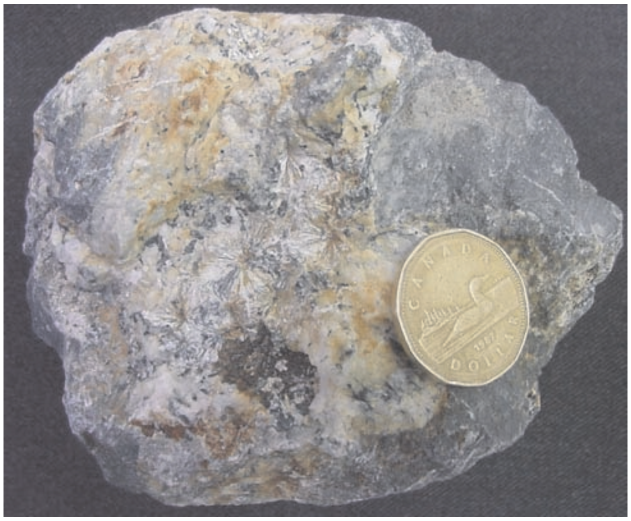

Photo 1. Radiating aggregates, to 1 cm in diameter, of pale buff pyrophyllite and quartz (white) alteration at the Briton iron prospect.

Photo 2. Aluminous alteration at the Briton iron prospect. The upper (beige-orange) layer consists of quartz, pyrophyllite, andalusite and minor nacrite. The lower (grey-blue) layer consists of corundum, quartz, pyrophyllite, andalusite and possibly nacrite.

grey, clear and blue-grey grains up to several millimetres in size, peppered with 1-2 millimetre round black grains, tentatively identified as andalusite. XRD studies indicate that this alteration consists of corundum (Al_2O_3), quartz, pyrophyllite, andalusite, and possibly nacrite. It is not clear from hand specimen examination whether the blue colour is due to corundum or quartz grains. More detailed petrographic work is required to determine the cause of the blue colour; if it is due to corundum, there may be potential for gem quality sapphire.

Other hematite-related alteration minerals noted in hand specimen included buff, hard massive sugary albite(?), and minor chlorite. Epidote occurs locally.

Geochemical analyses (Table 1) of the specular hematite (BR-5 and BR-10) returned up to 81.69% Fe_2O_3, 3.21% TiO_2, and 0.42% P_2O_5, along with anomalous V (3619 ppm), Sb (5.6 ppm) and Ga (23.9 ppm).

Two samples of the pale bluish grey alteration (BR-3 and BR-6) returned 20.72 and 29.9% Al_2O_3 respectively and anomalous amounts of F (500 and 930 ppm).

The **Pin Prospect** (MINFILE 92N 053) was not examined during this study; information provided here is summarized from assessment reports. Located four kilometres east of Perkins Peak, the Pin prospect is reported to consist of copper-bearing float hosted by intermediate volcanic rocks. "Chalcopyrite, chalcocite, bornite and considerable malachite staining is noted in float scattered throughout the property" according to assessment reports submitted by Cities Services Minerals Corp. (Murton, 1973; 1974). The reports also mentioned that the float "contains impressive copper and gold values associated with quartz veins". However, no assay values were reported.

Geological mapping, geochemical sampling and magnetic and IP surveys were done to follow-up on the float discoveries. A prominent quartz-sericite-pyrite shear zone (Figure 1) that dips moderately to the southeast and strikes at 070 degrees, has local malachite staining. Two other major areas of float mineralization were identified: one, comprising malachite and chalcocite, is located east of the small lake in the northeast corner of Figure 1; and the second is in the southeast corner and consists of pyrite, malachite and chalcopyrite associated with epidote and chlorite alteration. These occurrences could represent propylitic alteration and low-grade porphyry copper mineralization.

Prominent **quartz-sericite-pyrite shear zones** and their related gossans occur along a 4 km length of the valley. These were briefly examined and sampled at several locations as part of this study. Fabric in the shear zones dips moderately to the south and generally strikes at about 070 degrees. Pyrite content ranges up to about 10 per cent. Quartz-sericite-pyrite schist is present on the dump at the Briton adit (Sample BR-9) and previous workers reported that it was encountered near the end of the tunnel. This material was also found in outcrop a few hundred metres northwest of the Briton prospect, in a prominent cliff south of Chromium Creek, along the main access road, and at several places in Chromium Creek (BR-13). The outcrops represent a stacked series of shear zones with thicknesses ranging from tens to perhaps hundreds of metres.

Geochemically, one of the two quartz-sericite-pyrite schist samples (BR-13, Table 1) contains anomalous Hg (1.15 ppm) and F (830 ppm), and weakly anomalous Cu (60.2 ppm), As (62.3 ppm), and Co (38.3 ppm).

REGIONAL STREAM GEOCHEMISTRY

A single government stream sediment sample in Chromium Creek, 5 kilometres downstream from the Briton prospect, is anomalous in Fe (4.4%), Cu (225 ppm), Sb (4.1 ppm), As (43 ppm), Co (31 ppm), Hg (220 ppb), Lu (0.70 ppm), Sm (6.5 ppm), Tb (1.6 ppm), Yb (5.4 ppm), F (1100 ppm), F in water (420 ppb), sulphate (86) and pH (4.9). All of these elements are above the 95^{th} percentile for the 92N map sheet, and the F value is the highest on the sheet.

The high values for Fe, Sb, As, Co, Hg, F, sulphate and pH can be readily explained by corresponding anomalous concentrations of Fe, Sb and F in the hematite mineralization and its alteration, and by the anomalous Fe, Sb, As, Co, Hg, F and sulphide contents of the quartz-sericite-pyrite shear zones. The anomalous Cu value could be related to copper mineralization described for the Pin showings, however there may be undiscovered sources.

DISCUSSION AND CONCLUSIONS

Hematite at the Briton iron prospect appears to be of hydrothermal origin due to its intimate association with an unusual aluminous (advanced argillic) alteration assemblage consisting of quartz, pyrophyllite, andalusite, corundum and nacrite. The hematite probably formed by selective replacement of argillite layers within the intermediate volcanic country rocks. Alumina was probably derived from the argillite. Although the source of the hydrothermal fluids is not known, Late Cretaceous to Tertiary intrusions are located a few kilometres to the south.

The aluminous alteration includes a distinctive pale bluish grey assemblage of corundum, quartz, pyrophyllite, and andalusite. The source of the blue colour in this alteration has yet to be determined, but blue corundum is a possibility. Therefore, the potential for gem-quality sapphire should be investigated petrographically and perhaps by panning sediments in Chromium Creek below the iron deposit.

A similar aluminous assemblage has been identified at the Empress (Taseko) Cu-Au-Mo deposit (MINFILE 92O 033) some 140 km southeast of Briton. It contains clear and blue corundum that may be of gem-quality. The Empress deposit is also hosted by Mesozoic volcanic rocks on the northeast margin of the Coast Plutonic Complex, a setting similar to Briton iron. At Empress, porphyry mineralization is associated with alteration assemblages consisting of quartz, quartz-magnetite, quartz-andalusite-pyrophyllite, and plagioclase-quartz-pyrophyllite-andalusite. The latter assemblage also contains minor corundum, magnetite and chlorite (Simandl *et al*., 1997; 1998).

Aluminous alteration has been described from the upper parts of porphyry copper systems, most notably at El Salvador, Chile (Gustafson and Hunt, 1975) where andalusite, pyrophyllite and corundum are present. At the Equity Silver mine in northern British Columbia, Ag-Cu-Au-Sb mineralization occurs in a volcanic breccia matrix and is associated with an aluminous and borosilicate assemblage comprising andalusite, scorzalite, tourmaline, corundum and minor dumortierite. Magnetite occurs in the hangingwall and is associated with, and partially replaced by specularite in the corundum distribution zone (Wojdak and Sinclair, 1984).

Aluminous (advanced argillic) alteration at the Briton iron prospect could represent the upper part of a porphyry environment. Although copper values in the hematite deposit itself are low, several other features show that there is potential for copper mineralization in the broader area. In particular, stream sediments in Chromium Creek are highly anomalous in Cu (220 ppm) and have elevated F, Hg, As, Fe, Sb, As, and Co values; there are vague reports of porphyry-style Cu-Au mineralization at the Pin prospect; and Late Cretaceous-Tertiary intrusive rocks occur a few kilometres to the south. Given that the area has not been explored for nearly 30 years, prospecting and geological mapping are warranted.

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