THE FIR CARBONATITE A POTENTIAL TANTALUM - NIOBIUM RESOURCE

By Jody Dahrouge[1]

INTRODUCTION

Within the Blue River area of east-central British Columbia are a number of sill-like carbonatites that intrude gneissic metasedimentary rocks of the Proterozoic Horsethief Creek Group. These occurrences, which include the Bone Creek, Fir, Gum Creek, Howard Creek, Mill, Mud Lake and Verity-Paradise carbonatites, lie within a northerly trending belt of carbonatites that straddles the western side of the Rocky Mountain Trench.

The Fir Carbonatite, consists of a series of contemporaneously emplaced sills with nearly identical petrological, mineralogical and geochemical properties. The host gneisses have a general strike of north and dip 10^{o} to 15^{o} east. Although outcrop exposure is poor, the Fir Carbonatite has been traced at surface over an area of about 350 m by 450 m. Drilling indicates that the average thickness is about 40 m. It constitutes a very large resource of tantalum, niobium and phosphate, and remains open for expansion to the north, east and south. The economic significance of the Fir Carbonatite was first recognized during the early 1980's, while recent exploration by Commerce Resources Corp. confirmed the Fir Carbonatite as having very good potential for large tonnages with highly anomalous concentrations of tantalum and niobium..

The carbonatite is composed almost exclusively of beforsite, with primary magmatic mineralization that includes apatite, ferrocolumbite and pyrochlore. Ferrocolumbite and pyrochlore concentrations are at levels equivalent to many of the worlds known primary tantalum deposits. Tantalum mineralization is typically coarse grained with a fairly even distribution. Grades of individual samples collected from across the carbonatite range from 100 to 400 ppm Ta_2O_5.

LOCATION AND ACCESS

The Fir Carbonatite is located within North Thompson River valley of east-central British Columbia. It is accessible from Gum Creek logging road which branches from Highway 5, about 23 km north of the community of Blue River. Additional infrastructures within the area include the main line of the Canadian National Railway which is less than 1 km west of Fir and a B.C. Hydro Line about 1 km to the east (Figure 1).

The Fir Carbonatite is exposed on steep, west-facing slopes of Monashee Mountains at about 900 m elevation. Thick forest cover, variable sequences of unconsolidated overburden, and the recessive nature of the carbonatite rocks, have resulted in poor bedrock exposure.

PREVIOUS WORK

Exploration for carbonatites within the Blue River area began in about 1949 with the discovery of a vermiculite-bearing carbonate by Mr. Oliver E. French (Mariano, 1982). Subsequent exploration programs between about 1950 and 1980 included geologic mapping, geophysics, prospecting, stripping and trenching, and sampling for niobium, phosphate, vermiculite, uranium and tantalum.

Exploration culminated in 1980 and 1981 with a series of drill programs conducted by Anshutz Mining of Canada Ltd. This work was directed at the identification of carbonatite hosted tantalum mineralization, and included drilling the most promising of the known carbonatites: Bone Creek, Fir, Mill and Verity. Based primarily upon the 1980 and 1981 drill programs Aaquist (1982a, p.1) concluded

"The carbonatite occurrences at Blue River, British Columbia have the highest tantalum concentrations of any carbonatite in the world."

And (Aaquist, 1982b; p. 12),

"The Verity area, that was drilled in 1981, is the best defined and most continuous zone of carbonatite to date. About 2.13 million tons averaging 0.02% Ta_2O_5 and 0.126% Nb_2O_5 occur in the area..."

During 1987 and 1988, Digel et. al. (1989) located two new carbonatites within the Blue River area. The first along Serpentine Creek, is exposed by a logging road at about 1370 m elevation. The second carbonatite occurs at about 2040 m elevation on a small ridge just south of Gum Creek. It forms an approximately 10 m thick layer, concordant with the surrounding host rocks.

During February 2000, Commerce re-staked the known carbonatites and conducted a small surface sampling program to confirm the known tantalum mineralization at both Fir and Verity, and to locate new exposures on recently constructed logging trails. McCrea (2001) completed a re-evaluation of existing information, including 30

[1]*Dahrouge Geological Consulting Ltd.*
#18, 10509 – 81 Ave, Edmonton, AB T7X 3W6

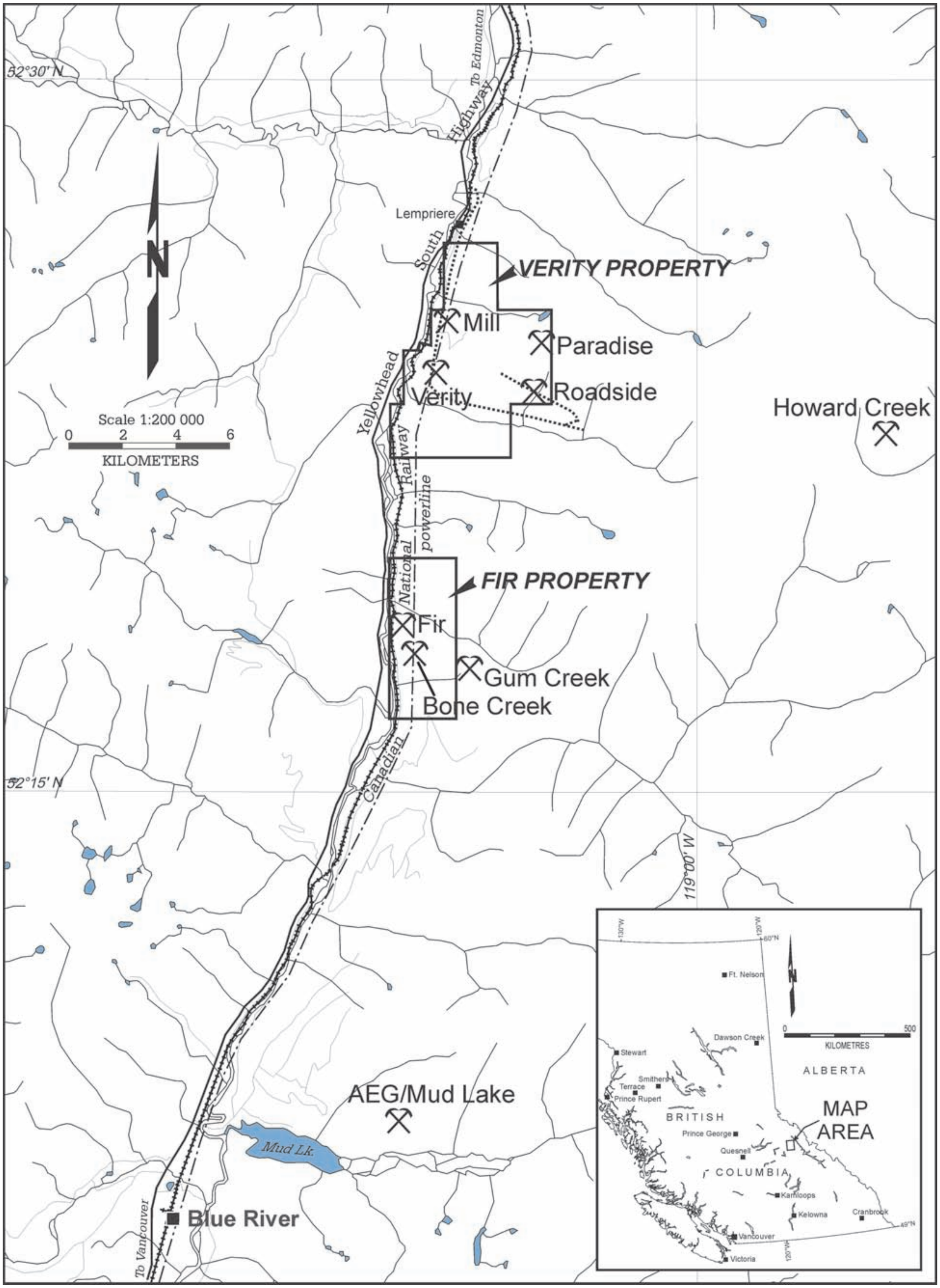

Figure 1. Locations of carbonatites within the Blue River area.

drill holes totalling 2,060 m and 715 samples. It resulted in updated resource-estimate for the Verity Carbonatite, as follows:

Grade Cut-Offs	Tonnes °	Composition		
(g/t Ta_2O_5)		Ta_2O_5 (g/t)	Nb_2O_5 (g/t)	P_2O_5 (%)
200 - 400	944,000	243	555	3.63
150 - 200	3,063,000	196	645	3.2
50 - 200	6,260,000	137	511	3.38

° Tonnages are cummulative

* After McCrea (2001, p.25)

Commerce Resources Corp. undertook additional reconnaissance scale exploration during 2001 within the Blue River area. Work included collection of rock, soil and stream sediment samples, and ground magnetic and radiometric surveys. These efforts were followed by drilling of six HQ holes totalling 1246.5 m at the Fir Carbonatite, and five NQ holes totalling 403.9 m at the Verity Carbonatite.

REGIONAL GEOLOGY

The Blue River area encompasses upper amphibolite facies (kyanite to sillimanite) metasedimentary rocks of the Proterozoic Horsethief Creek Group. These rocks were described by Campbell (1968) as: gritty feldspathic quartzite, phyllite, quartz-mica schist, garnet-staurolite and kyanite-mica schist, biotitic and/or horneblendic quartzo-feldspathic gneiss, minor marble and amphibolite and minor pegmatite with staurolite-kyanite schist.

Complex regional scale structures within this part of the Monashee Mountains include a mylonitic fault contact between Horsethief Creek Group rocks and Malton Gneiss to the north, and a northerly trending regional scale fault along the North Thompson River Valley. Pell and Simony (1981) describe the North Thompson fault as a major west side down normal fault, that forms a metamorphic and structural discontinuity between the Monashee Mountains and the Cariboo Mountains to the west.

The eastern flank of the Cordillera within British Columbia has previously been recognized as a locus of alka-

TABLE 1
WHOLE ROCK AND TRACE GEOCHEMISTRY OF VARIOUS LITHOLOGIES (FROM THE BONE CREEK, FIR AND GUM CREEK CARBONATITES)

Samples*	Bone Creek		Fir				Gum
Composition	**15028A**	**15028B**	**15601**	**15603**	**15629**	**15651**	**15038**
Major Elements (weight %)							
CaO	13.79	16.82	0.85	31.63	25.97	29.64	45.22
MgO	2.96	12.26	2.4	14.44	13.12	14.08	3.67
SiO_2	24.73	48.61	59.64	2.53	21.79	2.99	2.41
TiO_2	0.35	0.53	0.81	0.02	0.08	0.03	0.08
Al_2O_3	7.06	4.35	18.02	0.08	2.05	0.07	0.1
Fe_2O_3	23.84	10.72	8.49	7.65	9.16	9.18	4.1
Na_2O	1.23	2.02	4.8	0.17	0.46	0.38	0.42
K_2O	0.92	0.23	3.15	0.03	0.76	0.08	0.03
P_2O_5	9.6	1.73	0.2	3.97	3.5	3.97	1.82
Trace Elements (ppm)							
Ta_2O_5	576	137	5	255	154	415	75
Nb_2O_5	1907	610	133	651	439	2411	3,211
Cu	78	19	85	4	37	2	101
Ni	211	26	36	3	85	2	22
Rb	52	5	165	2	50	1	3
Sr	1694	615	313	3683	2334	4289	13077
Th	32	5	27	3	3	8	12
U	231	23	3	134	67	29	4
V	84	143	86	< 5	23	9	31
Zr	200	36	201	105	36	6	18
Ratios							
Nb_2O_5 / Ta_2O_5	3.31	4.45	26.6	2.55	2.85	5.81	42.81
Ta_2O_5 / U	2.49	5.96	1.67	1.9	2.3	14.31	18.75

*Samples 15028A: Carbonatite; 15028B: Amphibolite; 15601: Fenitized Gneiss 107.62 - 108.62 FDH1; 15603: Upper Beforsite Sill 109.62 - 110.62; 15629: Fenite / Amphibolite 146.37 - 147.37; 15651: Lower Beforsite Sill 169.03 - 170.03; 15038: Sovite.

*Major and Trace Element analysis were by ICP-MS (Inductively Coupled Plasma Mass Spectrometer) after lithium metaborite fusion. Tantalum and Uranium were by INAA (Instrumental Neutron Activation Analysis).

line igneous activity (Currie, 1976), which Pell (1987) subdivided into three northwest trending belts:

- an eastern belt, that encompasses most of the Main and Western Ranges of the Rocky Mountains,
- a central carbonatite belt, that includes the Rocky Mountain Trench and parts of the Omineca, Crystalline Belt, and
- a south-central belt centred around Frenchmans' Cap Gneissic Dome.

The central carbonatite belt, which extends about 50 km westerly and approximately parallel to the Rocky Mountain Trench, generally hosts multiply deformed and metamorphosed, sill-like bodies (Pell, 1987). Within the Blue River area the carbonatites typically have thin ampbhibole-rich haloes of fenite, and some are associated with syenites. Carbonatites within the Blue River area, include: Bone Creek, Fir, Gum Creek, Verity-Paradise, Serpentine Creek, Howard Creek and Mud Lake-Blue River.

PROPERTY GEOLOGY

The Fir Carbonatite area, is underlain by a sequence of near flat-lying to shallow easterly dipping metasediments and interlayered metabasites of the Proterozoic Horsethief Creek Group. Pegmatite dykes, lenses and sills, each of which may attain several meters across, intrude the sequence and cut all lithologies. The pegmatites generally consist of white feldspar and quartz with accessory muscovite. A number of flat-lying, sill-like, carbonatites are known to intrude the Proterozoic Horsethief Creek Group; they include Bone Creek, Fir and Gum Creek. The main carbonatite body, Fir, has been identified in outcrop and intersected by ten core holes over an area measuring about 350 m east-west and 450 m north-south. It consists of two subparrallel sills, a lower beforsite sill that varies from 26 to 50 m thick, and an upper beforsite that is up to 22 m thick (Figure 2).

According to Mariano (1982) the Fir Carbonatite is almost exclusively beforsite composed predominately of ferroan dolomite with minor apatite and dark-green amphibole. Both outcrops and drill core display primary igneous layering formed with bands richer and poorer in non-carbonate minerals. Fenitized country rock associated with the carbonatite appears limited to narrow intervals. Layers and pods up to 1 m thick, with greater than 50 per cent amphibole are common (Table 1).

Macroscopic textures such as a diffuse gneissocity, augen gneiss and tectonic brecciation indicate (Mariano, 1982 p.1)

"extensive tectonic deformation and post-emplacement metamorphism with significant mineralogical and geochemical redistribution."

Although a considerable thickness of carbonatite is noted at Fir, poor bedrock exposure with vast covered intervals, probable concealed internal structures and the lack of a readily recognized marker horizon, hinders accurate correlation of stratigraphy.

Prior ore mineralogical studies by Mariano (1982) identified two primary Ta-bearing phases: ferrocolumbite

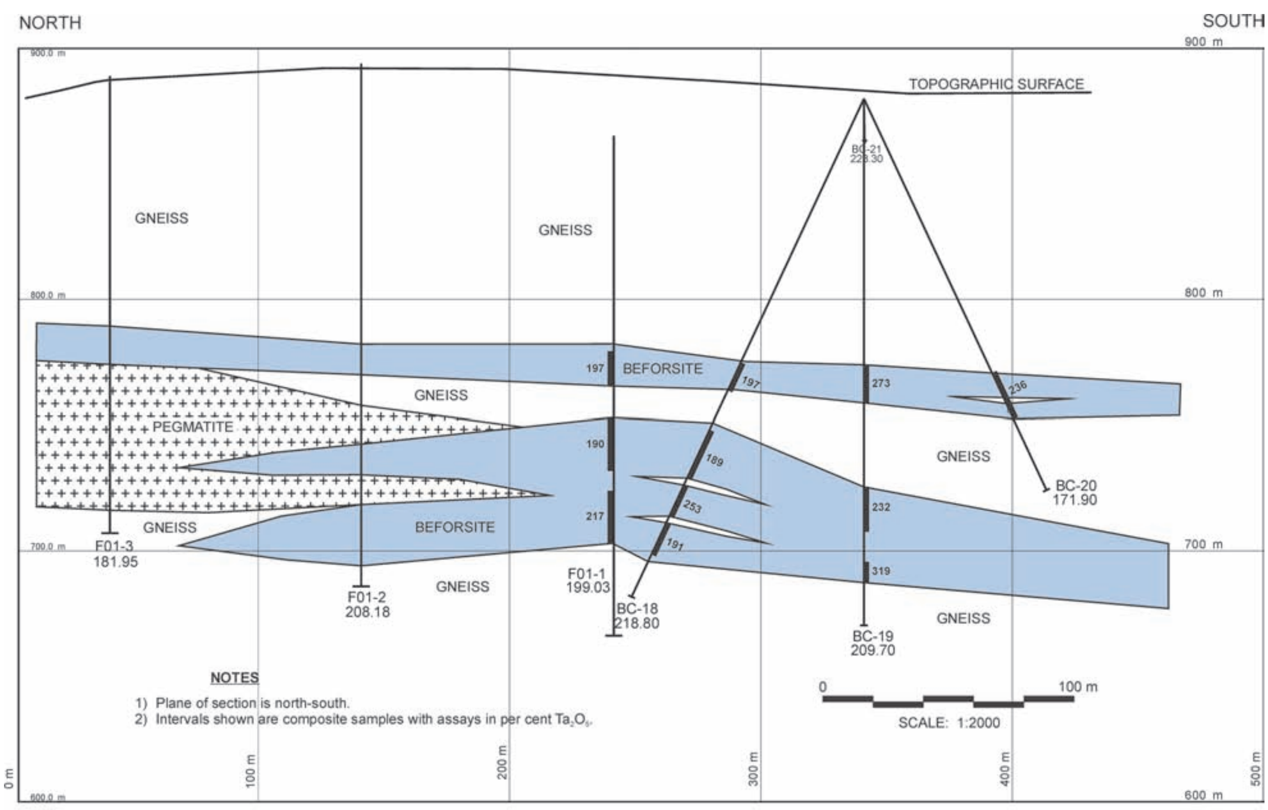

Figure 2: North-South Cross-Section Through the Fir Carbonatite.

($Fe(Nb,Ta)_2O_6$) and pyrochlore [$(Ca,Na)_2(Nb,Ta)_2O_6(OH,F)$]. For rocks examined from the Fir Carbonatite Mariano (1982) noted an approximate ratio of 20:1, columbite to pryochlore. In addition, (Mariano, 1982, p. 64)

"all pyrochlores examined from BC-19 are relatively low in U and high in Ta. They are light yellow in color and occur as grains intimately crystallized with ferrocolumbite and as isolated crystals in the dolomite ground mass. ... Unlike BC-19, BC-21 core at 173.6 m contains jet black pyrochlore that is strongly radioactive indicating high U content."

Microprobe analysis provided by Mariano (2001) for ferrocolumbite and pyrochlore from the Fir Carbonatite, follows:

Constituent* (Wt. %)	Ferrocolumbite	Pyrchlore
CaO	-	7.2 - 15
F	-	2.4 - 5.6
FeO	14 - 17	-
MgO	1 - 3.7	-
MnO	0.5 - 1.5	-
Na_2O	-	6.1 - 7.9
Nb_2O_5	66 - 77	43 - 70
Ta_2O_5	1.7 - 14	2 - 31
ThO_2	-	< 1.4
TiO_2	1.0 - 5.5	1.1 - 3.8
UO_2	-	0.8 - 19

* Typical amounts from BC-19 167.4 m (Sample T-619Z)

TABLE 2
SUMMARY OF DRILL RESULTS FOR THE FIR CARBONATITE

Hole Number	From (m)	To (m)	Length (m)	Ta_2O_5 (g/t)	Nb_2O_5 (g/t)	P_2O_5 (%)
COMMERCE RESOURCES CORP. (2001)						
FDH-1	108.62	122.32	13.7	197	1153	3.64
	135.37	156.16	20.79	190	1122	3.09
	164.03	185.09	21.06	217	1287	3.28
(inclusive)	*108.62*	*185.09*	*55.55*	*202*	*1178*	*3.28*
FDH-2	111.86	124.05	12.19	Assays Not Complete		
	151.49	163.68	12.19	Assays Not Complete		
	175.56	199.95	24.38	Assays Not Complete		
FDH-3	99.67	121.04	21.34	Assays Not Complete		
FDH-4	157.88	188.36	30.48	Assays Not Complete		
	192.94	199.03	6.09	Assays Not Complete		
FDH-5	157.58	188.98	31.4	Assays Not Complete		
	201.47	207.57	6.1	Assays Not Complete		
FDH-6	169.77	197.21	29.22	Assays Not Complete		
ANSCHUTZ MINING (CANADA) LTD. (1981)						
BC-18	116	128.2	12.2	197	566	3.11
	145.4	166.6	21.2	189	534	3.17
	169.7	183.3	13.6	253	797	3.68
	186.2	200.1	13.9	191	675	3.26
(inclusive)	116	*200.1*	*60.9*	*205*	631	3.29
BC-19	106.3	121.5	15.2	273	615	3.04
	154.5	172.3	17.8	232	1393	3.05
	184.4	192.6	8.2	319	1400	3.15
(inclusive)	106.3	*192.6*	*41.2*	*265*	*1108*	*3.06*
*BC-20**	*120.7*	*140.7*	*20*	236	*1231*	*2.67*
BC-21	129.10	142.90	7.70	165	750	2.32
	162.20	200.60	38.40	200	418	4.36
(inclusive)	129.10	200.60	46.1	194	473	4.02

**Hole BC-20 appears to have been terminated short of the lower intervals of carbonatite*

Of the ten drill holes to intersect the Fir Carbonatite, four were completed during 1981 (Aaquist 1982a) and six were completed during 2001 (Table 2). Results indicate a consistently mineralized body, with between about 200 and 250 g/t Ta_2O_5, 500 and 1000 g/t Nb_2O_5, and 3 to 4 per cent P_2O_5.

The Bone Creek Carbonatite is approximately 200 m stratigraphically above the Fir Carbonatite (Table 1). It has been trace intermittently, at an apparently continuous stratigraphic level, by soil and stream sediment geochemistry, and drilling over an approximate strike length of over 2,000 m. It is generally less than 5 m thick.

The Bone Creek Carbonatite is composed primarily of apatite beforsite with coarse pyrochlore and only minor ferrocolumbite (Mariano, 1982). Most pyrochlores are dark-mahogany-brown to jet-black with major tantalum and uranium. Analytical results indicated that the Bone Creek Carbonatite may have the greatest concentrations of tantalum and uranium (Table 1), for all the carbonatites in the Blue River area.

About 2000 m east of Fir, the Gum Creek Carbonatite occurs as a layer about 10 m thick at about 2040 m elevation on a ridge south of Gum Creek. During 2001 a single sample of sovite was collected from the Gum Creek Carbonatite (Table 1), it showed low to moderate grades of tantalum with highly elevated concentrations of niobium.

DISCUSSION AND CONCLUSIONS

Carbonatites generally occur as intrusive bodies that are exploited for a variety of commodities, including rare earth elements, niobium, vermiculite, fluorite, iron, copper, phosphate; while other products including nickel, uranium, gold, silver, platinum group elements, baddeleyite, zircon, magnetite and lime. Of the approximately 330 carbonatite systems known worldwide, none are currently exploited for tantalum. However, they do offer excellent potential for large tonnages.

The known carbonatites within the Blue River area contain highly anomalous concentrations of tantalum and niobium, with variable concentrations of accessory commodities that include phosphate, rare earth elements, uranium and vermiculite. This association provides an attractive exploration target not only for those commodities, but other potentially unique occurrences.

Tantalum concentrations for the Fir Carbonatite range from about 200 and 250 g/t Ta_2O_5, which are comparable to other primary tantalum operations. For instance, the Greenbushes Pegmatite in Australia contains about 90.7 Mt at 226 g/t Ta_2O_5, while the Woodgina Pegmatite deposits contains about 65.3 Mt at 371 g/t Ta_2O_5 (Sons of Gwalia, 2002). Although recoveries are not reported for the Greenbushes Pegmatite, those at Woodgina averaged varied from 64 to 77.9% for the years 1990 to 1995 (Roskill Information Services Ltd., 1999). Low recoveries for these pegmatite hosted deposits may in part be due to complex mineralogy, including the fine grain size of the tantalum minerals.

Some regional exploration has been completed within the Blue River area; however, much of the area remains under explored and more reconnaissance scale work is required. Results to date at Fir indicate a very large resource of coarse-grained, homogeneously mineralized beforsite carbonatite, with between about 200 and 250 g/t Ta_2O_5, 500 and 1000 g/t Nb_2O_5, and 3 to 4 per cent P_2O_5. The intrusive body, which remains open to the north, east and south, requires additional drilling to define its limits.

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