Potential for Palladium and Platinum Deposits in British Columbia

By David V. Lefebure
British Columbia Geological Survey

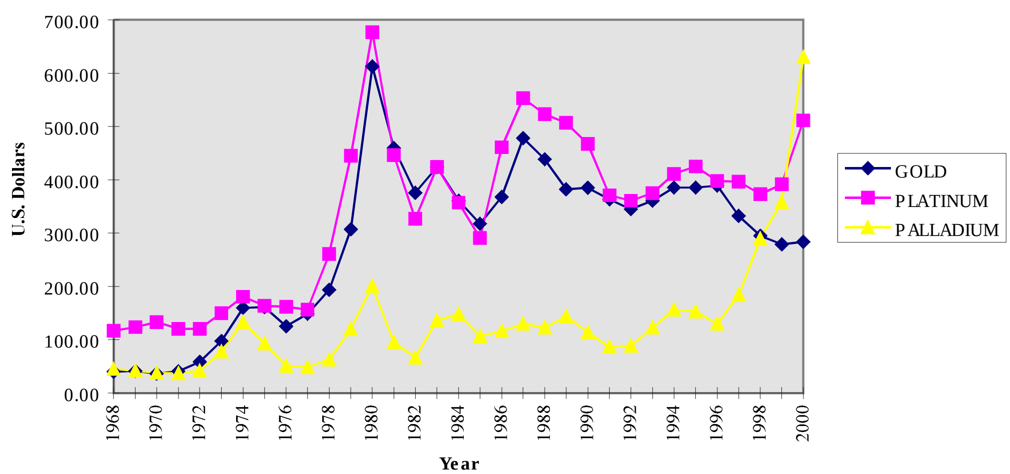
Introduction

High palladium (>US$700 per troy ounce) and platinum (>US$500 per troy ounce) prices have generated renewed interest in exploring for these metals. These high prices reflect their scarcity in the earth's crust and growing use in advanced technological applications. They have also attracted attention due to the poor demand for gold, which has a market value stuck below US$300 an ounce. British Columbia has had limited production of platinum from placers and as byproduct platinum and palladium from lode deposits. However, the recent price increase in palladium, coupled with a growing demand for platinum group elements (PGEs) signals an opportunity to explore for new types of deposits that may have been missed in the past. As well, some mineral occurrences may warrant a second look because their PGE grades are not well defined.

Increasing Demand

Palladium and platinum belong to a family of elements, called the platinum group elements. During much of the last century only platinum attracted attention as an important primary commodity for mining. Palladium was typically produced as a byproduct at some platinum or base metal deposits and was even stockpiled at the Noril'sk-Talnakh mines in Russia due to limited demand. During the last four years demand for palladium has risen with resulting increases in price (Figure 1). It is interesting to note that platinum is still attractively priced even though gold prices have fallen. This follows twenty years of near price parity between the two precious metals.

Figure 1. Platinum, Palladium and Gold Prices per Troy Ounce - 1968 to August 2000



Platinum and palladium have a variety of applications, including jewelry, electronics and alloys. The current demand for palladium and platinum is strongly influenced by their use in catalytic converters to reduce pollution from automotive gasoline engines. These particular metals are critical components and the increasing restrictions on emissions has dramatically increased consumption. The use of platinum in the United States as an autocatalyst peaked in 1996 at 59 000 kilograms, up from 1 700 kilograms in 1980 (Hillard, 2000). Recently, increasing amounts of palladium are used, in preference to platinum, to meet tighter hydrocarbon limits in the United States. The global demand for palladium in this application alone increased from about 12 000 kg in 1990 to approximately 189 000 kg in 1999 (Hillard, 2000). Despite platinum's declining importance as an autocatalyst, global demand for the white metal grew 4% in 1999. Palladium and platinum world consumption reached levels of 258 and 173.9 tonnes in 1999 (Hillard, 2000) with deficits in supply, caused in part by delays in shipping supplies from Russia. It is worth noting that gold consumption at 112 million ounces was more than an order of magnitude larger than the figures for either platinum or palladium.

What are PGEs?

PGEs or platinum group elements are grouped because they have similar chemical and physical properties and are commonly found together in nature (Table 1). Gold, silver and PGEs are referred to as precious metals because of their high unit value, while PGEs are often called noble metals as a result of their superior ability to withstand oxidation and corrosion. These metals are extremely rare, a characteristic they share with gold. PGEs, gold and silver are precious metals. Platinum is considered the rarest of the precious metals and over 40% of platinum consumption is for jewelry.

Table 1. Crustal Abundances and Main Uses of Platinum Group Elements and Gold.

Element	Symbol	Crustal Abundance (ppm)	Main Uses
Platinum	Pt	0.005	jewelry, autocatalyst, bushings, electrodes, crucibles, thermocouples, chemical
Rhodium	Rh	0.001	autocatalyst, furnace windings, electrical contacts, ballpoint pen tips
Iridium	Ir	0.001	thermocouples, crucibles
Palladium	Pd	0.013	autocatalyst, multilayer ceramic capacitors, dental and jewelry alloys
Osmium	Os	0.05	pen tips
Ruthenium	Ru	0.005	electrical and chemical industries
Gold	Au	0.004	jewelry, coins, bullion

Note: The crustal abundance is the Clarke value for the lithosphere and is taken from table 92 in Rosler and Lange, 1972 incorporating figures from Goldschmidt (1937) and Vinogradov (1962).

PGE Environments

Platinum group elements occur in a wide variety of environments (Table 2), but most production has been from large mafic to ultramafic intrusions and placers. The large intrusions are currently the dominant source of the world's PGEs. They can be divided into *layered mafic to ultramafic complexes* or *flood basalt-associated mafic intrusions.* Placer production is minor, although areas in Alaska and Russia produced significant quantities of platinum in the last century.

Table 2. Types of PGE Deposits and Occurrences

	Examples
Magmatic	
Layered Mafic-Ultramafic Complexes	Merensky Reef (South Africa), Stillwater (Montana)
Flood Basalt-associated Ni-Cu-PGE	Noril'sk (Russia), Wellgreen (Yukon)
Gabbroid-associated Ni-Cu±PGE	Lynn Lake (Manitoba), Giant Mascot (B.C.)
Alaskan-type Pt±Os±Rh±Ir	Nizhnetagil (Russia), Tulameen Complex (B.C.)
Alkalic-type Cu±Au±Pd±Pt	Maple Leaf (B.C.), Sappho (B.C.), Dobbin? (B.C.)
Alkalic porphyry Cu-Au	Copper Mountain (B.C.), Afton (B.C.)
Podiform Chromite	Guleman deposits (Turkey), Scottie Creek (B.C.)
Sedimentary	
Shale-hosted	Kupferschiefer (Germany, Poland), Nick (Yukon)
Hydrothermal	
Hydrothermal	New Rambler (Wyoming), Messina (South Africa)
Surficial	
Alluvial (Placers) Pt±Au	Goodnews Bay (Alaska), Tulameen (B.C.)

The *layered mafic-ultramafic complexes*, such as the Bushvelde Complex of South Africa and the Stillwater Complex in the United States, contain mineral bands that can be traced for tens of kilometres. Within these complexes the PGEs are confined to stratabound horizons that contain either platinum-rich chromite layers or copper-nickel sulphide lenses with associated platinum and palladium. Typically only the largest intrusions have economic concentrations of PGEs. Large, layered complexes are typically found in areas of stable continental crust, not in Cordilleran environments.

In the Canadian Cordillera the Axelgold layered gabbro intrusion is the only large intrusion that exhibits some similarities to *layered mafic-ultramafic complexes* (Evenchick *et al*., 1986). While chromite is reported from peridotite layers and the intrusion contains weakly disseminated sulphides, there are no reports of PGEs. A similar layered gabbro-norite intrusion with basal portions of dunite and peroditite in Alaska called La Perousse hosts the Brady Glacier Ni-Cu deposit with minor associated PGEs (Foley *et al*., 1997).

Mineralization associated with *flood basalt-associated mafic intrusions* is best represented by the Noril'sk-type deposits in Russia which are the world's second largest producer of PGEs. In 1999 the mines in the Noril'sk and nearby Talnakh regions produced 28% of the world's PGEs and were also selling palladium from their stockpiles. The copper-nickel-palladium-platinum mineralization occurs in gabbro and diabase intrusions, usually sills, related to extensive overlying Triassic flood basalts. This environment exists in the Canadian Cordillera with the best known mineral occurrences in the Yukon.

Voluminous Triassic flood basalts with associated mafic-ultramafic intrusive complexes are found in Wrangellia - a geological terrane that extends along the west coast of British up the Alaska Panhandle and into the Yukon. The volcanics are known as the Karmutsen Formation in the south and the Nikolai basalts in the north. Copper-nickel-PGE mineralization is associated with the 600 kilometre long, Kluane Mafic-Ultramafic Belt that extends from the southwestern Yukon into northern British Columbia (Hulbert *et al.*, 1997). The Wellgreen deposit, located approximately 250 kilometres west-northwest of Whitehorse, has reserves of 49.9 million tonnes grading 0.36% nickel, 0.35% copper, 0.51 g/t platinum and 0.34 g/t palladium. It was mined for nickel and copper in 1971 and 1972 when it produced 171 652 tonnes of ore. The Chilkat and Mansfield are two similar PGE-bearing occurrences that occur in the British Columbia portion of the Kluane Belt. Karmutsen flows and associated sills are extensive on Vancouver Island and the Queen Charlotte Islands. Tofino Nickel and Swede are two of the small number of copper-nickel-PGE occurrences that have been found along the west coast. Tofino Nickel has high grade grab samples with up to 18.7 grams per tonne palladium and 6.9 grams per tonne platinum.

Alaskan-type ultramafic intrusive complexes are commonly zoned and form sills, stocks or irregular intrusive bodies. They are known to contain platinum with minor associated iriduim, osmium and rhodium hosted by thin chromitite layers, concentrations of cumulus magnetite or clinopyroxenite (Nixon *et al.*, 1997). There has been relatively limited lode platinum production from these deposits, although they are associated with significant placers in Russia, Alaska and British Columbia. Lode shoots or vein-like bodies in Alaskan-type ultramafic bodies within the Nizhnetagil Massif of Russia have been mined and extend for tens of meters along strike, up to 6 to 7 metres in thickness and to depths of 150 metres with platinum grades ranging from 10s to 100s of ppm (Hulbert *et al.*, 1988). Lode platinum *Alaskan-type* occurrences in British Columbia are found in the Tulameen Complex (Grasshopper Mountain, Olivine Mountain, Lodestone Mountain), Turnagain Complex near Dease Lake and Wrede Creek complex west of Williston Lake. Typically the best grades of platinum are associated with chromitite schlieren. The Tulameen and Turnagain Alaskan-type intrusions have attracted the most exploration attention in the last decade.

One of the more interesting PGE deposits in Alaska is the Salt Chuck mine that is usually considered an Alaskan-type deposit (Evenchick *et al.*, 1986). However, it is distinctly different in age (early Paleozoic), metallogenetic features (Cu, Au and Pd enrichment) and chemistry (calcalkaline) (Foley *et al*., 1997). It produced 295,000 tonnes containing 0.95% copper, 1.12 ppm gold, 5.29 ppm silver and 2.4 ppm PGEs, mostly palladium (Foley *et al.*, 1997). Foley and his co-authors speculate that the Salt Chuck Intrusive Complex is related to the Sicker Arc and classify it with other composite plutons in Alaska that include alkaline to subalkaline granitic rocks.

Another intrusive setting for nickel and copper deposits, with associated byproduct PGEs, is *gabbroid intrusions* in greenstone and orogenic belts. The sulphides occur as lenses, net-textured stockworks and disseminations of pentlandite, chalcopyrite and pyrrhotite hosted by small to medium-size stocks. In British Columbia the Giant Mascot mine and Nickel Mountain prospect are examples of this type of deposit. Platinum and palladium grades of up to 2 and 3 g/t respectively have been reported for Giant Mascot.

A number of poorly understood copper-PGE mineral occurrences are associated with *alkalic* intrusive rocks in the Okanagan and Greenwood areas. These intrusive rocks have been correlated with Eocene Coryell intrusions based on composition and texture (Hulbert *et al*., 1997). The occurrences include the Dobbin, Sappho and Maple Leaf and other occurrences in the Franklin Camp. On the Dobbin property drilling has intersected 15 metres grading 0.54% Cu, 1.36 g/t platinum and 0.947 g/t palladium. The Maple Leaf, also called the Platinum Blonde, was mined in 1915-16 for copper and gold. A 23 tonne shipment of ore had an average grade of 9.6 % copper, 230 ppm silver, 0.68 ppm Au and 8.9 ppm platinum (Hulbert *et al.*, 1997). Subsequent sampling by government and industry geologists have confirmed the presence of anomalous platinum and palladium (up to 10 ppm) with Pd/Pt ratios greater than 1.

These alkalic PGE occurrences may be related to some of the copper-gold alkalic porphyries in the province which contain significant concentrations of palladium and platinum. For example, at Copper Mountain the sulphide concentrate from the mine yielded up to 2.8 grams per tonne palladium and 0.155 gram per tonne platinum and a sample of a bornite- chalcopyrite vein from the glory hole yielded 3.25 grams per tonne palladium. The Afton mine received credits in the 1980s for palladium in the copper concentrate.

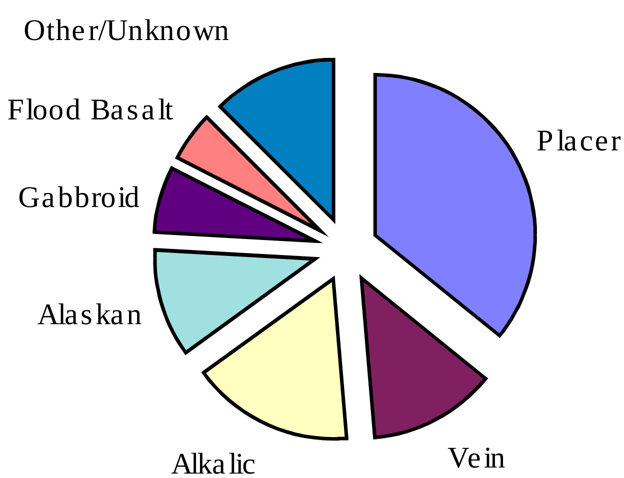
Podiform chromites hosted by ophiolites can have anomalous PGE contents for ruthenium, osmium and iridium. Since the individual pods are small and the chromite is lower quality, these are not very prospective for PGEs.

Shales can host thin layers of sulphides, such as pyrite, vaesite (NiS_2), jordisite (amorphous MoS_2) and sphalerite. These layers can extend laterally for kilometres and often have associated phosphatic chert and carbonate rocks. These layers are often polymetallic and contain multiple, economically attractive commodities, including PGEs. Unfortunately most horizons are too thin and their metallurgy is too complex to be commercially viable. Several occurrences with minor PGEs have been identified in the Yukon, including the Old Nick and Taiga prospects. Similar age shales occur in sedimentary strata along the east side of the Rocky Mountain Trench in British Columbia.

Hydrothermal PGE occurrences may occur in Cordilleran environments. Some of the British Columbia occurrences classified as veins could have formed in this manner.

British Columbia PGE Occurrences

There are more than a 100 mineral occurrences in British Columbia that have reported anomalous concentrations of platinum or palladium (Table 3). Since PGE analyses are relatively expensive and have been relatively unreliable until recently, there are probably more showings with anomalous platinum group elements than reported. For example, there are 134 nickel occurrences in British Columbia and not all of them have been tested for their PGE content.



Approximately a third of the province's PGE mineral occurrences are placers containing gold and platinum (Figure 3). Van Winkle Bar is the only platinum placer. The Tulameen and Similkameen river placers produced 620 000 grams of platinum between 1889 and 1936 (Nixon and Hammack, 1991). Lode occurrences are related to Alaskan-type, gabbroid-associated, flood basalt-associated and vein deposits. For information on individual occurrences the reader is referred to the provincial mineral occurrence database (MINFILE) on the British Columbia Ministry of Energy and Mines web site. **http://www.em.gov.bc.ca/mining/Geolsurv/minfile/search/**

Figure 2. Relative Abundance of PGE Occurrence Types in British Columbia.

Conclusions

The increasing demand for palladium, coupled with its scarcity, has pushed the price to historic highs. At the same time platinum has generally traded above US$370 per troy ounce. This has sparked interest in exploring for PGE deposits in the Canadian Cordillera, particularly those with high palladium contents. Current exploration activity is focused on magmatic sources of PGEs, including flood basalt-associated Ni-Cu-PGE (Noril'sk-type), gabbroid-associated Ni-Cu±PGE, Alaskan-type Pt±Os±Rh±Ir and Alkalic Cu±Au±Pd±Pt.

Sources of Information

Nixon and Hammack (1991) review the metallogeny of British Columbia PGE deposits. A comprehensive study of the province's Alaskan-type intrusions, including the Tulameen Complex, has been completed as well (Nixon *et al.*, 1997). This study shows that the many platinum placer occurrences are derived from chromite-hosted PGE mineralization in the intrusions, identifies several prospective intrusions and some exploration guidelines. Graham Nixon of the British Columbia Geological Survey is currently studying the nature of platinum and palladium mineral occurrences and their associated alkalic intrusive rocks on the Dobbin, Maple Leaf and Sappho properties.

Many of the PGE occurrences in the Canadian Cordillera have been visited by Larry Hulbert of the Geological Survey of Canada. He is currently working on a compilation map of PGE occurrences in British Columbia to be published next year.

References

Evenchick, C.A., Friday, S.J. and Monger, J.W.H. (1986): Potential Hosts to Platinum Group Element Concentrations in the Canadian Cordillera, *Geological Survey of Canada*, Open File 1433, map.

Foley, J.P., Light, T.D., Nelson, S.W. and Harris, R.A. (1997): mineral Occurrences Associated with Mafic-Ultramafic and Related Alkaline Complexes in Alaska; *Economic Geology*, Monograph 9, pages 396-449.

Hillard, H.E. (2000): Platinum-Group Metals; in Minerals Yearbook - 1999, *United States Geological Survey*, pages 58-1 to 10.

Hulbert, L.J., Duke, J.M., Eckstrand, O.R., Lydon, J.W., Scoates, R.F.J., Cabri, L.J. and Irvine, T.N. (1988): Geological Environments of the Platinum Group Elements; *Geological Survey of Canada*, Open File 1440, 148 pages.

Hulbert, L.J. and Carne, R. (1996): Wrangellia – a New Ni-Cu-PGE Metallogenetic Terrane; in New Mineral Deposit Models of the Cordillera, *Northwest Mining Association*, Short Course Notes, pages O-1 to 30.

Nixon, G.T. and Hammack, J.L. (1991): Metallogeny of Ultramafic-mafic Rocks in British Columbia with Emphasis on the Platinum-group Elements; *in* Ore Deposits, Tectonic and Metallogeny in the Canadian Cordillera, British Columbia, *British Columbia Ministry of Energy and Mines*, Paper 1991-4, pages 125-161.

Nixon, G.T., Hammack, J.L., Ash, C.A., Cabri, L.J., Case, G., Connelly, J.N., Heaman, L.M., Laflamme, J.H.G., Nuttall, C., Paterson, W.P.E. and Wong, R.H. (1997) Geology and Platinum-Group Element Mineralization of Alaskan-type Ultramafic-Mafic Complexes in British Columbia, *British Columbia Ministry of Energy and Mines*, Bulletin 93, 141 pages.

Rosler, H.J. and Lange, H. (1972): Geochemical Tables; *Elsevier Publishing Company,* New York, 468 pages.

Rublee, V.J. (1986): Occurrence and Distribution of Platinum-group Elements in British Columbia; B.C. *Ministry of Energy and Mines*, Open File 1986-7, 94 pages.

Suggested Reference for this report:

Lefebure, D.L. (2000): Potential for palladium and platinum deposits in British Columbia; British Columbia Ministry of Energy and Mines, GeoFile 2000-5.

Table 3. PGE Mineral Occurrences in British Columbia

MINFILE #	Name	Status	Commodities								Deposit Type
082ESW026	ROCK CREEK PLACER	Past Producer	AU	PT							Surficial placers
092GNE013	MONTE CRISTO	Showing	AU	PT							Surficial placers
092GNE019	CHILCO	Showing	AU	PT	PD	AG					Surficial placers
092HNE179	JOY MINING PLACER	Showing	AU	PT							Surficial placers
092HNE192	BEAR CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HNE194	CEDAR CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HNE196	EAGLE CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HNE197	HINES CREEK PLACER	Past Producer	PT	AU							Surficial placers
092HNE198	SLATE CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HNE199	TULAMEEN RIVER PLACER	Past Producer	AU	PT	CU						Surficial placers
092HSE229	CHAMPION CREEK PLACER	Showing	AU	PT							Surficial placers
092HSE230	GRANITE CREEK PLACER	Past Producer	AU	PT	OS	IR	RH	PD			Surficial placers
092HSE232	NEWTON CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HSE233	SIMILKAMEEN RIVER PLACER	Past Producer	AU	PT	AG						Surficial placers
092HSE235	TULAMEEN RIVER	Past Producer	AU	PT	IR	PD	RH	OS			Surficial placers
092HSE236	WHIPSAW CREEK PLACER	Past Producer	AU	PT							Surficial placers
092HSE238	DALBY MEADOWS	Developed Prospect	AU	PT	IR						Surficial placers
092HSW148	SOWAQUA CREEK	Past Producer	AU	PT							Surficial placers
092INW050	GLASGOW	Past Producer	AU	PT	AG						Surficial placers
092ISW078	VAN WINKLE BAR	Showing	PT	IR							Surficial placers
092JSE022	HEMRICK MINES	Showing	AU	PT	AG						Surficial placers
093A 085	MAUD CREEK PLACER	Showing	AU	AG	PT						Surficial placers
093G 025	COTTONWOOD PLACER	Past Producer	AU	PT							Surficial placers
093J 007	MCDOUGALL RIVER	Past Producer	AU	PT							Surficial placers
093J 012	MCLEOD RIVER	Past Producer	AU	PT							Surficial placers
093O 003	BILL CUST'S BAR	Past Producer	AU	PT	IR						Surficial placers

093O 004	NATION RIVER BAR	Past Producer	AU	PT	IR					Surficial placers
093O 005	RAINBOW CREEK	Past Producer	AU	PT	IR					Surficial placers
093O 006	PHILIP AND WHEEL CREEKS	Past Producer	AU	PT	IR					Surficial placers
093O 045	PARSNIP RIVER	Past Producer	AU	PT	AG					Surficial placers
094B 001	PETE TOYS BAR	Past Producer	AU	PT						Surficial placers
094B 002	BRANHAM FLATS	Past Producer	AU	PT						Surficial placers
094B 004	PEACE RIVER	Past Producer	AU	PT						Surficial placers
094D 007	MCCONNELL CREEK	Past Producer	AU	PT						Surficial placers
094D 008	INGENIKA RIVER	Showing	AU	PT						Surficial placers
104J 007	THIBERT CREEK	Past Producer	AU	PT						Buried-channel placers
103F 026	BLUE JACKET CREEK	Past Producer	AU	PT	FE	TI	ZR			Marine placers
093N 018	DAN	Showing	HG	CR	PT					Almaden Hg
082ESE110	MAPLE LEAF	Showing	AU	AG	PT					Au-quartz veins
092HSW043	MASTER ACE	Prospect	AU	AG	CU	BI	NI	PT		Au-quartz veins
092JW 038	SLATE	Showing	AU	AG	PT	WO	TE			Au-quartz veins
104J 012	KEYSTONE	Showing	AU	PT						Au-quartz veins
093L 109	GLACIER GULCH GOLD (BISMUTH)	Past Producer	AU	AG	BI	TE	PT			Intrusion-related Au pyrrhotite veins
082ENE003	UNION	Past Producer	AG	AU	ZN	PB	CU	PT		Polymetallic veins Ag-Pb-Zn±Au
082ENE005	GLOUCESTER	Showing	AU	AG	CU	MO	ZN	PB	Pt		Polymetallic veins Ag-Pb-Zn±Au
082ESW109	LAURION	Prospect	PB	ZN	AU	AG	PT	HG			Polymetallic veins Ag-Pb-Zn±Au
082FNW108	CABLE (L. 6503)	Showing	AG	PT	AU	CU	PB	ZN			Polymetallic veins Ag-Pb-Zn±Au
082LNW008	MOUNT IDA	Prospect	AG	PB	ZN	AU	PT				Polymetallic veins Ag-Pb-Zn±Au
082LNW022	SUNSET	Prospect	AG	PB	ZN	CU	AU	SN	Sb	Pt	Polymetallic veins Ag-Pb-Zn±Au
092HSW152	NEWJAY	Showing	AU	AG	CU	PB	ZN	PT			Polymetallic veins Ag-Pb-Zn±Au
082ESW203	ROADSIDE	Prospect	AU	AG	CU	PT					Cu±Ag quartz veins
082ESE081	MOTHER LODE (L.1508)	Developed Prospect	AU	PB	ZN	CU	MO	PT			Pb-Zn skarn
082ENE007	AVERILL	Showing	CU	AG	PT	PD					Alkalic Cu±Au±Pd±Pt
082ENE008	BUFFALO	Showing	CU	PT	PD						Alkalic Cu±Au±Pd±Pt
082ENE053	GOLDEN	Showing	PT	CU							Alkalic Cu±Au±Pd±Pt

082ENE055	MOUNTAIN LION	Showing	PT								Alkalic Cu±Au±Pd±Pt
082ENE056	LUCKY JACK (L.1026S)	Showing	CU	PT	AU						Alkalic Cu±Au±Pd±Pt
082ENE060	COLUMBIA	Showing	PT	CU							Alkalic Cu±Au±Pd±Pt
082ENE061	OTTAWA	Showing	PT	CU							Alkalic Cu±Au±Pd±Pt
082ENE009	MAPLE LEAF	Past Producer	AU	AG	CU	PT	PD				Alkalic Cu±Au±Pd±Pt
082ESE147	SAPPHO (L.2039)	Past Producer	CU	AG	PT	AU					Alkalic Cu±Au±Pd±Pt
082LSW005	DOBBIN	Prospect	CU	PT	PD	AG	MO	IR			Alkalic Cu±Au±Pd±Pt
092HSE033	FRIDAY CREEK	Prospect	CU	AU	AG	PD					Alkalic porphyry Cu-Au
092HSE195	ILK	Prospect	CU	AU	AG	PD					Alkalic porphyry Cu-Au
092INE002	PYTHON	Past Producer	CU	AG	AU	MO	PD				Alkalic porphyry Cu-Au
093J 024	WINDY	Showing	CU	AU	PD						Alkalic porphyry Cu-Au
093N 003	JENO	Prospect	CU	AU	AG	PD					Alkalic porphyry Cu-Au
092HSE001	COPPER MOUNTAIN (SIMILCO)	Past Producer	CU	Au	AG	PD					Alkalic porphyry Cu-Au
092INE023	AFTON	Past Producer	CU	AU	AG	MO	PD				Alkalic porphyry Cu-Au
092F 029	TOFINO NICKEL	Prospect	NI	CU	PT	PD	AU	AG			Flood Basalt-Associated Ni-Cu
114P 030	MOUNT MANSFIELD	Showing	CU	PT							Flood Basalt-Associated Ni-Cu
114P 031	CHILKAT (C and E NORTH)	Showing	CU	NI	ZN	PT					Flood Basalt-Associated Ni-Cu
103B 009	SWEDE	Prospect	CU	AG	PT	AU					Flood Basalt-Associated Ni-Cu
082FNE118	DYKES OPTION	Showing	CU	PT	PD						Gabbroid-associated Ni-Cu
092B 010	WILLOW GROUSE (L.135)	Past Producer	CU	NI	CO	PD	MO	AG			Gabbroid-associated Ni-Cu
092B 112	ORN 3	Showing	MA	CU	AG	AU	PD				Gabbroid-associated Ni-Cu
092HSW004	PRIDE OF EMORY	Past Producer	NI	CU	CO	AU	AG	CR			Gabbroid-associated Ni-Cu
092HSW093	STAR OF EMORY 3	Past Producer	NI	CU	CR	AU	PT	PD			Gabbroid-associated Ni-Cu
103P 110	SEA OTTER	Showing	NI	CU	CO	AG	AU	PT			Gabbroid-associated Ni-Cu
104B 006	E & L	Developed Prospect	NI	CU	PT	AG	TI	AU			Gabbroid-associated Ni-Cu
092HSW004	GIANT MASCOT	Past Producer	Ni	CU	CO	AU	AG	CR	PT	PD	Gabbroid-associated Ni-Cu
082ESE091	CASTLE MOUNTAIN NICKEL	Past Producer	NI	CR	FE	MA	CU	PT			Podiform chromite
082FSW130	VANDOT	Showing	CR	NI	PT	CO	TI	FE			Podiform chromite
092INW001	SCOTTIE CREEK	Developed Prospect	CR	AU	PT						Podiform chromite
092HNE011	GRASSHOPPER MOUNTAIN	Prospect	PT	CR	PD	AU					Alaskan-type Pt±Os±Rh±Ir

092HNE038	CATHY	Showing	CU	PT	PD	CR						Alaskan-type Pt±Os±Rh±Ir
092HNE128	D	Prospect	CR	PT	CU	NI	AB					Alaskan-type Pt±Os±Rh±Ir
092HNE184	OLIVINE MOUNTAIN	Prospect	PT	CR								Alaskan-type Pt±Os±Rh±Ir
092HNE205	H & H	Showing	CU	AG	PD	PT	AU					Alaskan-type Pt±Os±Rh±Ir
092HNE206	WEST SIDE	Showing	CU	AG	AU	PT						Alaskan-type Pt±Os±Rh±Ir
092HNE207	RIDGE ZONE	Prospect	CR	PT								Alaskan-type Pt±Os±Rh±Ir
092HSE034	LODESTONE MOUNTAIN	Developed Prospect	MA	FE	VA	PT	TI					Alaskan-type Pt±Os±Rh±Ir
092HSE159	NEWTON CREEK PLATINUM	Showing	PT	CU								Alaskan-type Pt±Os±Rh±Ir
104I 014	TURNAGAIN	Prospect	NI	CO	PT	CU	CR	WO				Alaskan-type Pt±Os±Rh±Ir
104I 118	CLIFF	Prospect	CU	NI	PD	PT						Alaskan-type Pt±Os±Rh±Ir
082N 044	KING DAVID	Showing	GE	UR	ZR	PT						Unknown
092F 461	KIT KAT 5	Showing	CU	NI	PT	PD						Unknown
092HNE170	TOR	Prospect	AU	PT	AG	PD	RH					Unknown
092ISW071	KEEFERS	Showing	CU	NI	CO	PT	PD					Unknown
092N 048	AT 2	Prospect	CU	NI	CO	HG	AU	AG	Pt	Pd		Unknown
094F 012	GRAYLING	Showing	CU	AG	NI	CO	PT					Unknown