Platinum-Group-Element (PGE) Placer Deposits in British Columbia: Characterization and Implications for PGE Potential

By Victor M. Levson, David J. Mate and Travis Ferbey

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INTRODUCTION

A number of techniques are now available that can be used to evaluate the relationships of PGE-Au rich placers with their original lode sources using sedimentological, geochemical and mineralogical data (Levson and Morison, 1995; Youngson and Craw, 1999; Knight *et al.*, 1999a, b; Chapman *et al.,* 2000; Levson and Blyth, 2001). Information about the type of PGE lode deposits can also be obtained from the study of placer deposits (Bowles *et al.,* 2000; Gornostayev *et al.*, 2000). The objective of this study is to use these types of data to lead to the identification of new PGE exploration targets (new deposit types and specific target areas) in British Columbia. Emphasis is placed on areas where high grade proximal placers occur but known lode sources have not been identified, especially where exposure in the probable source areas is poor. This study includes an evaluation of known and suspected platinum placers in BC (Table 1; Figure 1). Field and laboratory verification of reported PGE occurrences was conducted in areas with good potential. The geology of each placer was described and interpreted and the concentration of PGEs and other elements quantitatively assessed.

Platinum group elements occur in a variety of mineral deposit settings including: PGEs associated with Nickel deposits (*e.g.* Giant Mascot, Nickel Mountain areas; MINFILE 92HSW004 and 104B006,); PGE's in Cu-enriched Alkaline complexes (*e.g.* Whiterocks Mountain./Dobbin area; MINFILE 82LSW005); listwanite Au-PGE occurrences (*e.g.* Atlin area); and Alaskan-type complexes. An attempt was made to collect data from placer deposits with PGE potential in each of these settings. A well known example in British Columbia of a placer derived from an Alaskan-type PGE complex is the PGE-bearing placers in the Tulameen area. These placers yielded 620 kg of platinum from 1889 to 1936 (Nixon *et al.* 1990). The Salmon River placers in southwestern Alaska are also derived from an Alaskan-type complex and produced 20 200 kg of PGE, mostly in the form of Fe–Pt alloys (Foley *et al.* 1997).

The platinum-group elements include platinum, iridium, osmium, palladium, rhodium, and ruthenium. They have unique properties that result in a wide range of important applications. Platinum, for example, has a high melting

TABLE 1
PLACER DEPOSITS WITH REPORTED PGE'S IN BRITISH COLUMBIA
(SOURCE: MINFILE DATABASE)

Minfile #	Stream Name(s)	Content	NTS
082ESW026	ROCK CREEK/ JOLLY CREEK	Au Pt	82E/3E
092HNE192	BEAR CREEK/ LAWLESS CREEK	Au Pt	92H/10W
092HNE194	CEDAR CREEK/ MANION CREEK	Au Pt	92H/10W
092HNE196	EAGLE CREEK/ BRITTON CREEK	Au Pt	92H/10W
092HNE197	HINES CREEK	Pt Au	92H/10W
092HNE198	SLATE CREEK/ OLIVINE CREEK	Au Pt	92H/10W
092HNE199	TULAMEEN RIVER	Au Pt Cu	92H/10W
092HSE230	GRANITE CREEK	Au Pt Os Ir Rh Pd Cr Cu	92H/7E, 10E
092HSE232	NEWTON CREEK	Au Pt	92H/7W, 7E
092HSE233	SIMILKAMEEN RIVER	Au Pt Ag	92H/7E, 8W
092HSE235	TULAMEEN RIVER/ RUBY	Au Pt Ir Pd Rh Os Ru	92H/7E, 10E, 10W
092HSE236	WHIPSAW CREEK	Au Pt	92H/7E
092HSW148	SOWAQUA/ PIERRE/ PEERS CREEKS	Au Pt	92H/6E
092INW050	GLASGOW/ BABKIRK	Au Pt Ag	92I/13W
093G 025	COTTONWOOD	Au Pt	93G/1E
093J 007	MCDOUGALL/ LITTLE MCLEOD RIVER	Au Pt	93J/14W
093J 012	MCLEOD RIVER	Au Pt	93J/14E
093O 003	BILL CUST'S BAR	Au Pt Ir	93O/13E, 12E
093O 004	NATION RIVER BAR	Au Pt Ir	93O/5E
093O 005	RAINBOW CREEK	Au Pt Ir	93O/4W
093O 006	PHILIP AND WHEEL CREEKS	Au Pt Ir	93O/4E, 5E
093O 045	PARSNIP RIVER	Au Pt Ag	93O/11W
094B 001	PETE TOYS BAR	Au Pt	94B/4W
094B 002	BRANHAM FLATS	Au Pt	94B/2E
094B 004	PEACE RIVER/ GOLD BAR	Au Pt	94B/2E
094D 007	MCCONNELL CREEK	Au Pt	94D/16W
104J 007	THIBERT CREEK	Au Pt	104J/16E
103F 026	BLUE JACKET CREEK/ MASSET SOUND	Au Pt Fe Ti Zr	103F/16E
092HSE238	DALBY CREEK**	Au Pt Ir	92H/7E
092GNE013	MONTE CRISTO*	Au Pt	92G/16W
092GNE019	CHILCO*	Au Pt Pd Ag	92G/16W
092HNE179	JOY MINING*	Au Pt	92H/10E
092HSE229	CHAMPION CREEK*	Au Pt	92H/7W
092ISW078	VAN WINKLE BAR*	Pt Ir	92I/5E
092JSE022	HEMRICK MINES*	Au Pt Ag	92J/2E
093A 085	MAUD CREEK*	Au Ag Pt	93A/12E
094D 008	INGENIKA RIVER*	Au Pt	94D/16W

* Showing; ** Developed Prospect; all others Past Producers

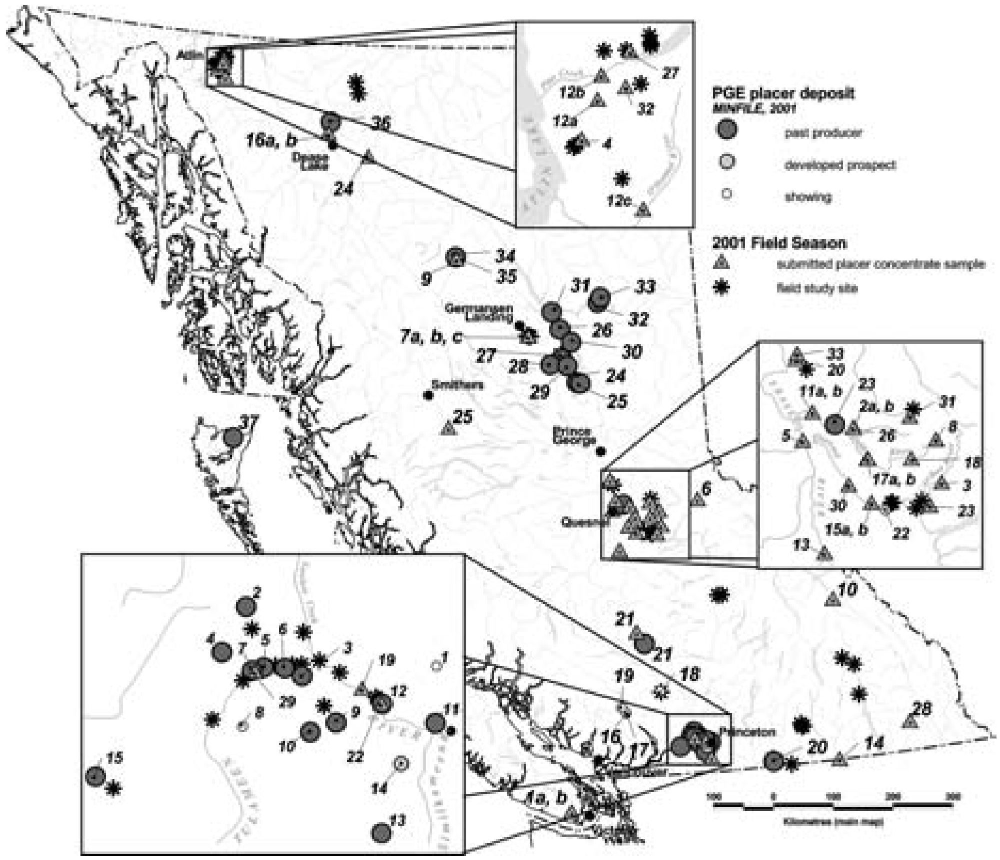

Figure 1. Locations of PGE placer deposits in British Columbia (*see* also Table 1), locations of placer samples analysed in this study (see Tables 3 to 5 for results), and locations of field study sites.

point (1775° C), is a good conductor, and is unusually hard for a metal (4-4.5). Applications include uses as a catalyst in the chemical and petroleum industry, in vehicle pollution control, electronics, power generation, medicine, dentistry, investment and jewellery. The level of demand and supply of PGE's has progressively increased in North America and dramatic increases in price have led to a renewed interest in exploration for the PGEs in recent years.

PREVIOUS STUDIES

Previous work on PGE's in British Columbia has been conducted by a number of authors. Good summaries have been provided by Nixon and Hammack (1991), Nixon *et al.* (1997) and Lefebure (2000). The distribution of PGE occurrences in the province in relation to geology has been mapped by the Ministry of Energy and Mines (2000) and Hulbert (2001). In addition, numerous reports dealing with PGE's in specific areas have been published (*e.g.* in the Tulameen area, Nixon et al., 1990; Cook and Fletcher, 1992). Historical reports dealing mainly with platinum in placer deposits include reports by the Munition Resources Commission (1920), O'Neill and Gunning (1934) and Rublee (1986). An excellent summary of platinum placers around the world is provided by Cabri *et al.* (1996).

OBJECTIVES

This paper reports on the preliminary results of field and laboratory work conducted in the first six months of a two year study. The objectives of the first year of the study are to: 1) substantiate reported PGE placer occurrences; 2) document new PGE occurrences; 3) provide high quality analytical results; 4) determine the nature of any contained PGE and PGMs in order to evaluate source deposit type; and 5) collect data that will help in determining the proximity of the PGE placers to their source areas.

Objectives for further research on the project include: determination of the proximity of selected placers to potential lode sources; evaluation of dispersal mechanisms of PGEs in till, colluvium and other surficial sediments; identification of preferred sample media and size fractions for locating buried PGE targets; identification of pathfinder elements for PGE exploration; and determination of suitable analytical tools (*e.g*. heavy mineral analysis of the coarse fraction versus trace element analysis of the fine fraction). In order to identify areas with the best potential for the discovery of new PGE targets, the distribution and geology of these placers needs to be compared with existing geochemical data, bedrock geology and PGE deposit models. Follow-up till geochemical sampling is planned for the second year of the study in areas where preliminary results indicate potential for discovery of proximal lode sources.

RESEARCH COMPONENTS

OFFICE EVALUATION

The study included an office evaluation of reported platinum placer occurrences in BC from the MINFILE database (Table 1) and from published works (*e.g.* Rublee, 1986). The distribution of these placers was compared with existing geochemical data, the occurrence of known PGE prospects, bedrock geology and PGE deposit models in order to identify areas with the potential for the discovery of new PGE targets. Field sites were selected from this information.

SAMPLE COLLECTION

Placer samples in areas of PGE potential were obtained in three ways:

- Placer property holders in the British Columbia Mineral Titles registry (as of May, 2001) were canvassed for concentrate samples. Data on the sample site location, type of placer, stratigraphic position, size and shape of placer minerals, method of concentration and processing circuit were requested (Table 2). Data useful for characterizing the host sediments including sedimentary structures, clast shape and lithology, alteration and grain-size distribution were also obtained. Submitted sample size was requested to be between 65 grams and 1 kilogram with grains less than 1 mm (finer than # 18 sieve size);

- Bulk samples were collected from streams in areas where geologic data suggested PGE potential. Sites of natural heavy mineral concentration were sampled wherever possible to increase the likelihood of obtaining detectable levels of PGE's. These sites included back-bar eddies, bar-top lags, and winnowed-channel deposits. Sediments

a

b

Figure 2. Stratigraphic setting of example placer deposits with PGE potential: 2a) Platinum, palladium and gold bearing gravels underlying glacial deposits at Slate Creek, Manson Creek area (Lloyd Worthing mining operation); 2b) Auiferous gravels underlying Pleistocene basalts at Ruby Creek, Atlin area (Wayne Klippert mine).

TABLE 2
DESCRIPTION COMPONENTS FOR PGE ANALYSIS SAMPLE SUBMISSION

Submitter information:				
Name	Mailing Address	Telephone	Fax	E-Mail
Sample location:				
NTS map	Stream name	Latitude and Longitude	UTM Coordinates	
Description of submitted sample:				
Weight	Grain-size fraction	Method of concentration	Treatment after concentration	
Description of placer mine and deposit from which sample originated:				
Type of mine	Size of mine	Type of deposit	Size of deposit	
Stratigraphic position of sampled horizon:				
Depth of sample	Depth to bedrock	Bedrock lithology	Overburden thickness and description	
Description of sediment from which sample originated:				
Clast shape	Clast lithologies	Stratification	Imbrication	
Cementation	Weathering	Iron staining	Manganese staining	
Description of placer minerals (gold and platinum if present):				
Size range	Shape	Known placer minerals	PGE documentation	
Grain size distribution (estimated percent by volume of each fraction):				
Cobbles and boulders	Coarse pebble gravel	Fine pebble gravel	Sand	Silt and clay
Description of processing circuit:				
Processing operation	Feed rate	Method of screening	Feed size	Concentration ratio
Special equipment	Trommel	Washing process	Riffle type	Sluice box type and slope

TABLE 3
RESULTS OF ICP-MS ANALYSIS OF SELECTED PLACER CONCENTRATE SAMPLES

ELEMENT SAMPLE #	Pt ppb	Au ppb	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppb	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	Sb ppm	Cr ppm
VLE2001-1a	< 2	359	6.7	23	6	51	51	117	34	528	37.7	6	0.19	387
VLE2001-1b	< 2	147600	1.2	2581	2412	50	21682	27	15	2746	12.7	1495	27.33	26
VLE2001-2a	3	347800	2.2	32	19	60	10373	142	32	744	22.4	8	1.37	613
VLE2001-2b	< 2	8	57.4	37	13	222	1000	135	11	315	3.4	30	7.39	193
VLE2001-3	< 2	2478000	3.7	220	1124	131	99999	115	35	587	11.8	31	2.8	111
VLE2001-4	5	38184	5.4	86	100	36	3723	229	25	407	11.7	75	99.21	205
VLE2001-5	8592	249300	2.0	27	88	81	11101	186	26	945	20.4	8	1.92	385
VLE2001-6	4	3673	2.8	34	19	77	637	47	19	373	3.7	11	0.48	26
VLE2001-7a	47	1040	1.7	14	61	50	362	85	36	711	36.2	8	0.54	675
VLE2001-7b	20718	1941000	17.9	104	28542	97	99999	357	260	881	30.2	4261	133.06	525
VLE2001-7c	4	60	13.3	196	95	279	2249	100	28	1833	5.2	53	4.2	39
VLE2001-8	4	335000	6.6	513	1233	299	77547	416	456	715	35.2	5041	11.98	54
VLE2001-9	11	89608	3.0	57	22	56	1551	34	27	942	20.5	7	1.33	279
VLE2001-10	< 2	193	1.1	33	106	57	174	68	35	722	6.9	971	1.51	30
VLE2001-11a	3	8459	1.1	30	17	177	869	166	47	1264	35.8	5	0.75	1213
VLE2001-11b	74	3459	2.6	32	20	53	995	57	22	1143	8.5	8	1.53	129
VLE2001-12a	2120	39000	5.8	86	1203	189	4275	1349	113	2228	21.2	17	25.49	2664
VLE2001-12b	3	2171	3.1	34	145	72	660	457	42	811	13.5	19	1.6	1774
VLE2001-12c	84432	4063000	8.9	113	66	105	99999	106	596	1156	17.7	14	2.06	537
VLE2001-13	7941	81579	0.9	18	7	53	6900	43	14	654	6.9	5	0.62	126
VLE2001-14	31	172100	8.4	103	2039	149	7629	92	30	665	33.0	23	11.4	377
VLE2001-15a	7	14116	1.0	40	15	107	876	65	27	991	14.8	11	0.94	308
VLE2001-15b	3	38000	3.0	27	23	138	735	104	35	1002	25.1	7	0.76	575
VLE2001-15c	3	3861	1.2	40	13	84	616	46	24	876	10.8	11	1.02	181
VLE2001-16a	270000	27566000	70.2	3413	3907	196	99999	298	197	534	16.7	197	47.03	103
VLE2001-16b	1692	534000	3.3	114	57	55	15983	127	44	801	36.7	5	0.83	289
VLE2001-17a	1631	1407800	0.9	27	17	153	70709	388	54	1460	19.3	3	0.72	4929
VLE2001-17b	4860	1302900	0.8	29	8	175	82236	432	62	1679	22.0	2	0.61	5569
VLE2001-18	146	97206	3.5	234	605	197	22554	155	52	925	28.6	57	2.43	1440
VLE2001-19	1517	7043	0.5	31	10	47	760	109	54	520	25.5	3	2.43	383
VLE2001-20	20	378000	8.4	15	42	62	10638	80	17	1413	16.8	6	0.93	647
VLE2001-21	19	72597	1.3	26	14	56	5535	29	17	1076	14.0	5	1.35	125
VLE2001-22	11435	527	0.5	27	117	36	161	112	56	561	27.0	3	1.74	386
VLE2001-23	7321	3834	11.1	42	27405	63	99999	123	34	450	23.5	155	56.88	804
VLE2001-24	12	2795	2.4	84	117	128	479	259	21	509	7.6	4	5.54	617
VLE2001-25	195	292600	6.5	30	283	356	89105	44	26	1379	14.1	399	6.64	145
VLE2001-26	44	182100	1.7	26	50	99	8751	234	39	1223	29.1	6	2.29	1406
VLE2001-27	13	3403000	3.1	47	830	74	99999	49	6	25383	6.3	0	2.47	99
VLE2001-28	20	580	0.7	19	18	64	453	42	23	757	36.0	5	0.4	119
VLE2001-29	27850	5653	1.2	27	25	42	1546	114	61	639	33.7	2	0.82	414
VLE2001-30	566	788200	1.8	39	15	115	45005	75	29	1198	22.6	9	1.02	462
VLE2001-31	41	1766	4.9	8907	7456	46471	75139	63	211	7371	19.8	181	28.01	< .5
VLE2001-32	127	1764900	40.3	53	169	88	62121	1372	99	1167	30.7	6	0.97	2770
VLE2001-33	18165	1783900	46.6	29	174	95	92236	149	26	1266	26.5	5	1.02	934
VLE2001-36	266	51834	1.6	42	40	112	5587	27	31	1482	33.0	23	1.63	121

ELEMENT SAMPLE #	Al %	Na %	K %	Pd ppb	U ppm	Th ppm	Sr ppm	Cd ppm	Bi ppm	V ppm	Ca %	P %	La ppm	Mg %
VLE2001-1a	0.34	0.009	0.01	< 10	0.1	0.4	8	0.06	0.05	1486	0.21	0.02	2	0.16
VLE2001-1b	0.88	0.01	0.02	< 10	0.4	0.4	111	0.39	5.47	96	0.95	0.027	4	0.41
VLE2001-2a	0.28	0.005	0.02	< 10	1.7	16.0	9	0.34	13.98	480	0.19	0.05	43	0.13
VLE2001-2b	1.4	0.01	0.2	< 10	1.4	2.0	14	0.29	0.2	157	0.09	0.051	6	1.87
VLE2001-3	0.91	0.017	0.1	< 10	2.0	27.6	25	0.86	3.35	130	0.36	0.079	89	0.51
VLE2001-4	0.23	0.004	0.03	< 10	0.8	0.9	6	0.15	20.45	243	0.11	0.02	5	0.33
VLE2001-5	0.32	0.005	0.02	63	10.9	76.9	16	0.12	2.69	748	0.32	0.087	153	0.19
VLE2001-6	1.03	0.012	0.21	< 10	1.5	14.6	385	0.12	0.37	10	5.66	0.049	29	0.63
VLE2001-7a	0.12	0.005	0.01	< 10	0.6	1.7	10	0.07	0.26	1157	0.28	0.059	5	0.1
VLE2001-7b	0.23	0.007	0.03	735	30.2	8.0	20	5.09	75.65	974	0.43	0.076	9	0.17
VLE2001-7c	1.34	0.011	0.12	< 10	2.2	5.6	75	3.64	0.48	67	1.06	0.119	11	0.81
VLE2001-8	0.13	0.005	0.03	< 10	1.2	4.3	20	2.93	8.93	14	0.53	0.039	11	0.42
VLE2001-9	0.47	0.015	0.04	10	1.6	2.5	30	0.13	0.34	708	0.47	0.097	13	0.22
VLE2001-10	0.67	0.01	0.08	< 10	1.1	5.7	95	0.05	0.37	25	4.52	0.042	22	1.9
VLE2001-11a	0.43	0.015	0.03	10	0.5	1.2	21	0.15	0.13	1242	0.37	0.071	5	0.32
VLE2001-11b	0.93	0.02	0.05	< 10	1.9	16.3	34	0.18	0.24	269	0.64	0.109	46	0.41
VLE2001-12a	0.23	0.008	0.02	38	1.9	36.0	6	0.34	19.12	204	0.3	0.055	59	0.76
VLE2001-12b	0.39	0.009	0.03	< 10	4.0	80.4	8	0.24	8.15	195	0.39	0.042	117	0.71
VLE2001-12c	0.36	0.013	0.04	541	13.1	8.0	18	10.9	12.67	787	0.72	0.125	29	0.3
VLE2001-13	0.68	0.023	0.06	72	1.3	10.0	27	0.15	0.24	242	0.57	0.06	28	0.54
VLE2001-14	0.19	0.008	0.03	< 10	26.7	168.6	15	0.85	6.37	833	0.65	0.115	100	0.24
VLE2001-15a	0.76	0.013	0.05	< 10	1.1	5.7	33	0.23	0.25	516	0.56	0.072	21	0.4
VLE2001-15b	0.42	0.01	0.02	< 10	3.9	11.3	29	0.21	0.77	948	0.52	0.081	22	0.26
VLE2001-15c	0.81	0.014	0.05	11	1.1	5.8	33	0.22	0.36	379	0.55	0.078	24	0.45
VLE2001-16a	0.13	0.011	0.01	6990	57.7	66.0	9	1.01	143.54	132	0.41	0.093	25	0.14
VLE2001-16b	0.09	0.006	< .01	< 10	1.1	4.1	5	0.06	1.48	1192	0.34	0.143	10	0.1
VLE2001-17a	0.7	0.014	0.04	51	2.3	18.7	16	0.17	0.51	959	0.31	0.031	45	0.52
VLE2001-17b	0.77	0.018	0.04	69	1.6	16.3	18	0.14	2.33	1081	0.33	0.028	43	0.59
VLE2001-18	0.65	0.085	0.05	11	1.2	11.0	24	3.74	2.11	681	0.72	0.044	22	0.38
VLE2001-19	0.28	0.01	0.02	22	0.2	0.8	25	0.1	0.1	1053	0.3	0.036	4	0.53
VLE2001-20	0.4	0.005	0.01	< 10	17.4	308.7	11	5.42	10.7	519	0.31	0.103	671	0.11
VLE2001-21	0.4	0.01	0.01	10	5.3	35.7	15	0.15	0.5	566	0.32	0.066	42	0.21
VLE2001-22	0.2	0.007	0.01	44	0.1	0.5	9	0.05	0.16	1104	0.25	0.028	2	0.41
VLE2001-23	0.13	0.011	0.01	< 10	6.8	1.2	18	57.57	2253.17	775	0.1	0.021	2	0.1
VLE2001-24	0.99	0.013	0.05	< 10	0.3	1.5	14	0.24	0.57	129	0.6	0.028	7	3.21
VLE2001-25	0.78	0.048	0.11	< 10	1.0	1.9	42	1.01	41.57	471	0.65	0.116	19	0.55
VLE2001-26	0.3	0.008	0.02	< 10	3.8	30.7	11	0.63	0.66	649	0.15	0.045	131	0.16
VLE2001-27	0.22	0.015	0.08	< 10	43.2	139.3	6	1.33	565.01	< 2	0.38	0.018	204	0.32
VLE2001-28	0.11	0.008	0.01	< 10	1.3	8.4	4	0.04	1.25	640	0.08	0.024	10	0.04
VLE2001-29	0.18	0.01	0.01	96	0.9	1.1	7	0.08	0.44	1305	0.25	0.028	4	0.25
VLE2001-30	0.55	0.027	0.04	20	2.7	10.0	40	0.18	0.46	826	0.67	0.083	14	0.36
VLE2001-31	0.38	0.014	0.06	< 10	0.8	4.7	2	263.94	13.32	4	0.33	0.017	1	0.16
VLE2001-32	0.1	0.007	0.01	< 10	1.9	3.3	2	0.26	3.04	405	0.1	0.025	4	0.52
VLE2001-33	0.3	0.009	0.02	140	22.7	310.6	13	0.17	42.66	756	0.27	0.114	685	0.14
VLE2001-36	0.31	0.022	0.03	< 10	1.7	2.1	14	0.83	1.35	1048	0.26	0.053	9	0.16

Table 3. Con't

ELEMENT SAMPLE #	Ba ppm	Ti %	B ppm	W ppm	Sc ppm	Tl ppm	S %	Hg ppb	Se ppm	Te ppm	Ga ppm
VLE2001-1a	16	0.297	< 1	< .2	1.2	< .02	0.03	417	< .1	< .02	11.5
VLE2001-1b	21	0.098	3	504.0	2.2	1.61	12.48	3513	4.6	0.12	3.0
VLE2001-2a	24	0.19	< 1	10.1	1.4	0.03	0.09	769	0.6	< .02	8.8
VLE2001-2b	89	0.021	4	2.7	5.2	1.17	0.6	10252	28.2	0.19	4.8
VLE2001-3	71	0.052	< 1	1188.3	2.4	0.08	0.18	55347	3.1	0.16	4.4
VLE2001-4	18	0.166	2	141.6	1.2	0.11	1.92	7397	1.5	0.13	2.1
VLE2001-5	51	0.414	< 1	7.2	2.2	0.02	0.07	5480	0.2	0.09	11.8
VLE2001-6	51	< .001	< 1	3.6	1.4	0.05	1.15	175	1.0	0.03	3.5
VLE2001-7a	21	0.245	< 1	1.7	0.7	< .02	0.01	147	0.1	< .02	11.8
VLE2001-7b	43	0.179	< 1	179.1	0.7	0.04	2.51	31010	455.9	4.65	10.4
VLE2001-7c	227	0.048	< 1	< .2	6.1	0.19	0.14	469	87.6	0.19	4.5
VLE2001-8	5	0.027	3	59.4	1.0	0.11	29.03	1463	32.3	13.33	0.9
VLE2001-9	77	0.278	< 1	0.9	2.1	0.02	0.07	548	0.1	0.02	10.2
VLE2001-10	34	0.012	< 1	7.5	1.8	0.04	1.95	913	0.7	0.04	2.3
VLE2001-11a	45	0.699	1	< .2	1.8	< .02	0.01	1249	< .1	< .02	19.9
VLE2001-11b	50	0.31	1	15.6	4.2	0.02	0.02	2936	0.4	0.02	5.0
VLE2001-12a	79	< .001	< 1	237.5	2.1	0.02	0.23	99999	0.3	0.07	4.6
VLE2001-12b	37	0.116	1	853.0	1.7	0.07	0.17	12248	0.3	0.09	7.7
VLE2001-12c	244	0.255	< 1	1373.3	1.9	0.02	0.06	99999	< .1	< .02	11.4
VLE2001-13	54	0.181	1	4.3	2.2	0.03	0.03	309	0.2	< .02	5.1
VLE2001-14	648	0.157	3	103.9	0.8	0.04	0.21	925	< .1	0.06	13.7
VLE2001-15a	45	0.322	2	0.7	2.8	0.03	0.01	1058	0.3	< .02	7.9
VLE2001-15b	38	0.282	< 1	17.6	1.8	< .02	0.38	99999	< .1	< .02	11.7
VLE2001-15c	43	0.288	3	3.0	2.9	0.03	< .01	2973	0.1	0.03	6.3
VLE2001-16a	< .5	0.371	< 1	1569.5	0.7	< .02	13.65	99999	21.4	5.32	2.8
VLE2001-16b	12	0.181	< 1	21.8	0.5	< .02	0.2	7956	< .1	0.04	16.7
VLE2001-17a	49	0.593	1	18.0	2.5	< .02	0.04	9147	0.1	< .02	15.6
VLE2001-17b	55	0.663	2	10.9	2.9	< .02	< .01	3318	0.6	< .02	17.6
VLE2001-18	76	0.22	557	208.2	2.3	0.05	1.33	21426	3.0	0.28	12.9
VLE2001-19	65	0.214	< 1	< .2	1.2	< .02	0.3	471	< .1	< .02	10.1
VLE2001-20	21	0.309	< 1	12.5	2.3	< .02	0.04	578	0.1	0.07	11.3
VLE2001-21	102	0.54	2	0.9	3.0	< .02	0.09	1687	< .1	< .02	6.3
VLE2001-22	52	0.186	< 1	3.5	1.1	< .02	0.23	1216	< .1	0.02	10.1
VLE2001-23	23	0.164	8	8.7	0.7	0.66	3.99	20766	260.2	102.57	6.3
VLE2001-24	60	0.253	5	2.4	3.4	0.03	0.06	315	0.3	0.02	3.0
VLE2001-25	138	0.284	4	3.7	2.7	0.1	0.5	415	0.4	1.6	12.3
VLE2001-26	35	0.261	4	0.9	1.7	0.02	0.04	2570	< .1	< .02	11.4
VLE2001-27	18	< .001	< 1	111.0	24.7	0.06	1.49	99999	20.3	10.75	1.6
VLE2001-28	13	0.038	< 1	28.9	0.3	< .02	0.07	168	< .1	0.03	8.8
VLE2001-29	34	0.233	< 1	5.2	1.0	< .02	0.12	652	< .1	0.04	14.6
VLE2001-30	58	0.341	7	8.8	2.6	0.02	0.06	3982	< .1	< .02	10.9
VLE2001-31	22	< .001	< 1	84.6	0.4	0.1	21.71	1670	16.7	0.05	3.1
VLE2001-32	13	0.049	2	482.9	0.8	< .02	0.05	3159	0.6	0.07	4.0
VLE2001-33	26	0.271	2	42.7	1.6	< .02	0.08	2429	0.8	0.08	16.5
VLE2001-36	159	0.189	4	3.2	2.1	0.02	0.23	1802	0.5	0.33	22.9

were screened in the field and concentrated in the laboratory (*see* below); and

- Samples were collected at active placer mines from representative stratigraphic units. Gravity concentrated samples were obtained where possible from active operations.

FIELD WORK

Field studies were conducted in the vicinity of known and reported PGE placer occurrences (Figure 1). PGE placers were evaluated in a variety of mineral deposit settings. Methods included stratigraphic, sedimentological, geochemical and geomorphological characterization of existing placer deposits and interpretation of depositional environments (Figure 2). The stratigraphic relationships of the placer deposits with the overburden sequences were determined and a detailed description of each sedimentary unit was obtained. Heavy mineral concentrates and representative samples for geochemical studies and size/shape analyses were collected (Figure 3).

LAB WORK AND QUALITY CONTROL

Samples were analyzed for platinum, palladium, gold and 36 other elements by ICP-MS (Table 3) and for gold, platinum and palladium by fire assay (Table 4). All samples received were submitted to the following procedures: 1) Samples were sieved with a #35 mesh screen (0.5 mm); 2) Any coarse visible gold or platinum, the +35 mesh fraction (if present), and any excess (over 50 grams) of the -35 mesh fraction were retained; 3) One split of the sample was milled to produce 40 to 50 g of -150 mesh material for analysis and the other split was archived. A quartz wash was used between each sample milled. If there was insufficient sample for a 30 g mill, 15 g, 10 g or 5 g samples were used for assaying; and 4) The -35 mesh (<0.5 mm) fraction was analyzed at Acme Analytical Laboratories in Vancouver by two methods:

- A 1 gram sample was analyzed for 39 elements (Table 3) by a combination of inductively coupled plasma, emission spectroscopy and mass spectroscopy analyses (ICP/ES & MS) after aqua regia digestion (6 millilitres of 2-2-2 HCL-HNO3-H2O at 95 degrees Celsius for one hour and diluted to 20 millilitres with water). The reported reliable upper limits for these analyses are: 100 ppm for Ag, Au, Hg, W, Se, Te, Tl, Ga and Sn; 2000 ppm for Mo, Co, Cd, Sb, Bi, Th, U and B; and 10,000 ppm for Cu, Pb, Zn, Ni, Mn, As, V, La and Cr (a fire assay is recommended for samples with higher levels.)

- Up to 30 grams (if available) were analyzed by fire assay (with an ICP finish) for Au, Pt and Pd (Table 4). (The reliable upper limit for an ICP finish is 10 ppm; a gravimetric finish is recommended for samples with higher levels.)

ACME and CANMET standards were used to monitor the quality of results.

From this data set, selected samples will be re-analyzed for the entire PGE suite. Results will be used to characterize source deposit types (*e.g.* ophiolites vs Alaskan type complexes) and to highlight areas where field work could be conducted to characterize the placers and determine lode proximity.

Laboratory studies included analyses of magnetic and non-magnetic fractions, fine and coarse fractions, and heavy mineral fractions. Size and shape analyses of placer minerals, and trace element geochemistry of individual placer grains are planned. Concentration of PGE's, gold and other elements was quantitatively assessed but caution is advised in applying grade estimates from these data due to small sample sizes, high natural variability in the placers and inconsistencies in the concentrating systems. Detailed lab analysis to be conducted in year two includes: characterization of PGE, PGM and other minerals in heavy mineral concentrates using reflected light microscopy, electron-microprobe analysis (of exotic phases), SEM microscopy and X-ray diffraction. Documentation of the trace element geochemistry of individual PGM's and the level of trace PGE in common base-metal sulphides is also planned. Results from the ongoing lab component of this study are intended to aid in the identification of the following: specific PGE's present, preferred size fractions for locating PGE targets, heavy mineral suites indicative of PGE potential, pathfinder elements, suitable analytical tools (*e.g.* heavy mineral analysis of the coarse fraction vs trace element analysis of the fine fraction), likely sources of PGE-rich minerals and PGE lode source types in different areas.

RESULTS

More than 150 concentrate samples and 27 bulk samples were submitted for analyses. Preliminary analytical results obtained for platinum, palladium, gold and other elements on 45 samples from 37 different placer properties were available at the time of writing. Results are presented in Tables 3 and 4 and a description of each sample analysed is provided in Table 5. The locations of analysed samples are shown on Figure 1. Results from the remaining 125 samples will be presented at a later date. It is important to emphasize that the results presented in Tables 3 and 4 are based on concentrate samples and therefore they cannot be used to directly calculate grades in the original (unconcentrated) sample material unless the concentration ratio is accurately known. For the purposes of this research, the results are intended to determine if elements such as platinum, palladium, nickel, copper, etc., are present (and not to determine

TABLE 4
FIRE ASSAY RESULTS

Element	Au**	Pt**	Pd**	Sample
Sample #	ppb	ppb	ppb	Weight (g)
VLE2001-1a	486	< 2	< 2	5
VLE2001-1b	4858980	< 2	14	3
VLE2001-2a	170030	166	3	30
VLE2001-2b	678	< 2	7	10
VLE2001-3	3475900	< 2	27	15
VLE2001-4	102762	2	4	10
VLE2001-5	193300	4010	28	15
VLE2001-6	561	2	3	30
VLE2001-7a	13537	9472	41	15
VLE2001-7b	3051760	51324	901	15
VLE2001-7c	115	2	9	30
VLE2001-8	817470	< 2	6	30
VLE2001-9	42692	7	6	30
VLE2001-10	3656	< 2	< 2	30
VLE2001-11a	27965	1568	8	3
VLE2001-11b	27246	116	< 2	10
VLE2001-12a	30529	2994	15	15
VLE2001-12b	7652	3	8	15
VLE2001-12c	3233200	36992	459	15
VLE2001-13	100110	2608	36	30
VLE2001-14	220250	34	< 2	15
VLE2001-15a	67679	43	< 2	30
VLE2001-15b	60528	358	14	15
VLE2001-15c	41860	5	3	30
VLE2001-16a	2.78E+07	645000	9389	10
VLE2001-16b	480350	11141	208	15
VLE2001-17a	30164	542	< 2	15
VLE2001-17b	792000	7748	234	15
VLE2001-18	170740	391	< 2	10
VLE2001-19	14466	11941	81	15
VLE2001-20	75834	2494	48	15
VLE2001-21	72996	274	< 2	15
VLE2001-22	2719	59744	331	15
VLE2001-23	553	8	< 2	15
VLE2001-24	12107	11	5	30
VLE2001-25	111954	18	< 2	10
VLE2001-26	274516	1060	22	15
VLE2001-27	2930000	343	< 2	15
VLE2001-28	791	8	11	15
VLE2001-29	7892	29386	343	15
VLE2001-30	259000	2489	45	30
VLE2001-31	6407	15	6	15
VLE2001-32	119600	6	< 2	10
VLE2001-33	2615600	40424	568	15
VLE2001-36	36800	760	3	30

TABLE 5
DESCRIPTION OF ANALYSED CONCENTRATE SAMPLES
(*SEE* TABLES 3 AND 4 FOR ANALYSIS RESULTS)

Sample Number	River/Creek Name	Mining District	Mapsheet	Latitude (NAD 27)	Longitude (NAD 27)	Type of Operation[1]	Sample Depth (m)	Fraction Analyzed[2]	Colour[3]	Grain Size[4]	Sorting[5]
1a	Leech R	Shawnigan L	92B/12	48.518	-123.782	testing	0.3	1	bl	f-cS	p
1b	Leech R	Shawnigan L	92B/12	48.518	-123.782	testing	0.3	2	inter	mS	w
2a	Mary, Norton Cr	Cariboo	93G/1E	53.071	-122.078	testing	n/a	3	inter-dg	mS	w
2b	Mary, Norton Cr	Cariboo	93G/1E	53.071	-122.078	testing	n/a	3	dg	mS	w
3	Kiethly Cr	Cariboo	93A/14W	52.750	-121.333	exploration	2	2	inter	fS	p
4	McKee Cr	Atlin	104N/5E	59.483	-133.533	n/a	11	3	bl	mS	w
5	Fraser R	Cariboo	93G/2E	53.016	-122.533	exploration	0.3	3	bl	fS	w
6	Castle Cr	Cariboo	93H/1W	53.100	-120.383	testing	0.5	3	bl	f-mS	p
7a	Slate Cr	Omineca	93N/10E	55.667	-124.533	testing	10-12	3	bl	fS w/ G	p
7b	Slate Cr	Omineca	93N/10E	55.667	-124.533	testing	10-12	3	r-o	S-G	p
7c	Slate Cr	Omineca	93N/10E	55.667	-124.533	testing	10-12	3	dg	Z	n/a
8	Cunningham Cr	Cariboo	93A/13E	52.980	-121.358	production	3-10	3	bl	f-mS	n/a
9	McConnell Cr	Omineca	94D/16W	56.833	-126.467	production	n/a	4	bl	mS	w
10	Quartz Cr	Golden	82N/6W	51.412	-117.323	exploration	1-2	3	br-g	f-mS	p
11a	Cottonwood R	Cariboo	93G/1W	53.161	-122.435	testing	1.5	1	bl	fS	w
11b	Cottonwood R	Cariboo	93G/1W	53.161	-122.435	testing	1.5	3	lg	mS	p-m
12a	Spruce Cr	Atlin	104N/11W	59.556	-133.493	production	n/a	4	bl	f-cS	p
12b	Pine Cr	Atlin	104N/11W	59.599	-133.488	production	n/a	4	bl	f-cS	p
12c	O'Donnel R	Atlin	104N/6W	59.371	-133.295	production	18	4	bl	mS	m
13	Fraser R	Cariboo	93B/8W	52.415	-122.394	testing	n/a	4	inter	f-mS	p
14	Pond O'Reille R	Nelson	82F/3W	49.010	-117.617	exploration	10	3	bl	f-mS	m-w
15a	Quesnel R	Cariboo	93A/12	52.669	-121.961	exploration	2-10	3	inter-dg	f-mS	w
15b	Quesnel R	Cariboo	93A/12	52.669	-121.961	exploration	2-10	4	bl	fS	w
15c	Quesnel R	Cariboo	93A/12	52.669	-121.961	exploration	2-10	4	inter-lg	f-mS	w
16a	Dease Cr	Dease L	104J/9E	58.656	-130.177	production	1-2	2	bl	fS	w
16b	Dease Cr	Dease L	104J/9E	58.656	-130.177	production	1-2	1	bl	fS	w
17a	Swift R	Cariboo	93H/04W	52.900	-121.977	exploration	1	3	bl	fS	w
17b	Swift R	Cariboo	93H/04W	52.900	-121.970	exploration	1	3	bl	fS	w
18	Swift R	Cariboo	93A/13E	52.887	-121.586	exploration	< 1	4	g	fS	w
19	Tulameen R	Similkameen	92H/7, 10	49.500	-120.668	exploration	1	4	inter	S-G	p
20	Government Cr	Cariboo	93G/7	53.448	-122.559	exploration	0.2	4	inter-bl	f-mS	w
21	Fraser R	Cariboo	92O/1E	51.172	-122.085	testing	0.2	3	bl	fS	w
22	Tulameen R	Similkameen	92H/7	49.478	-120.631	exploration	2	3	bl	mS	w
23	Black Bear Cr	Cariboo	93A/11W	52.633	-121.449	production	6	2	bl	fS	w
24	trib. Wheaton Cr	Dease L	104I/7E	58.333	-129.000	exploration	1-3	3	dg	mS	w
25	Bob Cr	Omineca	93L/7E	54.306	-126.635	exploration	1	4	inter	mS	m-w
26	Mary Cr	Cariboo	93G/1E	53.070	-122.083	exploration	n/a	3	bl	mS	w
27	Boulder Cr	Atlin	104N/11	59.647	-133.399	testing	4	2	bl	mS	w
28	Palmer Bar Cr	Fernie	82G/5	49.440	-115.900	exploration	1-3	2	bl	mS	w
29	Tulameen R	Similkameen	92H/10	49.533	-120.883	testing	n/a	3	bl	mS	w
30	Quesnel R	Cariboo	93B/16E	52.767	-122.150	testing	1.5-2	3	bl	mS	w
31	Jack of Club Cr	Cariboo	93H/4	53.110	-121.576	testing	n/a	3	g	f-mS	p
32	Snake Cr	Atlin	104N/11W	59.583	-133.400	exploration	10	2	bl	f-mS	p
33	Government Cr	Cariboo	93G/7	53.475	-122.549	exploration	n/a	4	dg	fS w/ G	p
36	Similkameen R	Princeton	92H/2	49.219	-120.532	testing	0.2-2	4	inter	f-cS	p

n/a = data not available

[1]Type of Operation (at time of sample concentration): exploration - < 10 m^3 of material removed; testing - 10-100 m^3 of material removed; production - operating mine, often with processing rates provided (e.g. yd/hour, tons/day, etc.)

[2]Fraction: 1 = magnetic fraction only, 2 = non-magnetic fraction only, 3 = both magnetic and non-magnetic fractions, 4 = unknown

[3]Colour: bl = black, br = brown, o = orange, r = red, g = grey, dg = dark grey, lg = light grey, inter = mix of felsic and mafic minerals

[4]Grain Size: Z = silt, fS = fine sand, mS = medium sand, cS = coarse sand; G = granule

[5]Sorting: w = well, m = moderate, p = poor

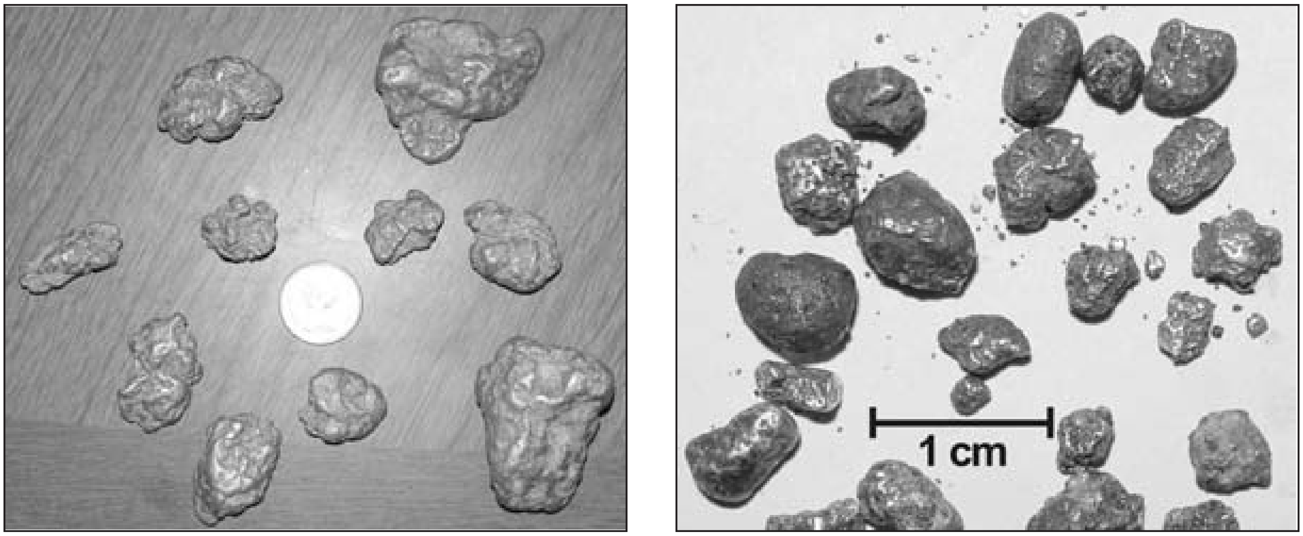

Figure 3. Representative placer mineral samples for size/shape analyses and trace element geochemical studies: 3a) gold nuggets from Birch Creek, Atlin area (Mike Bonnell mine); 25 cent coin for scale; 3b) platinum nuggets from the Tulameen River (supplied by Dave Javorski); note the variety in size, shape, angularity and composition (reflected by color and textural differences).

actual grades). In addition, the results are based on a small sample size and therefore are not representative of the entire deposit or even of a larger volume of the same sample material. In particular, gold and platinum are subject to the “nugget effect”. For example, a single large gold grain in the analyzed sample would yield a high gold result even though no gold may occur in the remainder of the sample that was not analyzed. Alternatively, an analyzed sample may show no detectable gold (or platinum) even though nuggets may be present in the remainder of the sample that was not analyzed. For this reason, the larger the sample analyzed the better, and much caution should be exercised in interpreting the significance of small sample results. Samples 15a, b and c provide a good example of the nugget effect. The samples are all from the same site and show little platinum (3-7 ppb) by ICP-MS (Table 3). By fire assay (Table 4), the samples likewise show low levels of platinum (5 and 43 ppb in samples 15c and 15a, respectively) except in sample 15b which contains 358 ppb platinum. These results highlight the fact that a low platinum value in one sample from one location does not preclude the possibility that significant platinum concentrations may still be present at the site.

The following discussion refers to the results of fire assay analyses (Table 4) unless otherwise specified. Platinum was found at 33 of the 37 sites and in 39 of the 45 samples (87% of the samples analysed and 89% of the sites yielded platinum). One additional sample (2001-8) yielded platinum by ICP-MS only (*i.e.* not by fire assay). Palladium was found at 28 sites by fire assay (2 ppb detection level) and at 18 sites by ICP-MS (100 ppb detection level). These data represent a total of 19 new occurrences of platinum in British Columbia (*i.e.* occurrences not reported in MINFILE or by Rublee, 1986). These new occurrences include six areas in the Cariboo region: Mary/Norton Creeks, Castle Creek, Cunningham Creek, Swift River, Black Bear Creek and Jack of Clubs Creek, as well as five new areas in the Atlin region: McKee Creek, Spruce Creek, Pine Creek, O’Donnel River and Snake Creek. Other new platinum occurrences are in the Dease Creek, Alice Shea Creek, Bob Creek (Houston area), Pend Oreille River and Palmer Bar Creek (Fort Steel area) drainages.

New areas with concentrations of platinum in excess of 100 ppb (Tables 3 and 4) occur at Dease Creek (up to 645 000 ppb), O’Donnel River (36 992 ppb), Swift River (three sites - up to 7748 ppb), Spruce Creek (2994 ppb), Mary Creek (1060 ppb), Norton Creek (166 ppb), Black Bear Creek (7321 ppb by ICP-MS), Bob Creek (195 ppb by ICP-MS) and Snake Creek (127 ppb by ICP-MS). Platinum results by fire assay at the latter three sites did not exceed 100 ppb, although for most samples the fire assay results are substantially higher than the ICP-MS results (compare Tables 3 and 4). New areas with levels of platinum between 2 ppb and 100 ppb by fire assay include McKee Creek, Castle Creek, Cunningham Creek (ICP-MS only), Pine Creek, Pend Oreille River, Alice Shea Creek, Palmer Bar Creek and Jack of Clubs Creek (Table 4). Drainages with concentrations of platinum in excess of 100 ppb where PGE’s have been previously reported include Slate Creek (up to 51 324 ppb), Government Creek (up to 40 424 ppb), Quesnel River (up to 2489 ppb), Cottonwood River (1568 ppb), Tulameen River (up to 59 744 ppb), Similkameen River (760 ppb), Fraser River (up to 4010 ppb) and Boulder Creek (343 ppb). The presence of platinum was also confirmed at McConnell Creek (Tables 3 and 4).

Stratigraphic and sedimentologic characteristics of PGE placer occurrences were documented at 40 locations throughout BC (Figure 1). Paleoplacer deposits and recent fluvial sediments were studied in the following drainages and areas: Tulameen River, Lawless Creek, Lockie Creek, Blakeburn Creek (tributary of Granite Creek), Rock Creek, Kaslo River, Mobbs Creek, Lardeau River, Franklin Creek, McDonald Creek, Burell Creek, Sappho area, Kaslo River, Thistle Pit, California Gulch, Burns Creek, Grouse Creek, Manson Creek, Slate Creek, Lost Creek, McConnell Creek, Nation River, Wheel Creek, Terry Creek, Fraser River, Sowaqua Creek, Raft Creek, Clearwater River, Quesnel River, Cariboo River, Likely, Keithley Creek, Slate Creek (Figure 2), Rosella Creek, McKee Creek, Ruby Creek, Boulder Creek, Wilson Creek, Wright Creek, and Birch Creek. Detailed case studies to investigate placer proximity criteria and downstream changes in PGE placers were conducted in the Tulameen River, Rock Creek, Slate Creek, and Quesnel River drainages.

For a few samples both magnetic and non-magnetic fractions were analysed (samples 1a, b, 11a, b, 16a, b; Table 5). Results show that both platinum and palladium can occur in significant concentrations in the magnetic fraction (*e.g.* 11 141 ppb Pt and 208 ppb Pd in sample 16b) probably reflecting, for example, the presence of iron in some of the PGE minerals. In sample 11, platinum and palladium concentrations were significantly higher in the magnetic fraction (sample 11a) than in sample 11 b where most of the magnetic minerals had been removed. These results suggest that the common practise of removing and disposing of the magnetic fraction in placer concentrates would be unwise until the PGE content of the magnetic fraction has been thoroughly investigated.

CONCLUSIONS

Preliminary results have identified a surprisingly high number of new areas with anomalous PGE concentrations in placers. A total of 19 new platinum placer occurrences have been identified and concentrations of platinum in excess of 100 ppb occur at nine of these sites. A number of other platinum and palladium occurrences have been verified with laboratory results including 8 sites with up to 100 ppb platinum. The presence of platinum was confirmed and quantified at an additional 14 sites with previously reported PGE placer concentrations. Palladium was detected in samples from 28 sites by fire assay and 18 sites by ICP-MS. Due to the nugget effect, results should be considered with caution and low values of PGE should not be considered insignificant. Preliminary data show that PGE's occur in both the magnetic and non-magnetic/weakly magnetic fractions and, as a result, magnetic concentrates should be evaluated before being discarded. Further work will identify suitable samples for more detailed analysis, determine specific PGE's and PGM's involved, identify new areas with lode source potential and document the stratigraphic, sedimentologic and proximity characteristics of PGE placer occurrences in areas with good potential.

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