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Geochemistry of Permian rocks of the Yukon-Tanana terrane, western Yukon: GEM-2 Cordillera project

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Foreword

Geochemical data, presented in this open file release, have been collected over the past fifteen years as part of regional mapping projects conducted under the auspices of the Geological Survey of Canada's Ancient Pacific Margin (NATMAP) and Geo-mapping for Energy and Minerals (GEM) programs. The data include major and trace element analyses for over 100 samples of Permian age rocks.

Introduction

The Yukon-Tanana terrane is a composite, peri-cratonic terrane of Devonian-Triassic age (Nelson et al., 2006; 2013), exposed from eastern Alaska to northwestern British Columbia (Fig. 1). The Paleozoic evolution of the Yukon-Tanana terrane has been subdivided into six tectonomagmatic cycles (Fig. 2), which affected this large rifted fragment of Laurentia's western margin (Nelson et al., 2006). The geochemical data in this report belong to rocks of the Permian age Klondike assemblage formed during Cycle 6, although some may belong to rocks of the earlier Cycle 5 (Klinkit). Klinkit cycle rocks formed during ca. 314-269 Ma (Pennsylvanian-Early Permian) arc and back-arc volcanism and related sedimentation. Klondike cycle rocks are interpreted to have formed from ca. 265-254 Ma in an arc setting, during westward-dipping subduction of Slide Mountain ocean crust and re-accretion of the Yukon-Tanana terrane to the North American western margin (Nelson et al., 2006).

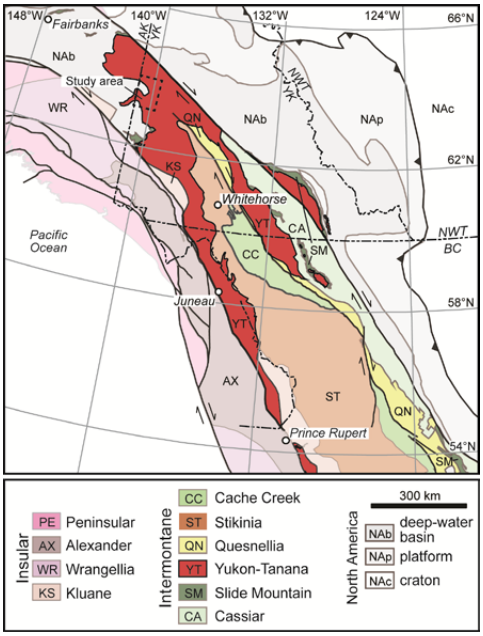

Figure 1. Terranes of the northern Cordillera modified from Nelson et al., 2013).

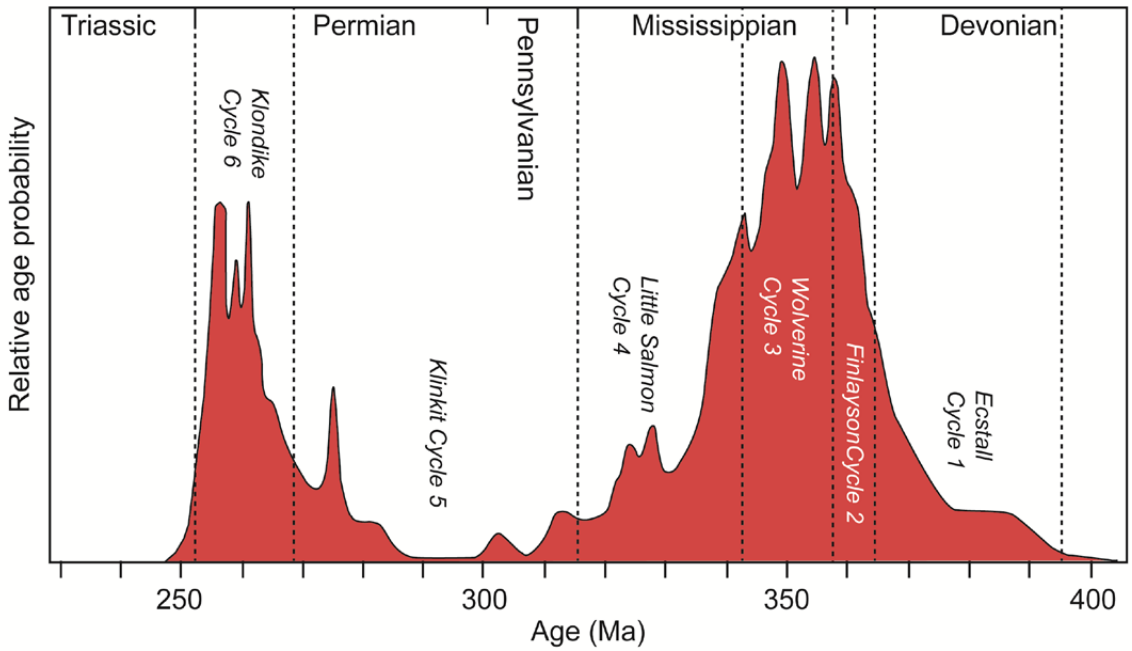

Figure 2. Geochronological frequency diagram for Devonian to Permian magmatism and high pressure metamorphism in the Yukon-Tanana terrane (n=147), modified from Nelson et al. (2006). The Paleozoic tectonic evolution of the Yukon-Tanana terrane is subdivided into six cycles. Data presented in this report are for rocks of Cycle 6.

Methodology and data quality

Data included in this report are a result of a multi-year effort by the Geological Survey of Canada and the Yukon Geological Survey to understand the geological history, architecture, and mineral potential of the Yukon-Tanana terrane in western Yukon. The data were acquired between 2002 and 2015; over the course of this period four laboratories were used for geochemical analyses. Samples collected during the NATMAP project (2002 to 2003) were analyzed at the University of Western Ontario (London, ON) and at the Ontario Geoscience Laboratories (Sudbury, ON). During 2009 and 2010, samples were analyzed by Activation Laboratories Ltd. (Ancaster, ON). In 2011, samples were analyzed by ACME Analytical Laboratories (Vancouver, BC). Samples, collected during 2014 and 2015 campaigns were analyzed by Bureau Veritas Commodities Canada Ltd. (Vancouver, BC), which acquired ACME Analytical Laboratories in 2011. A selection of archived samples that were previously not analyzed, were analyzed in 2015 at Bureau Veritas. Isotopic data included in this report were acquired at the University of British Columbia's Pacific Institute for Isotopic and Geochemical Research (PCIGR, Vancouver, BC).

Data acquired at Laurentian University

Major element analyses were performed using X-ray fluorescence (XRF) on fused discs at the University of Western Ontario (UWO). Trace element concentrations were determined using XRF on pressed pellets at UWO, and by inductively coupled plasma–emission spectrometry (ICP-ES) and inductively coupled plasma–mass spectrometry (ICP-MS) at the Ontario Geoscience Laboratories. Analyses of 4 duplicate samples suggest absolute errors in major element measurements are <0.4 wt. %, which in most cases is ≤2% relative.

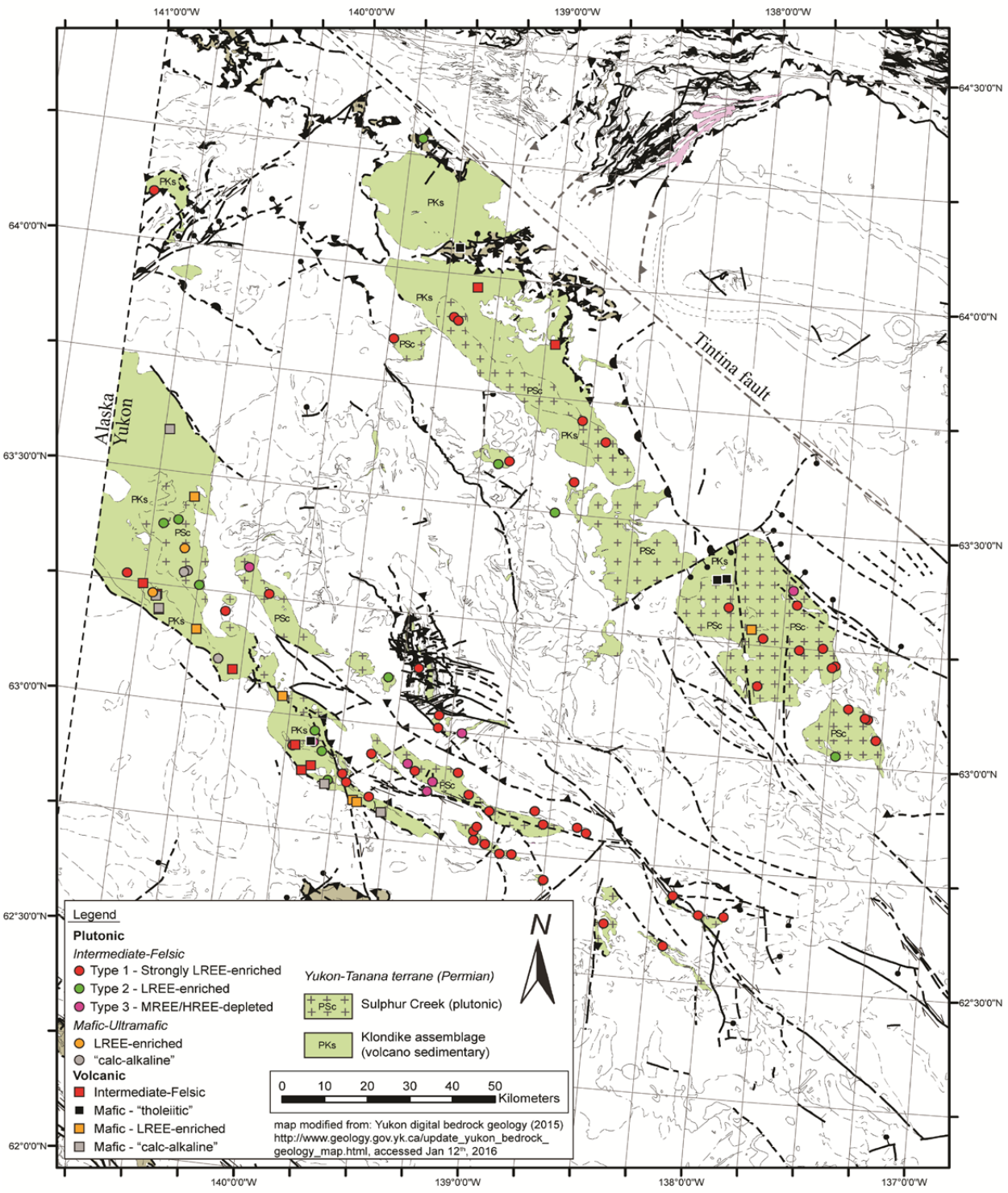

Figure 3. Map of the extent of Permian rocks of the Yukon-Tanana terrane in western Yukon, and location of geochemical samples listed in this report.

At concentrations approaching the limit of quantification (3.3 x limit of detection) the relative uncertainty in measurement of major elements is ≤20%. A review of data acquired at Laurentian University during the period 2002-2003 is available from MacDonald et al. (2005).

Data acquired at Activation Laboratories

Samples analyzed at Activation Laboratories (Ancaster, Ontario) were crushed and processed using lithium metaborate/tetraborate fusion and nitric acid dissolution. Analyses were performed by ICP-ES and ICP-MS (4Lithores analytical package). At a 95% confidence level, the uncertainty in measurement of major elements exceeding their limit of quantification is ≤3% relative. The less abundant major elements (TiO_2 and P_2O_5) are exceptions, with relative uncertainties of ≤10% and ≤15%, respectively. The uncertainty in measurement of most trace elements is ≤15% relative, at a 95% confidence level.

Data acquired at ACME Laboratories

Samples analyzed at ACME Analytical Laboratories (Vancouver, BC) were crushed and processed using lithium metaborate/tetraborate fusion and dilute nitric acid dissolution. Major element and trace element analyses were performed by ICP-OES and ICP-MS, respectively (analytical package 4A-4B). At a 95% confidence level, the uncertainty in measurement of most major elements exceeding their limit of quantification is ≤10% relative. The relative uncertainty in measurement of TiO_2 and MgO is ≤20%, whereas the relative uncertainty in measurement of MnO and P_2O_5 is ≤25%, and ≤65%, respectively. The uncertainty in measurement of most trace elements is 10-25% relative, at a 95% confidence level. Notably, the relative uncertainties in the concentration of Th and U are ≤40% and ≤150%, respectively.

Data acquired at Bureau Veritas

Samples analyzed at Bureau Veritas Minerals Laboratories (Vancouver, BC) were crushed and processed using lithium metaborate/tetraborate fusion and dilute nitric acid dissolution. Major element concentrations were determined using ICP-OES; the concentrations of trace elements were measured using ICP-MS (analytical package LF200). Trace metals were leached using aqua regia and analyzed using ICP-MS (analytical package AQ200). The uncertainty in measurement of most major elements, at a 95% confidence level is ≤5%, although at concentrations approaching the limit of quantification the relative uncertainties may be as high as 25-60%. The average relative uncertainty, at a 95% confidence level, for the less abundant MnO and P_2O_5 is 10-20%. The average uncertainty in measurement of most trace elements is 5-15% relative, at a 95% confidence level. However, the relative uncertainty in quoted measurements is ≤70% near the limit of quantification.

Results

Analyzed samples are inferred to be of Permian age and part of the Klondike assemblage, composed of either the Sulphur Creek plutonic suite (Tables 1-3), or the metavolcanic Klondike schist (Tables 4 and 5). A small subset of mafic plutonic rocks (Table 6) has not been classified.

The Sulphur Creek plutonic suite includes tonalite, granodiorite and granite, which may be further subdivided into: 1) the strongly-light rare earth element (LREE) enriched suite, 2) the LREE-enriched suite, and 3) the heavy REE (HREE) and middle REE (MREE)-depleted suite (Fig 4). The intermediate to felsic volcanic rocks (SiO_2>60 wt.%; Fig. 5) of the Klondike

schist are largely indistinguishable from the strongly LREE-enriched plutonic rocks in terms of their incompatible trace element geochemistry.

Basaltic to andesitic (SiO_2 ≤60 wt. %) members of the Klondike schist display important variations in immobile trace element geochemistry. On the basis of the trace element profiles, the mafic members of the Klondike schist may be classified as follows: 1) tholeiitic metavolcanic rocks with relatively flat REE and high field strength element (HFSE) profiles , 2) LREE-enriched metavolcanic rocks lacking significant HFSE depletion, and 3) calc-alkaline" metavolcanic rocks, characterized by LREE-enrichment and depletion in HFSE, primarily Nb, Ta, and Ti.

Discussion

The Permian Klondike assemblage is one of the defining elements of Yukon-Tanana terrane, and is generally accepted (e.g. Nelson et al., 2006) as having formed in an arc setting, during westward-dipping subduction of Slide Mountain ocean crust and re-accretion of the Yukon-Tanana terrane to the North American western margin. The known extent of Klondike assemblage rocks has increased significantly over the last decade, through new mapping and geochronology. Regional datasets are improved enough to warrant re-evaluation of existing tectonic models. It is striking that there is a close spatial relationship between numerous mineral deposits across Yukon-Tanana terrane and rocks of the Klondike assemblage; however, there has not been a genetic link established to date.

Geochemical investigation of the Permian plutonic and volcanic rocks, presented herein, indicates that while the suite is relatively homogeneous on the regional scale, important geochemical differences exist. These differences need to be investigated further to constrain the petrogenesis and tectonic setting of the Permian igneous suites and, perhaps ultimately, their relationship to younger mineralization. Future work will combine the geochemical data presented in this report, with isotopic (Sm-Nd and Lu-Hf) and geochronological (U-Pb and Ar-Ar) data to place new constraints on the timing and petrological processes involved in the evolution of the Yukon-Tanana terrane during the Permian Klondike cycle.

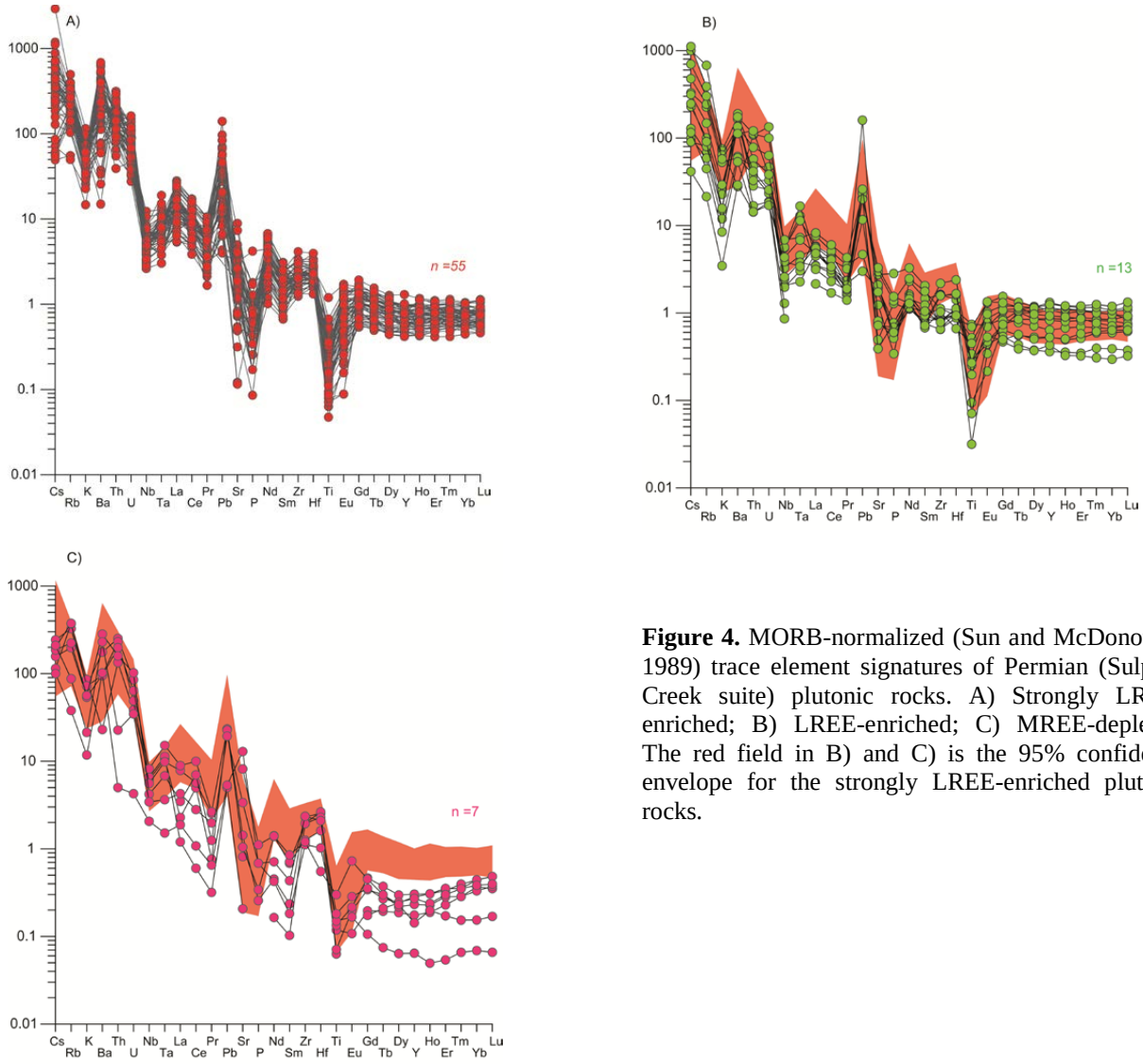

Figure 4. MORB-normalized (Sun and McDonough, 1989) trace element signatures of Permian (Sulphur Creek suite) plutonic rocks. A) Strongly LREE-enriched; B) LREE-enriched; C) MREE-depleted. The red field in B) and C) is the 95% confidence envelope for the strongly LREE-enriched plutonic rocks.

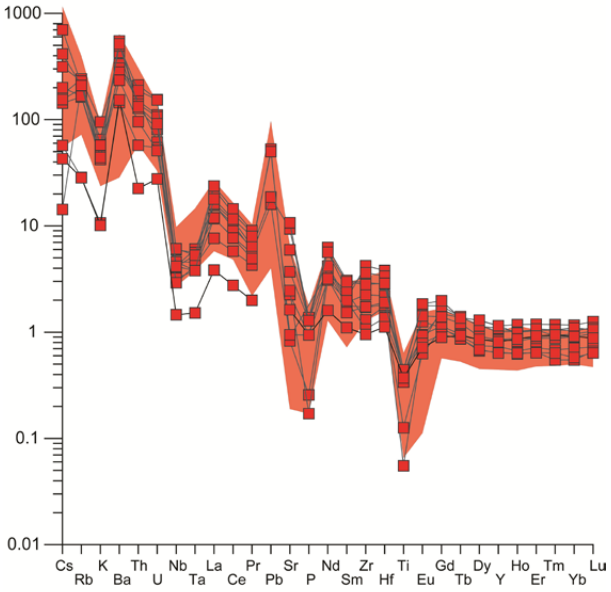

Figure 5. MORB-normalized (Sun and McDonough, 1989) trace element signatures of Permian (Klondike schist) intermediate to felsic volcanic rocks.

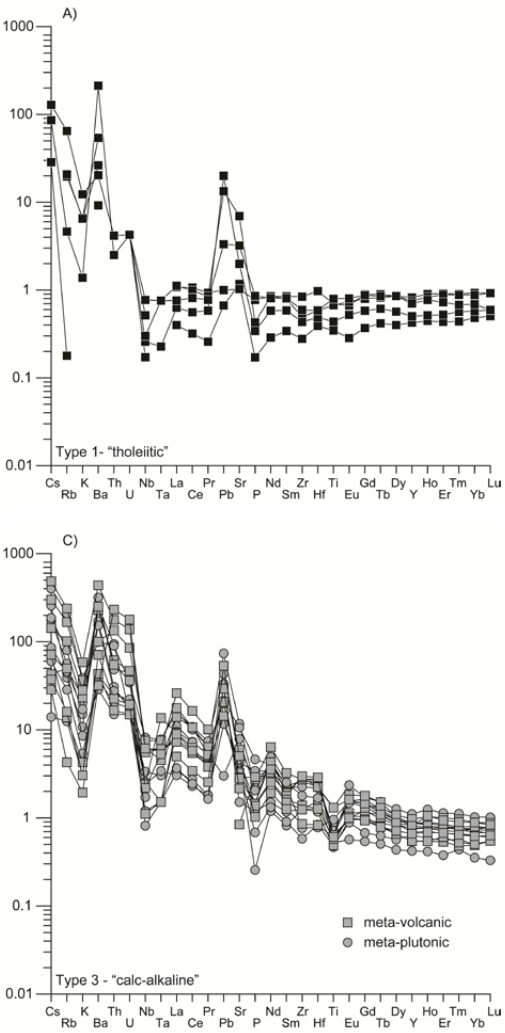

Figure 6. MORB-normalized (Sun and McDonough, 1989) trace element signatures of Permian (Klondike schist) mafic volcanic rocks and unclassified mafic intrusive rocks. A) Group 1 – tholeiitic volcanic rocks; B) Group 2 – LREE-enriched volcanic and intrusive rocks; C) Group 3 – "calc-alkaline" volcanic and intrusive rocks.

TABLE 1. Major and trace element compositions of the Permian Sulphur Creek plutonic suite (Strongly LREE-enriched)

Sample #	00GGA-034A[a]	00GGA-069A[a]	00GGA-072A1[d]	00GGA-075A[a]	00GGA-106A[a]	00RAY-044A[a]	00RAY-073[a]	00RAY-202A[a]	01RAY-310A1[d]	02RAY-288A1[d]	02RAY-304A[a]	02RAYG-275A2[d]	03GGA-264A1[a]
Easting	585784	609447	615504	609396	575980	585501	585720	579217	562682	615501	515565	532401	542008
Northing	6987398	7066242	7061828	7051161	7087425	6990521	6987404	7001350	7080325	7061838	7010992	7009112	7014569
Major elements (wt.%)													
SiO_2	74.70	73.31	75.03	69.76	74.20	74.13	74.97	75.15	70.68	73.66	65.51	71.09	67.24
TiO_2	0.20	0.45	0.19	0.41	0.41	0.25	0.18	0.14	0.27	0.19	0.47	0.30	0.66
Al_2O_3	12.94	11.49	13.25	14.34	12.38	13.14	12.98	13.25	14.80	13.32	16.21	14.80	15.01
Fe_2O_3	2.29	3.25	2.32	3.36	3.03	2.28	1.88	1.97	3.05	2.23	3.47	2.63	4.79
MnO	0.04	0.07	0.04	0.06	0.03	0.03	0.03	0.01	0.06	0.04	0.12	0.04	0.08
MgO	0.27	1.09	0.62	0.97	1.40	0.35	0.23	0.12	0.68	0.54	1.80	0.53	1.58
CaO	1.19	1.75	1.51	2.56	0.13	1.22	0.99	0.28	2.10	1.34	2.92	1.47	1.66
Na_2O	3.20	1.78	2.86	2.80	<0.01	2.91	2.79	3.79	2.55	2.39	2.63	2.42	5.63
K_2O	4.41	3.63	2.45	4.56	5.35	4.66	5.17	3.96	4.41	3.25	4.09	4.60	1.64
P_2O_5	0.04	0.09	0.04	0.10	0.10	0.05	0.02	0.02	0.10	0.02	0.10	0.07	0.20
LOI	0.50	2.7	1.15	0.7	2.70	0.70	0.50	1.00	0.79	2.03	2.00	1.00	1.30
Total	99.78	99.65	99.47	99.67	99.73	99.74	99.75	99.67	99.50	99.01	99.37	98.95	99.77
Trace elements (ppm)													
Ni	<20	<20	<3	<20	<20	<20	<20	<20	12	<4	<20	7	<20
Cr	-	-	6	-	-	-	-	-	<4	-	-	7	-
Co	2	4.2	<2	5.4	2.8	2	1.6	0.7	<3	<3	2.4	<2	6.2
V	19	30	20	30	27	10	<8	9	35	25	45	28	74
S	<500	<500	-	<500	<500	<500	<500	<500	-	335	<500	103	<500
Sc	5	9	7	8	7	6	4	3	6	6.59	6	4.98	14
Cu	1.2	6.5	<2	1.8	6.9	2.9	2.2	2	<2	-	6.8	-	4.3
Pb	6.2	13.8	<3	4.1	2	3.6	5.9	1.9	17	-	17.3	-	1.2
Zn	38	25	37	52	20	39	38	10	60	35	14	45	61
As	1.1	1.1	3	<0.5	2.7	<0.5	0.7	<0.5	3	-	<0.5	-	0.9
Mo	0.1	0.2	-	0.4	0.1	0.1	0.2	1.2	-	-	0.2	-	0.1
W	<0.5	6	-	2.7	3.3	<0.5	<0.5	2	-	17	1.9	-	<0.5
Cd	<0.1	0.1	-	<0.1	0.2	<0.1	<0.1	<0.1	-	-	<0.1	7	<0.1
Sn	1	2	-	1	2	1	1	1	-	-	2	-	<1
Nb	7.9	11.3	13	11	10	7.9	6.6	13.5	17.9	14.1	14.9	12.2	7.1
Ta	0.6	0.7	1.05	0.7	0.6	0.6	0.5	1	0.76	0.97	0.8	0.75	2
Zr	149.6	155.8	178	167.1	145.2	157.3	133.4	160.5	147	172	305.9	183	130.3
Hf	4.7	4.5	4.73	4.7	3.8	4.7	4.2	4.5	4.9	4.35	8.1	5.56	3.7
Y	21.7	28.3	23	21.4	18.9	11.7	16.6	14.5	14	21	25	13	22.5
Ga	16.3	13.5	13	16.5	14.8	15.2	13.9	15.9	17	13	16.1	15	13.6
Cs	1.7	0.6	0.38	3.1	1.1	2.9	5	1.1	>5.00	0.43	1.9	2.45	0.5
Sr	69.3	46.8	168	236.8	10.4	106.6	126.8	118.4	363	140	659.2	178	388.8
Rb	148.6	121.2	79	158.6	186.8	140.1	154.2	99.6	175	94	118.2	153	27.9
Ba	1467	2507	3400	2113	1850	1890	1667	2552	1874	4306	3883	2518	1036
Be	5	<1	N.D.	<1	<1	2	4	3	-	1.54	3	1.31	<1
Li	-	-	10	-	-	-	-	-	42	9	-		-
Th	13.7	11	17	16.7	12	13.9	14.6	9.9	17.39	16.1	21.3	20.62	4.7
U	3.2	2.5	5.54	4	1.8	3.2	2.7	1.6	4.1	4.85	7.6	4.16	2.2
La	22.9	34.4	42.04	36.5	15.9	17.6	39.4	17.6	40.65	34.29	60.7	33.43	17.1
Ce	66.7	62.4	77.96	94.2	43.6	76.6	77.1	36.6	71.94	69.11	119.2	73.34	37.7
Pr	4.77	7.38	9.8	7.02	3.64	3.47	8.36	3.34	8.45	8.17	12.17	7.18	4.43
Nd	15.6	28.6	34.3	24.7	13.2	11.7	32.6	12.3	29.52	29.65	44	24.75	18.9
Sm	3.08	5.17	6.57	4.72	2.45	1.9	5.02	2.36	5.78	5.99	6.46	4.75	3.76
Eu	0.37	1.01	1.21	1.03	0.4	0.26	0.4	0.27	1.31	1.63	1.49	1.17	1.02
Gd	3.51	4.93	5.75	4.57	2.5	2.07	4.21	1.98	5.02	5.36	5.34	4.37	3.74
Tb	0.63	0.75	0.94	0.68	0.44	0.35	0.58	0.36	0.7	0.89	0.79	0.74	0.6
Dy	4.02	4.52	5.29	4.04	2.8	2.01	3.22	2.13	3.85	5.51	4.36	4.36	3.68
Ho	0.82	0.91	1.13	0.79	0.63	0.44	0.64	0.51	0.73	1.18	0.83	0.93	0.86
Er	2.35	2.71	3.18	2.28	2.14	1.42	1.87	1.61	1.86	3.28	2.53	2.55	2.42
Tm	0.39	0.36	0.49	0.32	0.28	0.22	0.3	0.25	0.26	0.52	0.41	0.39	0.37
Yb	2.23	2.42	3.12	2.09	1.94	1.62	1.95	1.88	1.62	3.19	2.48	2.49	2.56
Lu	0.34	0.36	0.506	0.33	0.26	0.24	0.31	0.27	0.249	0.515	0.42	0.378	0.39

TABLE 1. cont.

Sample #	03GGA-383A1[a]	03RAY-006A1[d]	03RAY-269A[a]	09RAYEK-027A1[a]	09RAYJR-102A1[a]	09RAYJR-105A1[a]	09RAYJR-175A03[c]	09RAYJR-177A1[a]	09RAYJR-178A03[c]	09RAYJR-179A03[c]	09RAYJR-186A1[a]	09RAYMC-016A1[a]	09RAYRS-014A1[a]
Easting	508222	593671	577216	374817	371615	365165	647512	373965	356537	382824	378049	382171	384977
Northing	7015335	7054203	7086628	7012221	7016580	7026804	647512	7011907	7006830	6999632	7001985	6999772	6994537
Major elements (wt.%)													
SiO_2	75.20	75.24	74.37	72.32	71.25	66.55	74.33	75.71	74.89	68.91	71.32	68.76	65.80
TiO_2	0.11	0.23	0.17	0.46	0.48	0.36	0.37	0.24	0.20	0.42	0.34	0.45	0.63
Al_2O_3	12.01	13.58	13.90	13.73	13.73	14.92	13.17	12.89	12.49	15.34	14.31	14.90	15.23
Fe_2O_3	1.65	3.06	2.16	3.71	3.76	5.21	2.63	2.63	1.85	3.77	3.30	3.95	5.68
MnO	0.02	0.05	0.02	0.03	0.03	0.10	0.04	0.02	0.02	0.08	0.06	0.07	0.08
MgO	0.13	0.51	0.65	1.06	1.38	1.65	0.67	0.57	0.29	1.38	0.68	1.00	1.28
CaO	0.86	2.32	0.04	0.45	1.35	4.53	2.39	0.49	0.71	4.39	2.47	3.16	3.53
Na_2O	1.92	3.81	2.43	3.19	3.95	2.85	3.27	3.02	3.93	3.10	2.66	2.76	2.35
K_2O	7.00	1.06	4.25	2.59	3.00	2.60	2.14	2.35	3.67	2.79	4.27	3.92	3.70
P_2O_5	0.02	0.10	0.02	0.21	0.10	0.09	0.08	0.05	0.02	0.15	0.11	0.14	0.20
LOI	1.00	0.35	1.60	1.90	0.60	0.90	1.13	1.70	0.57	0.57	0.20	0.60	1.10
Total	99.88	100.31	99.57	99.63	99.68	99.79	100.20	99.65	98.63	100.90	99.73	99.74	99.56
Trace elements (ppm)													
Ni	<20	<3	<20	<20	<20	<20	< 20	<20	< 20	< 20	<20	<20	<20
Cr	-	-	-	-	-	-	40	-	40	20	-	-	-
Co	0.4	<1	1.4	5	4.3	10.6	3	2.1	1	6	3.8	5.9	6.5
V	<8	25	<8	39	37	94	26	20	9	57	31	42	59
S	<500	111	<500	<500	<500	<500	-	<500	-	-	<500	<500	<500
Sc	3	6.4	4	10	8	12	6	6	3	16	7	8	13
Cu	2.7	-	2.9	9.7	3.3	3.5	< 10	9	< 10	< 10	3.5	8.6	6.7
Pb	25.1	<3	13.8	1.9	3.8	1.3	11	2.5	10	20	12.7	4.3	3.6
Zn	4	23	5	38	43	46	< 30	9	< 30	60	65	59	80
As	0.6	4	<0.5	0.7	<0.5	<0.5	< 5	<0.5	< 5	< 5	1	1	0.6
Mo	0.1	-	<0.1	0.4	<0.1	<0.1	< 2	0.7	< 2	< 2	0.1	0.2	0.3
W	0.7	8	1.8	1	1.2	<0.5	< 0.5	0.5	< 0.5	< 0.5	<0.5	<0.5	0.6
Cd	<0.1	-	<0.1	<0.1	<0.1	<0.1	-	<0.1	-	-	0.1	<0.1	<0.1
Sn	2	-	3	3	3	<1	1	1	6	2	2	2	<1
Nb	18.7	9.4	10.7	10.3	11.7	7.6	8.9	6.6	11.6	13	12.6	13.2	14
Ta	1.4	0.71	1	1	0.9	0.6	0.99	0.5	1.41	1.09	1.3	1.3	0.5
Zr	139.3	121.9	159.5	183.4	169	99	159	129.1	175	183	137.1	162.8	220.1
Hf	4.9	3.9	5.5	4.7	4.8	2.7	3.8	3.5	4.4	4.1	4.2	4.6	5.6
Y	36.4	23.4	18.7	15.8	20.5	12.1	21.2	17	16.3	27.9	23.3	23.4	19.3
Ga	15.4	16	16	15.9	14.5	15.1	16	13.2	15	18	17.2	16.9	17.5
Cs	3.2	0.346	1.1	1.7	4.1	1.3	0.9	0.6	0.5	3.2	4.2	4.7	2.4
Sr	74.1	135	69.7	67.4	128.5	377.5	244	49	101	350	291.5	328.6	447.4
Rb	181.2	31	156.3	76.8	72.8	79.7	58	63.6	99	108	184.6	154.9	113.6
Ba	375	1054	3269	2620	2060	1002	2159	2834	2267	1172	1629	1442	2651
Be	3	0.52	3	<1	2	2	2	<1	3	3	5	6	2
Li	-	3	-	-	-	-	-	-	-	-	-	-	-
Th	28.3	6.57	20.3	11.2	14.1	9.9	14.3	9.6	21.1	25.2	12.6	14.4	13.8
U	5.70	1.525	3.50	2.30	4.50	1.30	4.22	2.50	4.22	2.42	2.40	2.30	1.60
La	65.5	13.66	39.2	19.4	35.8	21.5	66.9	17	33.8	70.1	24.3	27.4	34.5
Ce	127.4	37.02	40.2	66.1	74.4	38.9	107	36	66.3	129	50.2	62.2	91
Pr	13.9	3.055	8.04	4.89	7.52	4.05	14.0	4.01	7.16	13.3	5.02	6.33	7.41
Nd	49.2	10.9	27.0	17.5	29.0	13.5	43.7	14.0	22.2	46.3	18.7	22.4	26.1
Sm	8.01	2.2	4.08	3.79	5.15	2.35	6.89	2.7	3.79	8.15	3.9	4.53	5.15
Eu	0.16	0.493	0.58	0.71	0.85	0.69	1.05	0.44	0.333	1.29	0.9	1.12	1.41
Gd	7.08	2.552	3.67	3.43	4.57	2.17	4.79	2.76	2.81	6.27	3.67	4.21	5.3
Tb	1.04	0.503	0.61	0.56	0.69	0.36	0.72	0.49	0.47	0.90	0.64	0.69	0.73
Dy	5.78	3.708	3.52	3.31	3.76	2.01	3.92	3.02	2.94	4.93	3.86	3.76	4.38
Ho	1.18	0.854	0.68	0.68	0.74	0.44	0.76	0.58	0.62	0.95	0.79	0.75	0.75
Er	2.99	2.757	2.04	2.03	2.27	1.23	2.13	1.84	1.92	2.67	2.37	2.21	1.98
Tm	0.47	0.416	0.30	0.30	0.36	0.19	0.327	0.26	0.339	0.391	0.37	0.35	0.28
Yb	2.84	2.80	2.20	1.89	2.08	1.36	2.06	1.65	2.32	2.47	2.33	2.26	1.9
Lu	0.43	0.43	0.32	0.28	0.28	0.21	0.312	0.22	0.331	0.348	0.39	0.34	0.24

TABLE 1. cont.

Sample #	09RAYRS-064A1[a]	09RAYRS-097A1[a]	10RAYJR-048A02[c]	10RAYJR-068A01[a]	10RAYJR-092A01[a]	10RAYJR-103A02[c]	10RAYMC-005A02[c]	11RAYAZ-133A02[b]	11RAYAZ-293A01[a]	11RAYAZ-307A02[b]	11RAYAZ-309A02[b]	11RAYAZ-316A02[b]	11RAYAZ-360A02[b]
Easting	649573	357431	350834	645109	615152	606917	652392	564919	591816	597280	613249	610876	645826
Northing	7025655	7018369	6950041	6941625	6953879	6959044	6950160	6973307	6977201	6963538	6967258	6970255	6953973
Major elements (wt.%)													
SiO_2	57.54	75.39	69.52	68.59	71.05	70.31	72.88	70.96	73.83	73.05	76.64	64.75	73.10
TiO_2	1.52	0.12	0.39	0.53	0.30	0.38	0.20	0.2	0.20	0.31	0.06	0.85	0.39
Al_2O_3	15.21	12.83	14.50	14.85	14.56	14.11	13.66	14.53	13.40	13.22	12.53	14.76	12.84
Fe_2O_3	10.47	1.87	3.36	3.83	2.86	2.63	1.77	2.78	2.05	1.82	1.18	5.57	2.48
MnO	0.20	0.03	0.06	0.05	0.05	0.04	0.01	0.08	0.04	0.02	0.04	0.07	0.02
MgO	2.41	0.10	0.99	1.17	0.85	1.04	0.60	0.56	0.47	0.77	0.11	2.11	0.92
CaO	5.66	1.23	1.90	2.64	2.07	1.96	1.23	1.68	1.67	1.02	0.46	5.85	1.32
Na_2O	1.54	2.72	3.24	2.68	3.06	3.12	3.55	4.19	3.14	3.05	3.05	1.01	2.41
K_2O	3.41	4.86	3.96	4.13	4.14	4.43	4.26	3.9	4.70	5.55	4.66	2.39	4.72
P_2O_5	0.49	0.02	0.09	0.11	0.07	0.09	0.04	0.07	0.04	0.15	0.01	0.09	0.09
LOI	1.20	0.50	1.01	1.00	0.80	0.62	1.75	0.70	0.30	0.80	0.70	2.00	1.10
Total	99.60	99.65	99.01	99.54	99.81	98.73	99.94	99.62	99.84	99.76	99.44	99.50	99.43
Trace elements (ppm)													
Ni	<20	<20	< 20	<20	<20	< 20	< 20	<20	<20	32	24	32	<20
Cr	-	-	40	-	-	70	50	-	-	-	-	-	-
Co	14.2	0.5	6	6.1	4.5	4	4	2.9	2.7	2.3	0.6	7.6	4.2
V	166	<8	34	42	29	28	10	9	14	19	<8	85	23
S	<500	<500	-	<500	<500	-	-	-	<500	-	-	-	-
Sc	22	6	6	8	5	6	3	2	2	4	<1	12	5
Cu	3.1	3.5	< 10	17.6	1.3	< 10	20	-	6.1	-	-	-	-
Pb	1.2	9.4	29	4.3	9	42	21	-	8.3	-	-	-	-
Zn	85	25	40	43	38	50	80	-	35	-	-	-	-
As	<0.5	1.4	< 5	1.4	2.5	< 5	< 5	-	1	-	-	-	-
Mo	0.1	0.2	< 2	0.2	0.2	< 2	< 2	-	0.2	-	-	-	-
W	2.6	0.8	1	<0.5	<0.5	< 0.5	1.9	0.9	<0.5	1.2	<0.5	<0.5	<0.5
Cd	<0.1	0.1	-	<0.1	<0.1	-	-	-	<0.1	-	-	-	-
Sn	3	13	5	<1	<1	6	2	5	6	2	2	3	4
Nb	15.7	12.6	10.4	6.1	8.8	10	11.8	11	13.8	16.1	14.7	14.8	10.8
Ta	0.8	1.3	1.22	0.4	1	1.18	1.28	0.9	1.2	1.5	1.1	1.1	1.2
Zr	241.6	120.2	162	236.9	138.3	137	148	169.8	156.7	177.8	92.7	247.5	165.4
Hf	5.4	4.4	4.7	6.5	4.3	4.1	4.2	4.4	4.7	5.9	3.8	6.9	5.7
Y	25.4	26	22.1	19.7	22.6	15.2	19.4	13.4	17.5	14.9	13	27.2	22.2
Ga	19	16.9	17	18.2	17.1	18	14	16.2	13.6	13.6	13.4	19.2	13.7
Cs	0.4	1.5	7.8	2.8	6.2	2.8	1.8	1.8	2.6	3.6	1.8	3.4	4.8
Sr	279.8	137.3	284	328.5	365.6	209	210	295.5	235	159.9	43.9	798.8	169.7
Rb	94.4	147.4	151	100.4	140.6	150	121	122.2	149.1	187.8	220.1	113.4	162.7
Ba	2162	2585	961	3222	858	841	1447	2508	708	1167	162	470	1191
Be	3	3	4	2	5	5	2	5	3	3	4	1	<1
Li	-	-	-	-	-	-	-	-	-	-	-	-	-
Th	10.2	13.8	18.8	7.8	15.5	14.6	21.6	20.9	26.1	23.3	35.4	13.4	12.2
U	3.6	3.5	5.56	6.4	5.8	3.5	7.01	6.5	4.8	3.6	2.7	2.8	3.2
La	34.5	25.0	43.1	37.3	46.1	31.0	46.8	38.3	55.4	27.8	28.8	36.6	19.3
Ce	68.9	60.1	76.5	70.2	63.3	64.1	77.3	72.6	102.5	58.0	54.2	78.8	40.2
Pr	8.27	5.58	8.92	7.45	8.98	6.98	8.01	6.93	10.15	5.17	5.49	8.74	4.80
Nd	32.5	21.3	31.3	26.0	29.8	24.9	26.3	22.7	31.5	15.5	17.4	35.4	18.1
Sm	6.17	3.71	5.68	4.42	5.63	4.78	4.20	3.34	5.01	2.85	3.16	6.30	4.12
Eu	1.75	0.49	0.989	1.25	0.79	0.86	0.747	0.8	0.69	0.49	0.22	1.47	0.52
Gd	5.82	3.91	4.58	3.87	4.61	3.65	3.42	2.56	3.96	2.26	3.10	5.32	3.61
Tb	0.91	0.72	0.7	0.64	0.7	0.55	0.52	0.38	0.59	0.42	0.41	0.84	0.65
Dy	5.1	4.59	4.04	3.5	3.72	3.05	3.16	2.21	3.3	2.45	2.21	4.55	3.85
Ho	0.95	0.99	0.77	0.65	0.61	0.57	0.65	0.43	0.62	0.54	0.46	0.94	0.75
Er	2.64	2.69	2.23	2.07	1.97	1.68	2.00	1.42	1.8	1.74	1.46	2.66	2.32
Tm	0.39	0.43	0.334	0.32	0.3	0.248	0.303	0.22	0.25	0.29	0.24	0.41	0.37
Yb	2.68	2.90	2.20	2.16	2.05	1.65	2.13	1.73	1.81	1.66	1.75	2.57	2.43
Lu	0.37	0.4	0.346	0.37	0.27	0.264	0.361	0.27	0.28	0.32	0.25	0.39	0.34

TABLE 1. cont.

Sample #	11RAYAZ-373A02[b]	11RAYAZ-382A02[b]	11RAYCR-165B[a]	11RAYJC-127A1[a]	11RAYJR-103A1[a]	11RAYJR-109A02[b]	11RAYJR-238A01[a]	11RAYJR-240A01[a]	11RAYJR-261A02[b]	11RAYJR-261A02[b]	11RAYJR-262A01[a]	11RAYJR-264A01[a]	11RAYTD-040[a]
Easting	566049	597890	623625	552558	571864	571060	600342	604077	594968	594968	600373	597564	621355
Northing	6971415	6964632	6966499	6978620	6968583	6979033	6960835	6958781	6972235	6972235	6968820	6961378	6967600
Major elements (wt.%)													
SiO_2	74.36	74.42	74.47	74.83	69.09	76.99	71.37	73.64	76.21	76.06	72.64	71.91	69.45
TiO_2	0.48	0.22	0.17	0.10	0.73	0.09	0.36	0.25	0.14	0.15	0.16	0.35	0.38
Al_2O_3	11.94	13.78	13.02	13.25	13.69	12.36	14.11	13.31	12.78	12.88	13.84	14.01	14.64
Fe_2O_3	3.76	1.59	2.22	1.58	6.06	1.14	3.05	2.46	1.56	1.48	2.52	2.78	3.77
MnO	0.07	0.03	0.03	0.02	0.07	0.02	0.05	0.04	0.04	0.04	0.04	0.05	0.05
MgO	1.25	0.57	0.31	0.70	2.34	0.06	1.25	0.55	0.32	0.31	0.37	0.70	0.93
CaO	2.19	1.93	1.01	0.04	2.57	0.46	0.92	0.51	0.73	0.75	1.48	2.09	2.51
Na_2O	2.00	4.33	2.70	1.72	2.09	3.50	3.61	2.94	3.93	4.03	2.91	3.03	2.76
K_2O	2.60	2.56	5.55	6.53	1.85	4.82	4.40	5.49	3.12	3.16	4.76	4.46	4.47
P_2O_5	0.14	0.06	0.03	<0.01	0.10	<0.01	0.08	0.04	0.07	0.02	0.02	0.07	0.08
LOI	0.90	0.40	0.40	1.10	1.20	0.50	0.60	0.60	0.90	0.90	1.00	0.40	0.70
Total	99.73	99.90	99.89	99.91	99.81	99.96	99.79	99.82	99.83	99.80	99.77	99.83	99.76
Trace elements (ppm)													
Ni	<20	<20	<20	<20	48	<20	<20	<20	<20	<20	<20	<20	<20
Cr	-	-	-	-	-	-	-	-	-	-	-	-	-
Co	4.5	1.8	1.7	0.3	15.2	0.4	4.9	2.3	1.4	1.7	1.6	3.6	5.4
V	109	26	11	<8	80	<8	30	12	<8	<8	10	19	29
S	-	-	<500	<500	<500	-	<500	<500	-	-	<500	<500	<500
Sc	9	6	2	1	12	<1	6	3	1	2	2	4	5
Cu	-	-	3.6	18.8	22.2	-	10.3	3.3	-	-	3.3	1.1	6
Pb	-	-	4.6	2.9	5.3	-	12.9	10.1	-	-	11	9.9	6
Zn	-	-	25	20	66	-	56	40	-	-	31	41	58
As	-	-	<0.5	1.2	1.3	-	0.5	<0.5	-	-	1.4	<0.5	<0.5
Mo	-	-	<0.1	0.2	0.2	-	0.4	0.4	-	-	0.2	0.2	0.5
W	1	2.3	0.7	1	0.6	0.9	1.4	1.2	1.2	1.3	0.7	1.7	<0.5
Cd	-	-	<0.1	0.1	<0.1	-	<0.1	<0.1	-	-	<0.1	<0.1	<0.1
Sn	1	4	19.5	2	<1	1	3	3	2	2	2	5	2
Nb	10.5	10.5	2	24.7	12.3	28.6	10.2	10.8	13.7	14.9	11.9	11.7	11.8
Ta	0.8	1.0	1.8	1.5	0.5	1.7	1.1	1.1	1.4	1.4	1.0	1.1	0.5
Zr	129.1	114.5	143.3	221.2	210.4	134	171.8	173.8	105	109.2	166.4	164.2	213.4
Hf	3.6	3.9	4.5	8.1	5.3	4.4	4.7	5.2	3.5	3.2	4.7	4.8	5.4
Y	19.3	23.5	17.8	28.2	18.4	16.9	20.4	17.7	14.8	16.2	13	21.5	13.7
Ga	17	18.8	16.5	18.4	16.2	16.8	15.8	13.9	12.7	13	14	15.3	17.1
Cs	2.1	2.6	2.3	1.3	1.3	20.5	2.6	1.1	0.6	0.6	1.7	5.0	2.1
Sr	173.5	224.5	154.4	10.9	262.1	28.4	147.8	117.6	164.3	170	161.8	188.2	251.1
Rb	96.1	94	166.8	223.4	60.2	202.7	132.1	162.6	115.8	114.1	164.3	188.9	134.7
Ba	1750	411	493	212	442	94	1030	923	438	441	1460	773	1462
Be	1	2	3	3	<1	4	2	2	2	2	3	4	6
Li	-	-	-	-	-	-	-	-	-	-	-	-	-
Th	10.1	20.7	20.6	27.7	13.8	30.3	18.9	30.9	37.5	37.7	20.7	19.5	17.3
U	3.9	3.0	5.1	3.3	2.0	3.0	3.8	5.8	2.9	2.8	4.4	5.4	2.6
La	26.6	30.4	13.4	31.2	38.3	23.5	36	49.2	47	47.5	31.1	36.8	24.1
Ce	51.7	58.1	41.2	62.9	81.8	56.8	72.8	91.4	72.7	72.2	60.1	75.4	60.2
Pr	5.9	6.18	2.2	6.94	8.13	5.66	7.1	8.28	6.92	7.26	4.99	7.46	4.16
Nd	22.2	21.9	7.4	25.6	31.1	19.3	25.1	27.3	21.3	21.7	16.3	27.7	13.9
Sm	3.99	4.5	1.76	4.96	5.4	4.35	4.42	4.16	3.27	3.36	2.47	4.88	2.7
Eu	0.86	0.61	0.31	0.09	1.3	0.09	0.70	0.54	0.46	0.49	0.37	0.71	0.91
Gd	3.53	4.17	2.19	4.77	4.73	3.85	3.83	3.47	2.6	2.63	2.14	4.47	2.77
Tb	0.64	0.75	0.41	0.77	0.67	0.49	0.58	0.49	0.42	0.46	0.33	0.68	0.43
Dy	3.23	4.19	2.78	4.65	3.55	3.05	3.38	3.15	2.32	2.36	2.16	4.17	2.47
Ho	0.73	0.87	0.58	0.97	0.65	0.5	0.67	0.55	0.49	0.54	0.49	0.77	0.54
Er	2.04	2.61	1.93	2.85	1.87	1.67	2.08	1.74	1.59	1.54	1.41	2.26	1.49
Tm	0.32	0.39	0.31	0.45	0.28	0.31	0.3	0.26	0.25	0.26	0.25	0.37	0.24
Yb	2.28	2.43	2.30	3.12	1.92	2.48	1.89	1.72	1.78	1.95	1.75	2.26	1.47
Lu	0.35	0.39	0.34	0.48	0.28	0.36	0.28	0.25	0.30	0.31	0.31	0.35	0.21

TABLE 1. cont.

Sample #	11RAYWC-135A[a]	11RAYWC-279A01[a]	14RAY-130A01[a]
Easting	581720	630638	502091
Northing	6976319	6945193	7108675
Major elements (wt.%)			
SiO_2	76.53	73.56	66.39
TiO_2	0.08	0.32	0.26
Al_2O_3	12.17	13.31	15.98
Fe_2O_3	1.45	2.67	3.86
MnO	<0.01	0.04	0.07
MgO	0.24	0.40	2.29
CaO	<0.01	0.94	1.41
Na_2O	0.18	2.88	1.95
K_2O	8.30	5.09	4.91
P_2O_5	<0.01	0.05	0.06
LOI	1.00	0.50	2.20
Total	99.94	99.78	99.41
Trace elements (ppm)			
Ni	<20	<20	<20
Cr	-	-	-
Co	0.7	1.2	3
V	<8	14	21
S	<500	<500	-
Sc	<1	6	6
Cu	1.3	5.3	2.1
Pb	2.5	9.6	16.7
Zn	6	27	65
As	4	1.4	<0.1
Mo	<0.1	0.2	<0.1
W	2.6	0.9	1.4
Cd	<0.1	0.2	<0.1
Sn	2	4	3
Nb	19	9.8	13.9
Ta	2.5	0.9	1
Zr	91.8	231.8	228.5
Hf	3.3	6.5	5.9
Y	16.9	23.1	27.7
Ga	13	15.2	23.1
Cs	1.6	3.5	8.3
Sr	65	147.2	239.8
Rb	277.9	168.5	199.4
Ba	236	1084	4090
Be	<1	<1	<1
Li	-	-	-
Th	34.7	24.1	21.3
U	3.9	4.0	5.6
La	16.1	60.7	57.5
Ce	28.9	112.7	104.9
Pr	2.80	11.13	11.09
Nd	8.6	40.5	37.3
Sm	1.89	6.27	6.66
Eu	0.2	0.69	1.34
Gd	2.12	5.32	5.47
Tb	0.39	0.76	0.84
Dy	2.47	4.37	4.8
Ho	0.56	0.92	1.01
Er	1.66	2.46	2.90
Tm	0.28	0.39	0.46
Yb	2.17	2.52	2.93
Lu	0.32	0.37	0.42

[a]2014-2015 analyses by Bureau Veritas Commodities Canada Ltd.
[b] 2011 analyses by ACME Analytical Laboratories LTD
[c] 2009-2010 analyses by Activation Laboratories LTD
[d] 2000-2003 analyses at Laurentian University

TABLE 2. Major and trace element compositions of the Permian Sulphur Creek plutonic suite (Moderately LREE-enriched)

Sample #	01RAY-108A[a]	02RAY-099B1[d]	02RAY-104A1[d]	02RAY-186A1[d]	02RAY-201A1[d]	03GGAC-002A1[d]	03GGAC-137A1[d]	09RAYKR-096A1[a]	11RAYAZ-207A02[a]	11RAYAZ-370A01[a]	11RAYCR-109A[a]	11RAYJR-001A01[a]	14RAY-106A01[a]
Easting	572543	521451	525480	518421	515106	591164	605839	375565	559394	561769.39	557141	614952	562967
Northing	6998067	7017053	7014535	7029790	7028307	7053137	7043179	6990279	6978163	6971402.15	6982937	6953558	7129589
Major elements (wt.%)													
SiO_2	72.27	62.62	62.72	71.92	69.88	58.80	74.38	76.48	74.26	87.60	62.21	72.26	74.82
TiO_2	0.34	0.57	0.66	0.34	0.43	0.88	0.09	0.04	0.25	0.37	0.94	0.32	0.12
Al_2O_3	13.68	16.72	15.52	13.22	14.88	17.75	14.43	12.92	12.52	5.25	14.75	13.92	13.14
Fe_2O_3	2.96	5.86	6.41	3.99	3.79	8.72	1.17	0.97	2.91	2.76	7.86	2.41	1.96
MnO	0.06	0.11	0.08	0.06	0.07	0.14	0.04	0.03	0.05	0.02	0.14	0.03	0.02
MgO	0.81	2.14	2.57	0.85	0.92	2.31	0.14	0.11	0.59	0.98	2.53	0.83	0.12
CaO	1.86	6.58	6.29	3.07	1.94	5.08	1.08	1.22	2.25	0.21	6.95	1.28	0.47
Na_2O	2.61	1.67	2.87	3.67	2.50	3.25	2.80	3.66	3.71	0.59	1.83	2.82	2.58
K_2O	4.17	1.14	0.25	0.61	2.11	1.64	4.62	3.83	1.86	0.86	1.08	5.16	5.43
P_2O_5	0.07	0.18	0.16	0.06	0.08	0.33	0.06	0.07	0.04	0.09	0.09	0.07	0.15
LOI	1.00	2.01	1.79	1.08	1.60	0.58	0.74	0.60	1.40	1.20	1.40	0.70	1.10
Total	99.86	99.60	99.32	98.87	98.20	99.48	99.55	99.93	99.82	99.92	99.76	99.80	99.95
Trace elements (ppm)													
Ni	<20	<2	13	-	<2	10	19	<20	<20	22	<20	<20	<20
Cr	-	24	47	<3	-			-		-	-		-
Co	3.5	17	15	5	<4	11	-3	0.5	3.2	3.7	15.1	2.9	1.1
V	34	100	151	40	45	35	7	<8	30	61	200	19	<8
S	<500	350	329	364	144			<500		<500	<500	<500	-
Sc	7	12	24	16.79	14.53	13.2	4	2	8	5	30	5	4
Cu	6.7	32	<9	-	-	n.d	n.d.	2	1.4	19.5	13.8	4	5.4
Pb	7.8	6	<4	-	-	7	48	3.5	1.4	6.2	0.9	7.7	6
Zn	41	33	42	22	47	90	15	13	19	49	53	38	35
As	0.8	<1	2	-	-	3	8	<0.5	<0.5	7.3	1	0.7	<0.1
Mo	<0.1	-	-	-	-	N.D.	N.D.	<0.1	0.3	0.5	0.5	0.5	0.7
W	<0.5	-	-	16	12	3	5	<0.5	<0.5	<0.5	<0.5	0.9	4.6
Cd	<0.1	11	8	3	3			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sn	3	-	-	-	-			3	4.6	<1	<1	4	12
Nb	10.1	5.9	9.0	2.1	2.5	16	13.1	5.7	2	7.6	4.8	12.9	13
Ta	0.9	-	0.45	-	-	0.96	2.2	0.5	0.4	0.6	0.3	1.5	1.7
Zr	116.8	76	83	58	59	48.3	59.8	48	119.4	121	82.8	161.3	62.3
Hf	3.4	1.36	1.92	2.29	1.99	1.8	2.3	2.1	3.3	2.9	2.2	4.9	2
Y	14.7	12	26	35	37	30.04	23.08	32	24.2	10.1	17.9	14.8	30.1
Ga	14.3	17	17	15	16	20	19	10.7	12.7	5.5	15.3	18.1	18.3
Cs	4.9	1.73	0.29	0.81	2.2	0.634	3.344	2.3	1.6	0.7	0.9	7.8	7
Sr	156.2	296	267	188	65	247	73	68.2	111.1	35.1	173	189	44.4
Rb	169.4	51	12	25	83	45	137	126.8	56.2	33	37.9	217	380.1
Ba	710	852	183	337	822	1102	850	375	1195	388	1044	1098	176
Be	2	-	-	0.4	0.73	0.87	2.62	<1	<1	<1	<1	3	<1
Li	-	8	6	11	-	-	-	-	-	-	-	-	-
Th	14.5	5.0	1.72	1.71	2.02	3.93	9.41	5.7	6.9	4.5	3.4	13.4	13
U	1.8	1.2	0.8	0.86	0.88	1.543	2.97	2.2	1.8	1.1	1.2	4.7	6.3
La	12	13.76	14.23	5.38	7.88	20.54	11.19	8.6	19.1	13.3	12.2	14.5	8.7
Ce	25.3	23.43	30.52	12.74	17.2	45.07	31.45	21.5	38.1	24.8	23.7	34.2	23.3
Pr	2.5	2.49	4.22	1.85	2.41	5.664	2.739	2.25	4.6	3.08	2.85	3.1	2.13
Nd	9.4	9.4	18.04	8.37	10.57	23.88	9.92	8.2	16.9	11.3	11.9	11.5	8.1
Sm	1.89	1.78	4.66	2.76	3.25	5.4	2.47	1.99	3.85	2.07	2.5	2.52	2.18
Eu	0.54	0.99	1.37	0.88	1.04	1.332	0.479	0.35	0.71	0.45	0.74	0.49	0.22
Gd	1.82	1.72	4.81	3.97	4.47	5.685	2.714	3.02	3.85	1.98	3.16	2.36	2.52
Tb	0.38	0.26	0.78	0.75	0.79	0.889	0.566	0.71	0.69	0.29	0.52	0.37	0.68
Dy	2.29	1.69	4.4	5.19	5.25	5.411	3.834	4.8	3.88	1.71	3.23	2.4	4.56
Ho	0.51	0.33	0.91	1.22	1.2	1.12	0.808	1.09	0.86	0.36	0.68	0.5	1.0
Er	1.72	0.96	2.56	3.57	3.41	3.205	2.437	3.20	2.63	1.03	2.06	1.52	3.11
Tm	0.28	0.14	0.35	0.57	0.53	0.457	0.374	0.47	0.39	0.18	0.31	0.27	0.46
Yb	1.94	0.90	2.17	3.63	3.26	2.94	2.47	3.22	2.56	1.19	2.02	1.81	2.95
Lu	0.29	0.147	0.32	0.605	0.527	0.42	0.344	0.49	0.42	0.17	0.33	0.28	0.39

TABLE 3. Major and trace element compositions of the Permian Sulphur Creek plutonic suite (REE-depleted)

Sample #	02GG-A172A2[d]	00RAY-079B[a]	09RAYJR-106A1[a]	11RAYAZ-286A01[a]	11RAYAZ-302A02[b]	11RAYCR-155A[a]	11RAYJR-259A01[a]
Easting	536501	591387	364097	579884	585323	*557012*	*586235*
Northing	7020398	6986953	7030362	6977866	6971744	*6980163*	*6974315*
Major elements (wt.%)							
SiO_2	64.85	70.48	68.52	74.50	76.27	76.23	73.86
TiO_2	0.38	0.23	0.19	0.17	0.09	0.08	0.15
Al_2O_3	17.89	14.98	17.30	13.32	12.28	12.37	13.54
Fe_2O_3	3.20	3.27	2.06	2.33	1.32	2.00	2.18
MnO	0.03	0.08	0.04	0.03	0.01	0.02	0.03
MgO	0.85	0.55	0.62	0.45	1.17	0.54	0.38
CaO	4.66	1.33	3.88	0.20	0.30	0.04	0.49
Na_2O	3.70	3.74	5.45	2.87	2.57	1.77	3.44
K_2O	1.54	4.07	0.85	5.25	3.88	6.17	5.21
P_2O_5	0.13	0.08	0.08	0.04	<0.01	<0.01	0.03
LOI	1.19	0.90	0.80	0.70	1.70	0.70	0.50
Total	98.42	99.72	99.77	99.89	99.58	99.96	99.82
Trace elements (ppm)							
Ni	<1	<20	<20	<20	<20	<20	<20
Cr	-	-	-	-	-	-	-
Co	<3	3.2	3	1.7	1	<0.2	1.3
V	69	15	29	10	<8	<8	9
S	-	<500	<500	<500	-	<500	<500
Sc	3.33	2	1	2	1	<1	2
Cu	<0.5	2.6	1.8	1.2	-	2	3.6
Pb	-	5.8	1.6	6.8	-	1.5	7
Zn	84	37	28	19	-	3	18
As	-	0.7	<0.5	1.1	-	0.5	1.7
Mo	-	0.2	<0.1	0.3	-	0.7	0.1
W	-	1.1	<0.5	3.3	1.1	2.4	0.8
Cd	4	<0.1	<0.1	<0.1	-	<0.1	<0.1
Sn	-	1	<1	3	3	3	2
Nb	7.8	9.8	4.8	19.1	13	15.3	14.3
Ta	0.48	0.9	0.2	2	1.3	1.5	1.4
Zr	89.4	174.1	82.5	143.6	92.8	144.5	171.2
Hf	1.13	4.3	2.1	4.7	3.3	5.4	5.2
Y	4.1	7.6	1.8	8.5	6.5	7.9	4.9
Ga	24	15.7	15	13.8	10.9	17.4	12.4
Cs	1.47	1.3	0.7	1.4	1.1	0.8	1.7
Sr	735	303.2	1161.3	94.1	73.3	18.6	128.6
Rb	49	125.1	21.2	210.1	110.4	207.8	182.7
Ba	1449	1778	642	598	613	145	1108
Be	0.58	4	3	4	<1	5	6
Li	21	-	-	-		-	-
Th	2.72	19.1	0.6	23.7	27.8	16.1	30.2
U	1.63	4.8	0.2	3	2.3	1.8	4
La	10.65	8.7	4.7	22.3	19.6	3	5.7
Ce	21.02	52.4	8.1	74.8	42.7	4.5	37.2
Pr	2.61	1.65	0.86	3.49	3.35	0.42	1.01
Nd	10.22	5.2	3.1	10.1	10.3	1.2	3.3
Sm	2.24	1.14	0.48	1.87	1.8	0.27	0.62
Eu	0.74	0.29	0.17	0.22	0.2	<0.02	0.11
Gd	1.66	1.3	0.39	1.71	1.26	0.64	0.72
Tb	0.2	0.18	0.05	0.25	0.2	0.14	0.13
Dy	1.05	1.12	0.29	1.35	0.99	1.1	0.85
Ho	0.2	0.24	0.05	0.31	0.23	0.31	0.19
Er	0.51	0.89	0.16	1.05	0.84	0.99	0.68
Tm	0.07	0.16	0.03	0.16	0.13	0.18	0.13
Yb	0.47	1.17	0.21	1.35	1.01	1.34	1.12
Lu	0.077	0.18	0.03	0.22	0.17	0.22	0.16

TABLE 4. Major and trace element compositions of the felsic/intermediate volcanic rocks of the Permian Klondike schist

Sample #	11RAYJR-266A02[b]	11RAYJR-268A02[b]	11RAYAZ-368A02[b]	11RAYAZ-125A03[b]	10RAYJR-098A02[c]	03GGA-391A1[d]	02RAY-308A1[a]	00GGA-103A[a]	00GGA-064A[a]	11RAYAZ-278A02[b]
Easting	535834	515779	557332	555202	553064	512237	532185	580441	600546	573946
Northing	6995136	7010935	6974394	6972975	6978861	7013117	6997382	7095340	7083918	6966933
Major elements (wt.%)										
SiO_2	63.85	67.59	71.16	66.83	69.05	68.97	61.60	76.18	75.47	68.88
TiO_2	0.56	0.43	0.51	0.55	0.52	0.44	0.50	0.16	0.07	0.47
Al_2O_3	16.62	15.58	13.52	16.08	13.17	15.92	16.26	12.45	12.03	13.06
Fe_2O_3	3.97	2.68	4.00	3.58	4.97	3.28	5.40	1.61	1.59	3.00
MnO	0.11	0.08	0.05	0.1	0.09	0.05	0.08	0.02	0.02	0.08
MgO	2.58	2.01	1.41	2.09	0.98	1.02	2.97	0.47	1.29	2.00
CaO	3.05	2.00	2.44	3.07	4.12	0.65	4.29	0.02	0.36	3.89
Na_2O	2.73	2.57	2.53	3.05	4.18	4.97	2.43	0.99	2.04	3.57
K_2O	4.15	4.13	3.18	3.33	0.77	3.70	3.05	6.87	4.7	0.73
P_2O_5	0.15	0.15	0.02	0.16	0.11	0.11	0.15	0.03	<0.01	0.11
LOI	1.70	2.30	0.70	0.60	1.88	0.80	2.80	0.90	2.1	3.60
Total	99.44	99.47	99.52	99.39	99.84	99.91	99.56	99.71	99.63	99.41
Trace elements (ppm)										
Ni	<20	36	61	<20						
Cr	-	-	-	-	< 20	14	<20	<20	<20	30
Co	7.2	2.5	7.7	5.5	20	-	-	-		-
V	51	28	53	44	7	<1	11.7	0.8	0.7	7.9
S	-	-	-	-	75	59	102	10	13	85
Sc	9	6	12	8	-	66	<500	<500	5400	-
Cu	-	-	-	-	17	5.1	14	4	5	18
Pb	-	-	-	-	< 10	-	26.8	3.4	0.9	-
Zn	-	-	-	-	< 5	15	5.6	15.8	4.8	-
As	-	-	-	-	40	36	60	6	9	-
Mo	-	-	-	-	< 5	16	2.2	3.1	<0.5	-
W	2.1	1.5	0.9	1.1	< 2	-	<0.1	0.2	0.9	-
Cd	-	-	-	-	< 0.5	3	1.5	0.8	0.9	<0.5
Sn	3	2	2	2	-	-	<0.1	<0.1	<0.1	-
Nb	9.7	14.2	9.6	10.7	2	-	1	2	3	3
Ta	0.5	0.7	0.7	0.6	6.8	13.9	7.5	9.7	10.7	3.4
Zr	207.9	267.5	128.3	216.4	0.56	0.74	0.5	0.8	0.5	0.2
Hf	5.9	6.9	3.9	5.8	79	312.3	166.6	127	96.4	70.4
Y	32.2	23.7	17.8	30.4	2.8	7.8	4.5	3.7	3.6	2.3
Ga	16	15.9	14.4	18.1	32	23.95	18.2	20.6	28.2	22.7
Cs	2.9	2.2	4.9	1.4	15	20	15.4	14.5	16.4	12
Sr	535.6	333.2	221.8	961.6	0.4	1.081	1	1.2	0.1	0.3
Rb	117.2	129	119.7	93.5	203	85	843.5	74.4	80.6	146.2
Ba	3255	3120	1479	3462	16	110	91.5	135.2	119.7	15.9
Be	3	2	2	3	909	1757	1916	2102	2706	964
Li	-	-	-	-	< 1	1.49	<1	<1	2	1
Th	15.9	22.5	11.5	16.8	-	13	-	-	-	
U	4.3	7.2	2.4	5	6.88	25.34	18.1	18.5	15.3	2.7
La	44.8	59.3	29.7	55.8	2.56	7.269	5.2	2.9	3.8	1.3
Ce	86.9	108.5	57.7	98.2	19.1	40.52	39.5	39.1	29.3	9.6
Pr	10.51	11.91	6.5	11.44	43.4	84.61	72.2	77.7	58.7	20.7
Nd	41.3	41.2	23.2	45.7	5.65	8.526	8.18	7.86	7.29	2.63
Sm	7.85	6.56	4.03	8.08	22.6	30.62	29.3	27.1	26.5	11.7
Eu	1.88	1.45	0.80	1.81	5.22	5.39	5.01	4.67	6.28	2.90
Gd	7.27	5.12	3.5	6.48	0.945	0.967	1.28	0.64	0.81	0.73
Tb	0.91	0.81	0.58	0.94	5.47	4.184	4.06	3.93	6.01	3.29
Dy	5.89	4.14	3.12	5.19	0.92	0.641	0.58	0.61	0.93	0.62
Ho	0.99	0.89	0.64	1.01	5.86	3.813	3.04	3.38	5.24	3.89
Er	3.18	2.60	1.90	3.07	1.19	0.826	0.63	0.67	1.03	0.87
Tm	0.48	0.40	0.29	0.48	3.52	2.638	1.92	2.12	3.12	2.73
Yb	3.34	2.76	1.76	3.15	0.537	0.422	0.25	0.31	0.42	0.43
Lu	0.48	0.44	0.29	0.50	3.55	2.93	1.67	2.15	2.78	2.78

TABLE 5. Major and trace element compositions of the mafic volcanic rocks of the Permian Klondike assemblage

Sample #	09RAYJR-069A1[a]	09RAYJR-119A01[c]	11RAYCR-156A[a]	14RAY-077D01[a]	14RAY-088A01[a]	02RAY-313A1[a]	02RAYG-085A1[a]	09RAYJR-120A1[a]	11RAYAZ-198A01[a]	11RAYJR-097B01[a]	11RAYJR-267A02[b]	14RAY-077A01[a]
Type	1	1	1	1	1	2	2	2	2	2	2	2
Easting	645975	648093	556400	370608	575208	548438	521513	354762	568147	569156	526124	370608
Northing	7031998	7032438	6980223	6867814	7104211	6990296	7035746	7020495	6967285	6967024	7003815	6867814
Major elements (wt.%)												
SiO_2	47.07	49.05	59.51	57.26	54.66	47.85	52.46	48.69	47.37	47.23	47.71	54.09
TiO_2	1.01	0.555	0.85	0.88	0.44	1.39	0.88	1.07	0.77	0.72	2.02	1.15
Al_2O_3	15.85	15.03	14.32	14.24	15.57	15.47	16.49	15.61	18.19	17.92	15.70	14.13
Fe_2O_3	9.60	9.97	9.91	10.00	9.19	*9.17*	*12.58*	9.94	12.53	12.22	10.97	10.34
MnO	0.16	0.155	0.11	0.14	0.15	0.16	0.12	0.17	0.23	0.21	0.17	0.36
MgO	9.04	10.06	4.00	4.54	7.29	7.23	4.28	8.32	5.85	7.19	4.20	5.85
CaO	11.93	10.33	4.49	3.22	7.52	10.99	2.80	9.41	10.01	10.26	13.82	5.63
Na_2O	2.10	2.38	2.82	7.16	2.19	3.33	6.55	2.64	1.66	1.42	2.70	6.14
K_2O	0.47	0.48	0.89	0.10	<0.01	0.36	0.75	1.17	1.95	0.15	0.45	0.06
P_2O_5	0.10	0.04	0.05	0.09	0.02	0.18	0.03	0.19	0.10	0.06	0.34	0.10
LOI	2.30	2.47	2.80	2.10	2.80	3.60	2.90	2.40	1.00	2.40	1.60	1.90
Total	99.74	100.5	99.79	99.72	99.81	99.74	99.84	99.70	99.65	99.76	99.65	99.80
Trace elements (ppm)												
Ni	91	120	<20	<20	77	120	<20	<20	<20	26	31	83
Cr	-	390	-	-	-	-	-	-	-	-	-	
Co	36.2	36	18.2	25.2	32.5	29.9	24.8	34.6	36.9	38	36.8	35.7
V	224	263	189	219	288	255	302	273	353	380	366	273
S	<500	-	800	-	-	<500	<500	<500	<500	<500	-	-
Sc	34	42	37	27	38	33	44	37	45	44	34	33
Cu	1.5	<10	31.9	7.5	114.3	11.8	44.8	1.6	157	138.7	-	87.9
Pb	1	6	4	0.3	0.2	2.9	1.6	14	1.3	1.6	-	1.7
Zn	25	70	72	24	53	33	76	39	54	51	-	71
As	0.9	<5	<0.5	<0.1	<0.1	<0.5	<0.5	<0.5	<0.5	<0.5	-	<0.1
Mo	<0.1	<2	<0.1	1	<0.1	<0.1	<0.1	0.1	0.3	0.2	-	0.2
W	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cd	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	-	<0.1
Sn	1	3	<1	<1	<1	1	<1	1	<1	<1	1	<1
Nb	0.7	0.6	1.8	1.2	0.4	3.1	0.4	3.7	1.9	1.3	17	1.9
Ta	0.1	0.03	0.1	<0.1	<0.1	0.2	0.3	0.3	0.1	<0.1	0.9	0.1
Zr	43.9	32	36.4	62.1	20.6	110.1	34.5	66.5	61.4	37.5	164.1	86.9
Hf	1.2	1	1.2	2	0.8	2.9	1.2	1.8	1.7	1.3	4.3	2.3
Y	19.7	14.1	21	23	11.9	23.6	14.8	16.4	15.2	13.4	38.9	24.7
Ga	16	12	15.4	14	14.6	15.4	13.4	16.7	16.6	16.1	24.9	15.7
Cs	<0.1	< 0.1	0.9	0.6	0.2	0.8	0.3	0.2	1.2	<0.1	0.2	0.2
Sr	288.8	179	624.9	92.2	105.6	355	103.3	276.9	164.6	122.6	683	78.9
Rb	11.6	11	36.3	2.6	0.1	7.2	19.4	28.8	39.7	1.5	10.4	0.7
Ba	166	341	128	1337	58	223	120	590	1228	83	117	181
Be	<1	< 1	<1	<1	1	<1	2	2	<1	1	1	1
Li	-	-	-	-	-	-	-	-	-	-	-	-
Th	<0.2	< 0.05	0.5	0.3	<0.2	1.7	0.6	2.1	2.6	1.5	2.8	0.5
U	<0.1	0.2	0.2	0.2	0.2	0.5	0.2	0.7	0.8	0.6	0.8	0.2
La	1.9	1.57	2.8	2.7	1	8.3	5.4	9.5	11.2	7.3	21	4.9
Ce	6.1	4.19	7.4	8.0	2.4	22.1	11.7	18.4	22.8	16.1	47.5	13.2
Pr	1.02	0.77	1.12	1.23	0.34	2.9	1.57	2.65	2.73	1.96	5.91	1.95
Nd	5.9	4.25	6.2	6.2	2.1	14.1	8.2	12.8	11.5	8.6	24.8	9.7
Sm	2.13	1.54	2.09	2.23	0.9	3.71	2.31	2.79	3.06	2.07	5.82	2.89
Eu	0.82	0.532	0.75	0.68	0.29	1.27	0.78	1.09	0.87	0.69	1.87	0.98
Gd	3.21	2.14	2.93	3.28	1.36	4.29	2.59	3.21	3.04	2.25	6.57	3.94
Tb	0.57	0.41	0.55	0.60	0.28	0.76	0.49	0.56	0.50	0.39	1.25	0.75
Dy	3.88	2.59	3.87	3.89	1.82	4.70	2.84	3.32	2.80	2.39	6.98	4.53
Ho	0.78	0.52	0.84	0.91	0.45	0.94	0.59	0.63	0.67	0.51	1.57	0.95
Er	2.15	1.56	2.62	2.71	1.29	2.55	1.68	1.84	1.74	1.43	4.59	2.80
Tm	0.31	0.257	0.40	0.41	0.20	0.36	0.26	0.26	0.27	0.21	0.70	0.40
Yb	2.10	1.76	2.67	2.83	1.47	2.22	1.67	1.72	1.90	1.44	4.32	2.79
Lu	0.27	0.269	0.42	0.42	0.23	0.36	0.25	0.24	0.27	0.24	0.63	0.43

TABLE 5. cont.

Sample #	03GGA-412A1[d]	03GGA-418A[a]	03GGA-419A[a]	11RAYAZ-258A02[b]	11RAYAZ-258B02[b]	11RAYJR-160A02[b]	14RAY-084A1[a]
Type	3	3	3	3	3	3	3
Easting	515766	516849	516789	561177	561177	575092	513624
Northing	7010549	7007542	7007853	6970410	6970410	6965178	7051573
Major elements (wt.%)							
SiO_2	48.34	50.72	51.49	59.85	49.26	55.25	50.75
TiO_2	0.77	0.73	0.73	0.62	1.66	0.81	0.79
Al_2O_3	19.42	15.76	14.46	17.20	18.41	15.73	14.42
Fe_2O_3	11.16	8.62	8.74	4.89	8.33	7.21	8.06
MnO	0.14	0.14	0.14	0.12	0.16	0.10	0.11
MgO	5.45	7.25	7.62	6.02	6.95	6.35	5.23
CaO	7.20	5.27	7.31	0.85	4.88	5.40	7.43
Na_2O	3.26	3.82	3.71	6.68	5.75	3.02	3.30
K_2O	0.22	2.03	1.68	0.14	0.31	4.22	2.64
P_2O_5	0.12	0.16	0.17	0.34	0.34	0.32	0.17
LOI	3.80	5.1	3.5	3.10	3.30	0.90	6.80
Total	99.88	99.6	99.61	99.82	99.39	99.37	99.72
Trace elements (ppm)							
Ni	10	50	92	<20	66	61	77
Cr	-	-	-	-	-	-	-
Co	29	27.1	32.5	9.5	34.2	27.4	28.6
V	334	228	210	105	190	183	116
S	130	<500	<500	-	-	-	<500
Sc	25.5	27	29	9	23	24	14
Cu	67	83.5	58.3	-	-	-	32.5
Pb	16	8.8	4.3	-	-	-	6.2
Zn	108	49	42	-	-	-	84
As	7	5.4	0.9	-	-	-	<0.5
Mo	-	0.1	0.1	-	-	-	0.1
W	-	1	<0.5	1	0.8	1.1	<0.5
Cd	-	<0.1	<0.1	-	-	-	0.1
Sn	-	<1	<1	<1	2	2	2
Nb	2.6	5.1	5.6	14.3	12.9	14.1	17.6
Ta	0.2	0.7	1.8	0.6	0.8	0.8	1
Zr	63.3	92.1	102.8	220.6	212	201.8	208.4
Hf	1.7	2.6	2.6	5.9	4.6	5.7	5.3
Y	18.6	15.3	15.2	22.7	27.2	24.1	21
Ga	21	15.3	14.2	18	16.8	17.1	16.7
Cs	0.261	1	0.3	0.2	0.5	3.4	2.1
Sr	453	194.2	253.1	75.7	258	537.5	294.2
Rb	9	56.6	27.9	2.4	7.7	133.5	93.6
Ba	448	1580	1441	201	273	2756	631
Be	0.25	4	<1	3	2	3	2
Li	23	-	-	-	-	-	-
Th	2.7	6.6	7.4	27.8	2	21.3	16.1
U	0.91	1.7	2.2	8.4	0.7	6.5	4
La	12.44	22.4	23.1	34.8	18.3	65.2	44.2
Ce	25.67	43.4	47.1	79.9	40.8	123.1	80.4
Pr	3.36	5.03	5.18	6.86	5.26	13.35	8.42
Nd	14.02	18.5	19.1	26.0	22.7	46.4	31.3
Sm	3.32	3.94	4.25	4.69	5.05	8.5	5.15
Eu	1.02	1.01	1.06	1.16	1.65	1.87	1.01
Gd	3.44	3.54	3.82	4.27	5.22	6.56	4.51
Tb	0.53	0.53	0.54	0.73	0.87	1.01	0.65
Dy	3.24	3.00	3.02	3.99	4.9	4.68	3.85
Ho	0.69	0.55	0.55	1.07	1.04	0.90	0.77
Er	2.00	1.80	1.59	2.79	2.98	2.53	2.13
Tm	0.29	0.24	0.22	0.41	0.44	0.36	0.32
Yb	1.89	1.54	1.49	2.71	2.71	2.44	2.32
Lu	0.29	0.25	0.25	0.38	0.40	0.35	0.36

TABLE 6. Major and trace element compositions of the Permian mafic plutonic rocks

Sample #	03GGA-396A1[a]	02RAY-302A1[a]	02RAY-099A1[d]	02RAY-102A2[d]	02RAY-308B1[d]	03RAYR-036A2[d]	02RAY-G274A	15RAY-JR141C01[a]	15RAY-JR043B02[a]	15RAY-EW100A01
Type	2	2	3	3	3	3	3	3	3	3
Easting	514791	520972	521451	522424	532185	622732	532109	360315	354709	357486
Northing	7011444	7023006	7017053	7017753	6997382	7041763	7009046	6882457	6881009	6882703
Major elements (wt.%)										
SiO_2	46.79	57.29	51.74	53.67	47.16	63.39	47.74	47.39	50.84	48.17
TiO_2	1.52	0.72	0.61	0.81	1.66	0.59	0.66	0.91	0.92	1.21
Al_2O_3	18.29	16.54	17.03	14.06	18.13	11.42	10.02	16.49	16.77	17.53
Fe_2O_3	7.93	*7.71*	8.94	7.44	9.11	9.59	5.63	9.12	7.93	11.55
MnO	0.14	0.12	0.15	0.12	0.15	0.34	0.09	0.14	0.12	0.20
MgO	6.23	3.87	5.48	7.32	6.37	5.39	12.54	9.88	7.48	5.86
CaO	10.7	7.60	10.79	9.50	8.05	5.45	19.77	9.45	8.36	10.02
Na_2O	3.55	2.24	1.13	1.94	3.41	1.86	0.31	3.05	4.39	2.40
K_2O	0.85	1.77	0.39	2.80	1.24	0.22	0.62	1.46	1.09	0.78
P_2O_5	0.31	0.14	0.08	0.17	0.40	0.14	0.03	0.24	0.26	0.54
LOI	3.30	1.70	2.23	0.86	2.57	0.80	2.1	1.30	1.30	1.20
Total	99.65	99.75	98.57	98.69	98.25	99.19	99.69	99.54	99.49	99.46
Trace elements (ppm)										
Ni	54	20	21	140	85	50	194	145	81	23
Cr	-	-	21	371	133	104	-	-	-	-
Co	24.6	20.8	34	31	20	17	28.1	38.2	29.3	31.4
V	192	200	236	12	179	164	141	193	158	356
S	<500	<500	539	472	>400	222	<500	-	-	-
Sc	33	24	37	17	23.36	15.5	34	27	22	30
Cu	58	24.3	27	13	38	305	50	48.1	43.9	57.4
Pb	0.6	0.8	6	13	-	10	3.5	0.9	22.1	6.4
Zn	44	30	69.3	93	75	108	4	33	48	35
As	0.5	<0.5	<1	3	-	<1	0.5	1	<0.5	1.5
Mo	<0.1	0.1	-	-	-	-	<0.1	<0.1	0.1	0.5
W	<0.5	1.3	-	-	18	3	0.8	<0.5	<0.5	0.5
Cd	<0.1	<0.1	12	11	4	-	<0.1	<0.1	0.2	<0.1
Sn	1	1	-	-	-	-	2	3	1	<1
Nb	8.7	4.2	4	19	14	5.6	2.8	6	7.8	1.9
Ta	0.7	0.4	-	1.03	0.78	0.45	0.2	0.2	0.4	0.2
Zr	151.9	72.7	43	132	167	93.9	91.9	189.4	198.2	56.6
Hf	3.2	1.8	1.72	3.45	4.47	2.4	3.2	4.7	5.1	1.6
Y	21.3	13	18	25	31	21.51	11.8	23	19.3	23.9
Ga	15.2	16.5	15	20	17	15	11.4	20.4	20	18.3
Cs	0.3	0.6	0.42	2.81	0.5	0.10	0.6	1.3	1.2	1.8
Sr	970.2	318.7	307	411	382	136	372.2	710.6	1052.9	952.3
Rb	12.7	54	16	117	26	7	24.8	44.9	31.7	21.9
Ba	475	778	234	625	966	260	181	1082	1588	2001
Be	3	3	-	-	0.79	0.54	<1	3	<1	<1
Li	-	-	8	32	17	6	-	-	-	-
Th	2.4	3.8	2.45	10.79	3.31	2.99	1.8	3.7	11.3	5.8
U	0.7	1.3	0.83	1.62	0.92	1.04	0.7	0.8	0.7	2.1
La	16.3	13.5	9.18	39.14	19.5	7.6	8.3	23.8	40.5	27.6
Ce	37.5	25.2	18.31	80.94	42.8	17.2	20.5	54.3	75.6	55
Pr	4.59	2.86	2.16	9.8	5.86	2.39	2.4	7.04	8.54	6.92
Nd	20	12	9.66	35.95	24.85	10.95	8.7	29.1	31.9	29.5
Sm	4.26	2.25	2.38	6.67	5.78	3.08	2.16	6.16	5.97	6.19
Eu	1.64	0.83	0.9	1.51	2.40	0.97	0.58	1.6	1.53	1.6
Gd	4.59	2.5	2.49	5.49	6.27	3.57	1.99	5.38	4.90	5.96
Tb	0.72	0.41	0.42	0.8	1.02	0.59	0.34	0.75	0.72	0.84
Dy	4.29	2.10	2.58	4.27	5.74	3.70	1.98	4.34	3.93	4.44
Ho	0.81	0.45	0.59	0.83	1.26	0.77	0.42	0.78	0.71	0.89
Er	2.33	1.53	1.66	2.28	3.37	2.32	1.12	2.27	1.98	2.4
Tm	0.3	0.23	0.26	0.35	0.51	0.35	0.20	0.34	0.30	0.35
Yb	1.88	1.32	1.52	2.24	3.12	2.29	1.08	2.07	1.94	2.19
Lu	0.31	0.20	0.25	0.33	0.46	0.35	0.15	0.31	0.27	0.3

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