



Industry, Energy and Technology

Mines

TILL GEOCHEMISTRY OF THE DEAD WOLF POND (NTS 2D/10) MAP AREA

J.S. Organ and S.D. Amor

Open File 002D/10/0954

**St. John's, Newfoundland
November, 2020**

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SUMMARY

Analytical results for the <63 µm fraction of 118 routine till-geochemical samples, and six field duplicates, from central Newfoundland (NTS map area 2D/10) are released. These samples have been analyzed by ICP-OES for aluminum, arsenic, barium, beryllium, cadmium, calcium, cerium, chromium, cobalt, copper, dysprosium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, niobium, phosphorus, potassium, rubidium, scandium, silver, sodium, strontium, sulphur, titanium, vanadium, yttrium, zinc, and zirconium; and by INAA for antimony, arsenic, barium, bromine, cerium, cesium, chromium, cobalt, europium, gold, iron, hafnium, lanthanum, lutetium, molybdenum, rubidium, scandium, samarium, selenium, sodium, tantalum, terbium, thorium, tungsten, uranium, and ytterbium. Loss-on-ignition (LOI) was determined gravimetrically, whereas fluoride was analyzed by ion-selective electrode. The quality of the analyses has been checked for acceptable accuracy and precision. Maps are included for the following elements: arsenic, beryllium, cerium, cesium, copper, fluoride, gold, lead, phosphorus, rubidium, tantalum, terbium, tungsten, uranium and zinc. Interpretations of the geochemical data, and of the surficial geology, will be released later as two separate Open File reports.

INTRODUCTION

This report provides the results of a till-geochemistry survey conducted in the Dead Wolf Pond map area (NTS 2D/10) in 2019 (Figure 1). The samples were collected as part of an ongoing till-geochemistry and surficial-mapping program across the island of Newfoundland. The primary objective is to assist the mineral exploration industry by delineating prospective areas using both till-geochemical anomalies and regional ice-flow history. The initial surficial mapping work and ice-flow history for the study area are summarized by Organ (2020). The field work was restricted to forestry-resource roads in the northern half of the study area using truck and ATV traverses. Sampling will continue adjacent to passable forest-access roads and in the southern half of the study area during the next field season.

Using aerial photography and ground-truthed data, a detailed map of the surficial geology and landforms for the survey areas will be released at a later date, along with an interpretation of the geochemical data, as two separate open files.

This report comprises notes on the content of the database, followed by descriptions of methods of sampling, sample preparation, and analytical procedures, including quality assurance. Maps of certain key elements (As1, Au1, Be2, Ce1, Cs1, Cu2, F9, P2, Pb2, Rb1, Ta1, Tb1, U1, W1 and Zn2) are included to show various spatial distribution patterns. Interpretation of the geochemical data will occur when sampling of the study area has been completed, following the next field season.

NOTES ON DATABASE

The location for each sample is given in Appendix A, as Universal Transverse Mercator (UTM) eastings and northings (Zone 21, NAD 27). Analytical data, along with a short description of each sample and site, are also included. Within the database, elements are denoted by a combi-

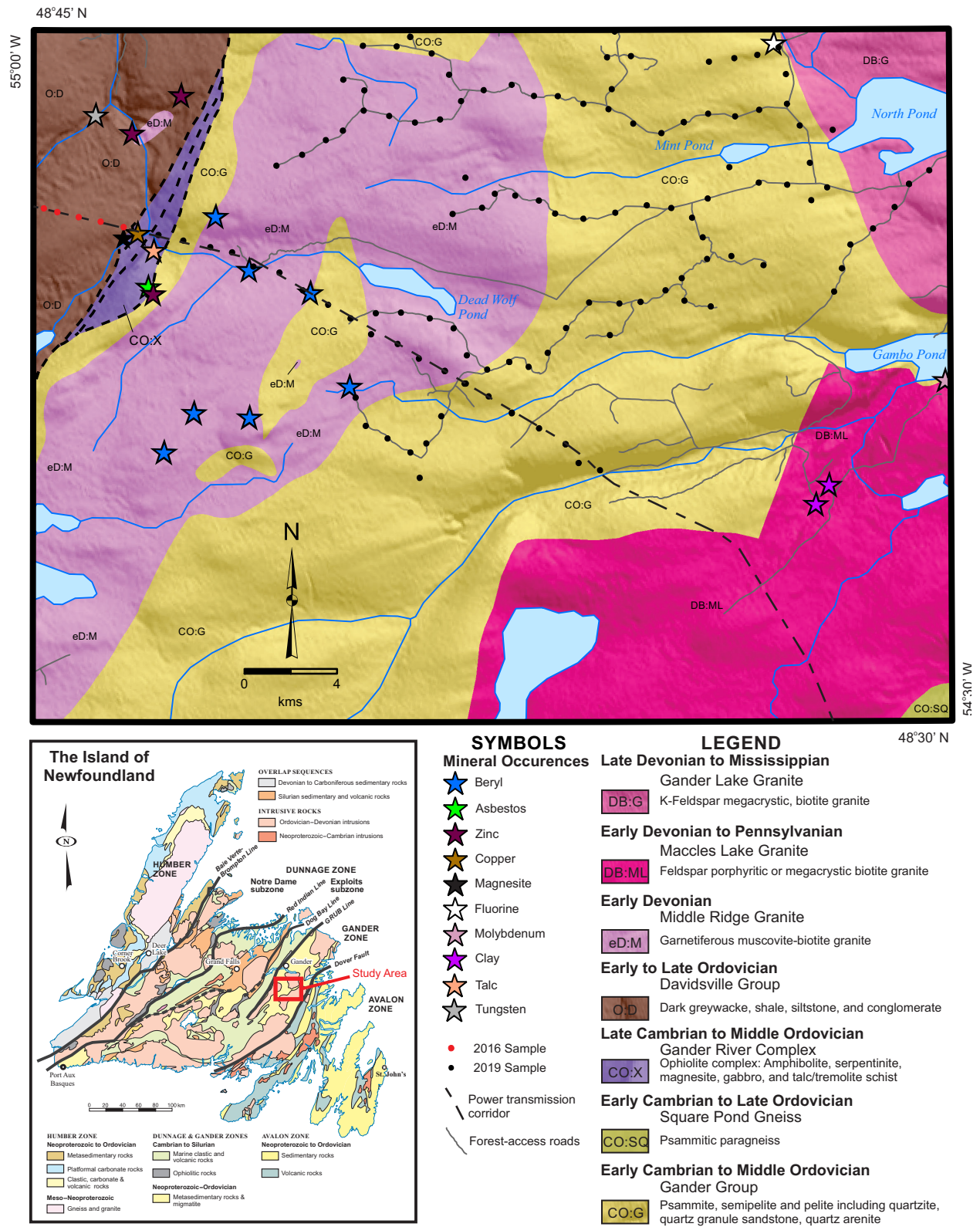


Figure 1. Maps showing location of 2019 routine till-geochemical samples (black dots) released with this open file, along with 5 samples (red dots) released by Campbell (2019) in Open File NFLD/3358. General geology (GSNL, 2019a) and mineral occurrences (GSNL, 2019b) are also displayed and are discussed by Organ (2020).

nation of the elemental symbol followed by numeric suffix identifying the analytical method: 1 – Instrumental neutron activation analysis (INAA), 2 – Inductively-coupled plasma optical emission spectrometry (ICP-OES) after multi-acid (HF/HCl/HNO₃/HClO₃) digestion, 6 – ICP-OES after nitric acid digestion, 9 – Ion-selective electrode (ISE) after alkaline fusion.

Detection limits reported by the lab are replaced by a value that is ½ of the detection limit. A code of -9 has been given to 64 samples requiring ICP-OES re-analysis; an explanation is given in the quality assurance section.

SAMPLING METHODS

The locations of till samples collected from the forest-access roads of the northern half of NTS map area 2D/10 are shown in Figure 1. Approximately 1 kg of till was collected, and placed in a Kraft paper bag, from the C or BC soil horizon exposed in hand-dug pits, mudboils, roadcuts or ditches. Sample spacing was determined by access along existing roadways, and the availability or appropriate sample material. Along forest-access and other roads, the sample density was one sample every 1 linear kilometre. Field duplicates were collected at six sites, at an overall frequency of 1 in 19, to estimate the natural inhomogeneity of the sample medium. The results of the field-duplicate analyses are summarized in a later section.

SAMPLE PREPARATION METHODS AND ANALYSIS

Samples were processed in the geochemical laboratory of the Geological Survey of Newfoundland and Labrador (GSNL) in St. John's, where they were air-dried at 60°C, and dry-sieved through 63 µm (230 mesh) stainless-steel sieves to recover the silt and clay fraction for analysis.

The analyses for 61 elements from the silt and clay fraction of 118 C- or BC-soil horizon samples, collected in 2019, are a component of the database in Appendix A. The GSNL laboratory carried out inductively-coupled plasma optical emission spectrometry (ICP-OES) following a multi-acid (HF/HCl/HNO₃/HClO₄) digestion, for Al, As, Ba, Be, Ca, Cd, Ce, Co, Cr, Cu, Dy, Fe, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, S, Sc, Sr, Ti, V, Y, Zn and Zr.

Instrumental neutron activation analysis (INAA) was carried out by Bureau Veritas (formally Maxxam Laboratories) in Mississauga, Ontario, for the following elements: As, Au, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Lu, Mo, Na, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, U, W, and Yb.

Of the 61 elements determined, 11 were determined by both ICP-OES and INAA: As, Ba, Ce, Co, Cr, Fe, La, Mo, Na, Rb, and Sc.

Analyses for silver, fluoride, and loss-on ignition (LOI) were also completed at the GSNL laboratory. Silver was analyzed by ICP-OES after nitric acid digestion. Fluoride was analyzed by ion-selective electrode (ISE) after an alkaline fusion, and LOI was determined gravimetrically.

Analytical variables are labelled in this report and in the database with a combination of element symbol name and a numeric suffix indicating analytical method; the unit of measurement is also given. A complete list of analytical variables is given in Table 1, and the analytical methods are described, in detail, by Finch *et al.* (2018).

QUALITY ASSURANCE

Quality assurance consisted of the analysis of one reference standard and one analytical duplicate in every sequence of 20 samples. For the ICP-OES analyses, the standards consisted of the Canmet standards TILL-1, and TILL-2 (Lynch, 1996). For the samples submitted for INAA analysis, these same standards were used until their supply was exhausted, at which point they were replaced by till standards OREAS-46 and OREAS-47 (www.ore.com.au). Standard and duplicate analyses for INAA and ICP-OES, were mostly satisfactory. However, ICP-OES re-analysis was requested for a sequence of 64 samples (lab numbers 7834650-7834713) due to unacceptable

Table 1. Geochemical variables with analytical method, units, detection limit (D.L.), number of analyses below the detection limit (<D.L.) and range of data values. INAA analyses for six elements had multiple detection limits, due to their low sample weight, and are listed separately in the detection limit column. The suffix “1” denotes INAA analysis; “2” denotes ICP-OES analysis after multi-acid digestion; “6” denotes ICP-OES after nitric acid digestion; and “9” denotes ISE after alkaline fusion

Element	Method	Units	D.L.	<D.L.	Max	Min	Element	Method	Units	D.L.	<D.L.	Max	Min
Ag6	AAS	ppm	0.1	117	0.1	<0.1	Mg2	ICP-OES	%	0.01	0	1.2	0.4
Al2	ICP-OES	%	0.01	0	8.6	5.3	Mn2	ICP-OES	ppm	1	0	1420	694
As1	INAA	ppm	0.5	0	195	1.2	Mo1	INAA	ppm	1, 2	114	1	<2
As2	ICP-OES	ppm	1	0	95	2	Mo2	ICP-OES	ppm	1	66	2	<1
Au1	INAA	ppb	1, 2, 3	45	24	<1	Na1	INAA	%	0.05	0	2.3	1.1
Ba1	INAA	ppm	50	0	660	170	Na2	ICP-OES	%	0.01	0	2.1	1.1
Ba2	ICP-OES	ppm	1	0	667	196	Nb2	ICP-OES	ppm	1	0	19	8
Be2	ICP-OES	ppm	0.1	0	10.4	1.9	Ni2	ICP-OES	ppm	1	0	54	15
Br1	INAA	ppm	1	9	74	<1	P2	ICP-OES	ppm	1	0	1345	172
Ca2	ICP-OES	%	0.01	0	1.2	0.4	Pb2	ICP-OES	ppm	1	0	44	8
Cd2	ICP-OES	ppm	0.1	4	0.3	<0.1	Rb1	INAA	ppm	10	0	220	50
Ce1	INAA	ppm	1	0	190	54	Rb2	ICP-OES	ppm	5	0	221	54
Ce2	ICP-OES	ppm	5	0	137	44	S2	ICP-OES	ppm	100	57	794	<100
Co1	INAA	ppm	2, 4, 5	1	31	<2	Sb1	INAA	ppm	0.1	0	2.8	0.2
Co2	ICP-OES	ppm	1	0	39	7	Sc1	INAA	ppm	0.1	0	17.8	6.3
Cr1	INAA	ppm	2	0	280	68	Sc2	ICP-OES	ppm	0.1	0	19.2	7.2
Cr2	ICP-OES	ppm	1	0	114	41	Se1	INAA	ppm	1, 2, 3	118	<1	<1
Cs1	INAA	ppm	0.5	0	25	3.2	Sm1	INAA	ppm	0.1	0	11.3	4.5
Cu2	ICP-OES	ppm	1	0	80	10	Sr2	ICP-OES	ppm	1	0	147	86
Dy2	ICP-OES	ppm	0.5	0	5.6	2.3	Ta1	INAA	ppm	0.1	0	4.4	1
Eu1	INAA	ppm	0.5, 1.5	10	2.5	<0.5	Tb1	INAA	ppm	0.5	0	1.6	0.6
F9	ISE	ppm	5	0	463	107	Th1	INAA	ppm	0.5	0	27.2	8.4
Fe1	INAA	%	n/a	0	4.2	1.8	Ti2	ICP-OES	ppm	5	0	8142	3840
Fe2	ICP-OES	%	0.01	0	3.9	1.8	U1	INAA	ppm	0.1	0	56.2	2.6
Hf1	INAA	ppm	1	0	22	7	V2	ICP-OES	ppm	1	0	110	41
K2	ICP-OES	%	0.01	0	2.8	1.0	W1	INAA	ppm	2	0	37	1
La1	INAA	ppm	0	0	62	23	Y2	ICP-OES	ppm	1	0	27	9
La2	ICP-OES	ppm	1	0	68	22	Yb1	INAA	ppm	0.5	0	4.3	1.3
Li2	ICP-OES	ppm	0.1	0	90.5	23.3	Zn2	ICP-OES	ppm	1	0	121	30
LOI	Gravimetric	%	0.1	0	15.0	0.6	Zr2	ICP-OES	ppm	1	0	115	65
Lu1	INAA	ppm	0.10	0	0.7	0.2							

magnitude of the spread between the Ce, La, Rb, Sr, Ti and Zr analyses of two duplicate pairs. Pending re-analysis, the analyses corresponding to these lab numbers have been assigned a code of -9 in the accompanying database. When the re-analyses are available these values will be amended.

ACCURACY

Comparison of the total-content ICP-OES analyses of the standards with ‘recommended values’ (based on the arithmetic means of multiple analyses) indicate that the multi-acid digestion is near total (>95% recovery) for Al, Ba, Ca, Co, Cu, Cr, Fe, Li, Mg, Mn, Na, Ni, P, Rb, Sc, Sr, and V, but only partial (<75%) for Be, Y and Zr (Table 2). The greatest underestimations are for Zr (mean recovery 18% of the recommended values). For several elements, the recovery is greater than 100%, indicating that the element is being overestimated; the greatest overestimation is for Sr (average 119% of the recommended values). Overall, only eleven elements (Al, Ba, Ca, Cr, Fe, Li, Mg, Mn, Na, P, and Rb) out of 30 show recoveries within $\pm 5\%$ of 100%.

Not surprisingly, elements showing near-total recoveries by INAA are more numerous because they are not dependent on mineral solubility in a digestion reagent. Comparison of recoveries for standards TILL-1 and TILL-2 with those of OREAS-46 and OREAS-47 can be made in Table 3. Recoveries of 95% or less in standards TILL-1, and TILL-2 were only reported for Cs, Rb, U and Yb (Table 3). Thirteen elements out of 26 (As, Ba, Br, Co, Fe, Hf, La, Lu, Mo, Sb, Sm, Tb, Th and W) show average recoveries within $\pm 5\%$ of 100%. Overestimations (>105%) are reported for the following six elements Au, Ce, Cr, Sc and Ta, with the greatest overestimation for Eu (119% of the recommended values).

Table 2. Accuracy of ICP-OES analyses; calculated as the arithmetic mean of multiple analyses of each certified reference standard, divided by the recommended value for the standard. The overall arithmetic mean, for all standards, is expressed as a percentage

	TILL-1	TILL-2	Arithmetic Mean
Al2	0.94	0.95	95%
As2	0.92	0.96	94%
Ba2	1.01	1.00	101%
Be2	0.63	0.88	75%
Ca2	0.93	0.97	95%
Cd2			
Ce2	0.92	0.85	89%
Co2	1.14	1.13	114%
Cr2	0.98	0.96	97%
Cu2	1.05	1.08	107%
Dy2			
Fe2	1.01	1.01	101%
K2	0.95	0.93	94%
La2	0.96	0.92	94%
Li2	1.00	0.95	98%
Mg2	0.96	0.98	97%
Mn2	1.03	1.03	103%
Mo2		0.93	93%
Na2	1.00	1.01	101%
Nb2	0.75	0.83	79%
Ni2	1.10	1.06	108%
P2	1.01	0.97	99%
Pb2	0.89	0.97	93%
Rb2	0.98	1.00	99%
S2			
Sc2	1.19	1.15	117%
Sr2	1.17	1.22	119%
Ti2	0.91	0.96	93%
V2	1.08	1.09	108%
Y2	0.71	0.45	58%
Zn2	0.92	0.94	93%
Zr2	0.16	0.21	18%

Table 3. Accuracy of INAA analyses; calculated as the arithmetic mean of multiple analyses of each certified reference standard, divided by the recommended value for the standard. The overall arithmetic mean, for all standards, is expressed as a percentage

	TILL-1	TILL-2	Arithmetic Mean	OREAS-46	OREAS-47	Arithmetic Mean
As1_ppm	1.00	1.00	100%	0.69	1.05	87%
Au1_ppb	1.29	1.00	114%	0.31	1.08	70%
Ba1_ppm	1.03	1.02	102%	1.06	1.06	106%
Br1_ppm	0.94	0.98	96%			
Ce1_ppm	1.11	1.12	112%	1.07	0.98	103%
Co1_ppm	0.94	1.08	101%	1.11	0.96	103%
Cr1_ppm	1.17	0.96	106%	0.94	0.88	91%
Cs1_ppm	0.80	1.08	94%	1.29	1.15	122%
Eu1_ppm	1.08	1.30	119%	1.14	0.90	102%
Fe1_pct	1.04	1.04	104%	0.79	0.73	76%
Hf1_ppm	1.08	1.00	104%	1.22	1.22	122%
La1_ppm	0.96	1.05	100%	1.02	0.87	94%
Lu1_ppm	1.00	0.98	99%	1.25	1.00	112%
Mo1_ppm		1.00	100%		1.10	110%
Na1_pct	1.09	1.11	110%	1.00	0.89	95%
Rb1_ppm	0.82	0.98	90%	0.89	1.12	101%
Sb1_ppm	0.97	1.00	99%		0.93	93%
Sc1_ppm	1.15	1.12	114%	1.01	0.85	93%
Se1_ppm						
Sm1_ppm	1.03	1.07	105%	1.02	1.02	102%
Ta1_ppm	1.14	1.00	107%	1.30	1.54	142%
Tb1_ppm	0.91	1.00	95%			
Th1_ppm	1.00	0.99	100%	0.96	0.99	97%
U1_ppm	0.91	0.91	91%	0.95	1.02	98%
W1_ppm		1.00	100%			
Yb1_ppm	0.90	0.86	88%	0.94	0.84	89%

Recoveries for the OREAS-46 and OREAS-47 standards of 95% or less were reported for As, Au, Cr, Fe, La, Sb, Sc, and Yb. Average recoveries within $\pm 5\%$ of 100% were reported for 8 out of 26 elements (Ce, Co, Eu, Na, Rb, Sm, Th and U). Six overestimations ($>105\%$) are shown for elements Ba, Cs, Hf, Lu, and Mo, with the greatest overestimation for Ta (142% of the recommended values).

Control charts for the ICP-OES analyses are shown in Appendix B. For the INAA analyses, TILL-1, TILL-2, TILL-3, OREAS-46 and OREAS-47 were each analyzed only once; therefore, it is not possible to create control charts. Instead, analyses of these standards are shown in Table 4, accompanied by the standards' expected (mean) values and upper and lower limits of acceptabil-

Table 4. Analyses of standards TILL-1, TILL-2, TILL-3, OREAS-46 and OREAS-47 used in INAA analyses. Those elements whose analyses were below the detection limit are shown as <DL. Analyses outside the two-standard deviation limit are denoted with a plus sign for overestimations, and a minus sign for underestimations

Element	TILL 1			TILL 2			TILL 3			OREAS 46			OREAS 47							
	m-2s	m	m+2s	m-2s	m	m+2s	m-2s	m	m+2s	m-2s	m	m+2s	m-2s	m	m+2s	Lab Number	Lab Number			
AsI	16	18	20	22	26	30	26	30	26	79	87	95	0.52	1.01	1.5	0.7	8.7	9.57	10.44	10
AuI	0.5	7	13	1	2	6	1	6	14	1	6	14	0	1.61	3.61	<DL	39.21	44.3	49.4	48
BaI	584	702	820	428	540	652	428	540	652	453	489	525	429.8	460.51	491.23	490	426.98	472.73	518.49	500
BrI	5.2	6.4	7.6	10	12.2	14.4	12	14.4	12	3.5	4.5	5.5	4							
CeI	59	71	83	84	98	112	84	98	112	32	42	52	31.95	37.25	42.54	40	48.41	56.24	64.08	55
CoI	14	18	22	10	12	14	10	12	14	11	15	19	8.44	9.93	11.41	11	47.08	52.14	57.2	50
CrI	53	65	77	58	74	90	58	74	90	95	123	151	56.44	66.29	76.13	62	90.96	113	135.05	99
CsI	0.6	1	1.4	0.8	10	12	10	12	14	0.9	1.7	2.5	0.54	0.62	0.7	0.8(+)	1.81	2.01	2.21	2.3(+)
EuI	0.3	1.3	2.3	1.4	0	1	0	1	2	0	1	2	0.81	0.88	0.95	1.0(+)	0.91	1.01	1.1	0.9
FeI	4.37	4.81	5.25	5	3.84	4.18	3.5	3.84	4.18	2.54	2.78	3.02	3.25	3.41	3.57	2.7(-)	3.39	3.57	3.75	2.6(-)
HfI	11	13	15	9	11	13	9	11	13	4	8	12	3.63	4.11	4.59	5	3.47	4.1	4.74	5
LaI	24	28	32	36	44	52	36	44	52	17	21	25	16.9	19.68	22.46	20	26.995	30.91	34.87	27
LuI	0.4	0.6	0.8	0.2	0.6	1	0.2	0.6	1	0	0.2	0.4	0.14	0.16	0.18	0.20(+)	0.14	0.16	0.18	0.16
Mol				10	14	18	10	14	18	17.9	1.95	2.12	2.48	2.59	2.69	2.6	10.35	12.71	15.08	14
NaI	1.86	2.01	2.16	1.37	1.62	1.87	1.37	1.62	1.87	41	55	69	30.27	33.54	36.81	30	2.48	2.57	2.66	2.30(-)
RbI	32	44	56	119	143	167	119	143	167	0.7	0.9	1.1	0.06	0.1	0.15	<DL	33.98	37.6	41.23	42(+)
SbI	6.8	7.8	8.8	0.6	0.8	1	0.6	0.8	1	8	10	12	8.24	9.17	10.09	9.3	0.26	0.32	0.39	0.3
ScI	9	13	17	10	12	14	10	12	14	2.7	3.3	3.9	2.95	3.33	3.71	3.4	8.23	9.27	10.31	7.9(-)
SmI	5.1	5.9	6.7	6.2	7.4	8.6	6.2	7.4	8.6	0.5	0.7	0.9	0.13	0.31	0.48	0.4	3.73	4.01	4.28	4.1
TaI	0.5	0.7	0.9	0.8	1.5	1.9	0.8	1.5	1.9	0.5	0.7	0.9	0.32	0.36	0.4	<DL	0.26	0.46	0.65	0.70(+)
TbI	0.7	1.1	1.5	0.8	1.2	1.6	0.8	1.2	1.6	0.7	1.1	1.5	0.32	0.36	0.4	<DL	0.35	0.39	0.42	0.25(-)
ThI	4.5	5.5	6.5	15.6	18.4	21.2	15.6	18.4	21.2	3.8	4.6	5.4	2.73	3.23	3.72	3.1	3.43	3.84	4.25	3.8
UI	1.6	2.2	2.8	4.9	5.7	6.5	4.9	5.7	6.5	1.7	2.1	2.5	0.67	0.74	0.81	0.7	0.71	0.79	0.86	0.8
WI				3	5	7	3	5	7	1.1	1.5	1.9	0.96	1.07	1.17	1	0.96	1.08	1.19	0.9(-)
YbI	3.1	3.9	4.7	2.7	3.7	4.7	2.7	3.7	4.7	182	230	278	135.02	159.13	183.24	<DL	136.02	161.12	186.21	<DL
ZrI	386	502	618	312	390	468	312	390	468	182	230	278	135.02	159.13	183.24	<DL	136.02	161.12	186.21	<DL

ity (mean plus and minus two standard deviations), that would be used to create control charts if there were more standard analyses.

PRECISION

The overall precision of the field and analytical duplicates is shown in Table 5 and summarized in bar-chart form in Figure 2. Although it gives an indication of the elements whose analyses are relatively precise, and relatively imprecise, this single parameter does not take into account

Table 5. Overall analytical and field precision

Element	Precision (95% C.L)		Element	Precision (95% C.L)	
	Analytical	Field		Analytical	Field
Al2	2.3	5.8	Mg2	3.6	6.9
As1	9.3	30.1	Mn2	1.4	19.3
As2		47.2	Mo1		
Au1	178.4	141.7	Mo2		
Ba1	11.6	11.4	Na1	11.9	19.0
Ba2	1.8	6.6	Na2	3.4	2.6
Be2	4.1	10.8	Nb2	13.8	17.2
Br1	4.9	65.8	Ni2	3.1	12.5
Ca2	1.7	26.8	P2	2.1	62.7
Cd2	66.7		Pb2		12.9
Ce1	16.9	21.1	Rb1	9.5	8.5
Ce2	6.5	23.4	Rb2	2.2	11.4
Co1	27.6	26.8	S2	74.6	
Co2	5.7	17.7	Sb1	21.3	27.5
Cr1	21.1	15.1	Sc1	11.8	18.6
Cr2	1.4	4.4	Se2	3.6	8.0
Cs1	5.8	12.0	Sm1	4.5	31.7
Cu2	3.0	24.7	Sr2	3.4	5.9
Dy2	3.7	25.8	Ta1	14.4	21.2
Eu1	110.4	59.7	Tb1	10.4	18.8
Fe1	12.3	15.1	Th1	3.0	23.2
Fe2	3.2	13.5	Ti2	2.7	21.1
Hf1	14.8	35.6	U1	7.5	16.0
K2	2.2	6.0	V2	2.5	13.4
La1	8.0	27.9	W1	40.0	40.0
La2	7.3	25.0	Y2	5.9	24.7
Li2	3.1	12.9	Yb1	23.6	45.5
LOI	3.8	35.4	Zn2	2.0	10.0
Lu1	7.8	34.1	Zr2	2.3	16.7

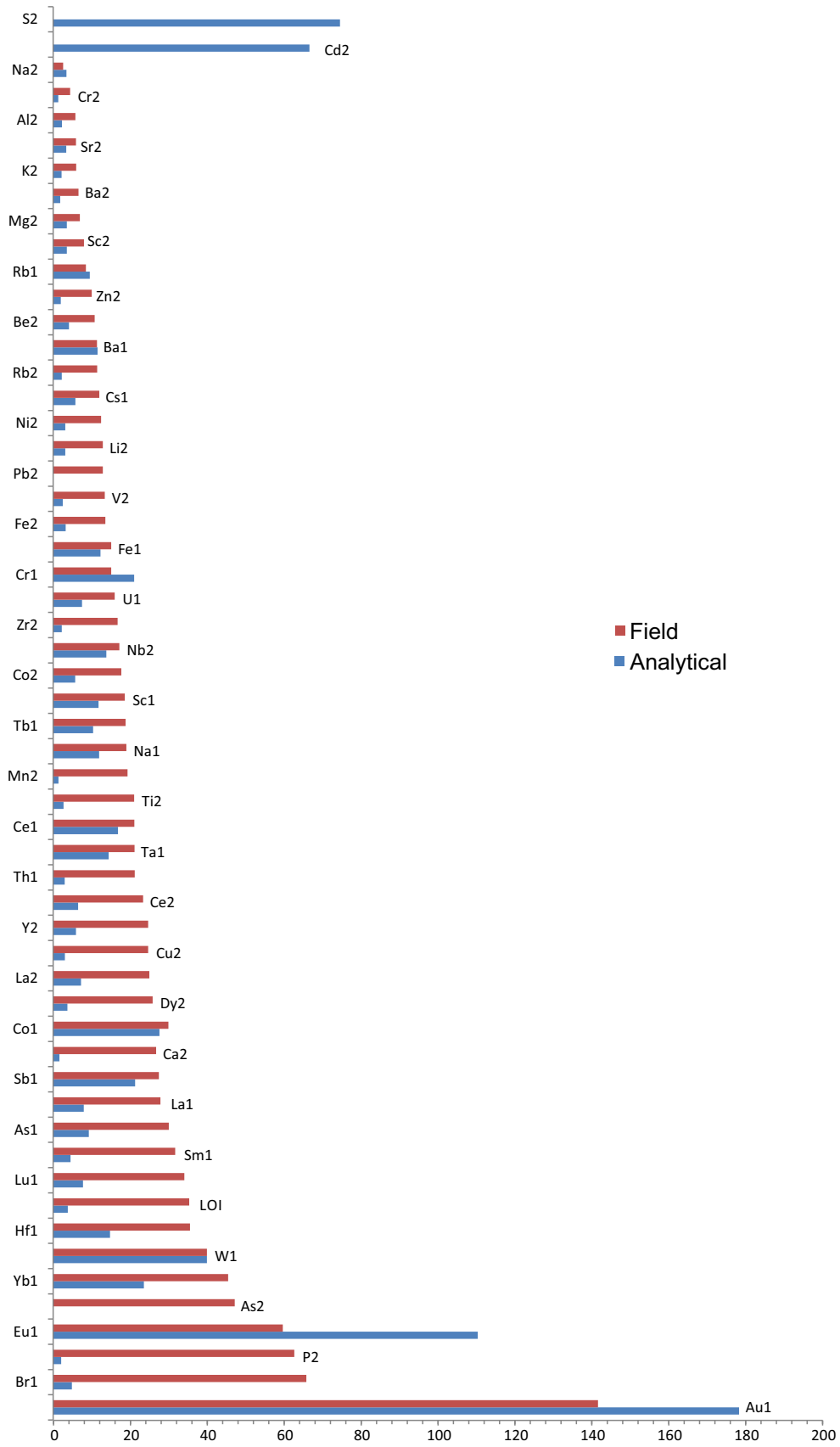


Figure 2. Bar chart summarizing precision of field and analytical duplicates.

the variability of precision with concentration level. Therefore, results of analytical and field duplicates for all elements are displayed graphically in Appendix C as precision (Thompson and Howarth, 1978). Figures 3 and 4 show examples where the elements' repeatability in field duplicates varies conspicuously from the repeatability in analytical duplicates (Sm by INAA and Mn by ICP-OES), and where it does not (Cr by INAA and Sr by ICP-OES).

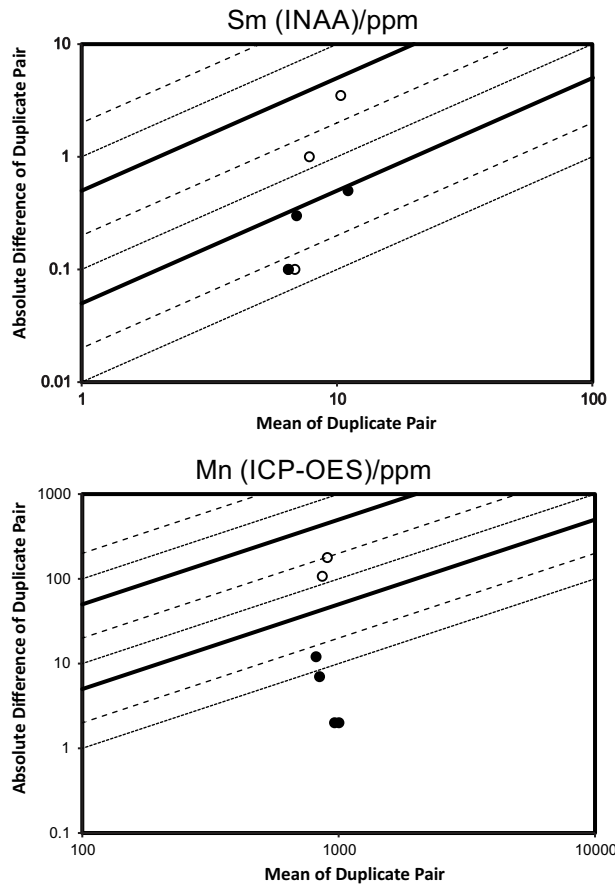


Figure 3. Thompson-Howarth precision plots for field and analytical duplicates of Sm (INAA analyses) and Mn (ICP-OES analyses): examples of elements whose field variability significantly exceeds its analytical variability. In these precision plots, the mean of each pair of duplicates is plotted against their absolute difference; both axes are scaled logarithmically. A series of parallel lines indicates precision of gradually increasing absolute value, from $\pm 1\%$ to $\pm 200\%$. Field duplicates are denoted by open circles, and analytical duplicates by closed circles; the absolute value of the precision for the former is invariably greater (i.e., the reproducibility is worse).

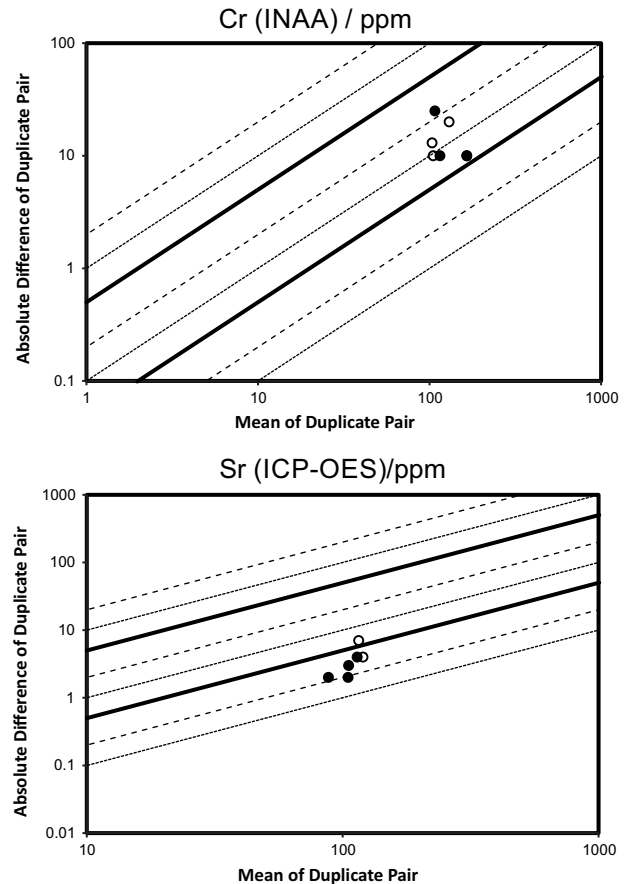


Figure 4. Thompson-Howarth precision plots for field and analytical duplicates of Cr (INAA analyses) and Sr (ICP-OES analyses): examples of elements whose field variability does not significantly exceed its analytical variability.

DISPLAY OF DATA

Preliminary geochemical-symbol maps for 15 elements are shown in Appendix D. Two important points should be kept in mind when viewing these maps: 1) Sampling has only been completed in the northern half of the study area, adjacent to passable roadways, the southern half of the study area along with infill sampling will be completed during the next field season; 2) ICP-OES analysis of the samples that were collected is incomplete, as 64 samples require re-analysis.

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APPENDICES A–D

Appendix A is available as a digital comma-separated file (.csv) and Appendices B–D are available as pdf files through [this link](#).

Appendix A: Till Geochemistry, 2019

Suffixes used after element symbol name are described below:

1. INAA
2. ICP-OES after multi-acid (HF/HCl/HNO₃/HClO₄) digestion
6. ICP-OES after nitric acid digestion
9. ISE after alkaline fusion

Units

- Al₂, Ca₂, Fe₁, Fe₂, K₂, LOI, Mg₂, Na₁, Na₂ in weight percent (pct).
- Ag₆, As₁, As₂, Ba₁, Ba₂, Be₂, Br₂, Cd₂, Ce₁, Ce₂, Co₁, Co₂, Cr₁, Cr₂, Cs₁, Cu₂, Dy₂, Eu₁, F₉, Hf₁, La₁, La₂, Li₁, Li₂, Lu₁ Mn₂, Mo₁, Mo₂, Nb₂, Ni₂, P₂, Pb₂, Rb₁, Rb₂, S₂, Sb₁, Sc₁, Sc₂, Se₁, Sm₁, Sr₂, Ta₁, Tb₁, Th₁, Ti₂, U₁, V₂, W₁, Y₂, Yb₁, Zn₂ and Zr₂ in parts per million (ppm).
- Au₁ in parts per billion (ppb).

Detection limits in the database are replaced by a value that is ½ of the detection limit.

Appendix B: Control Charts

Appendix C: Thompson-Howarth Precision Plots of Field and Analytical Duplicates

Appendix D: Geochemical-symbol Maps