YMEP 19-051

SEAGULL BATHOLITH GEOCHEMISTRY

T. Liverton

December 2020

YMEP 19-051 SEAGULL GRANITE

INTRODUCTION

The YMEP grant was provided to enable analytical work that would complete the ongoing investigation of chemistry and metallogeny of the Seagull batholith. A helicopter sampling programme carried out with Charlie Roots in 2011 covered a wide area of easily accessible rock exposure (Fig. 1). Whole-rock analyses were obtained from this material and the remaining material stored for later mineral separation and mica analysis.

GEOLOGY

The mid Cretaceous Seagull batholith has the largest number of peripheral tin prospects known in the Yukon. The Seagull batholith, Hake batholith, Thirtymile stock and Ork stock are a distinctive suite of one-mica granites with the chemistry of A-type intrusions. All are distinctive in their enrichment in boron and fluorine and contain fluorite, topaz and tourmaline as accessory minerals. The Seagull batholith has Sn ± tantalite-columbite mineralization as sheeted vein, greisen and skarn mineralization.

CURRENT WORK: METHODS

It was the intention to complete the analytical work with complete analyses of biotite mica from the granite. The rock specimens, which had previously been sawn to remove weathering 'rinds' were reduced to approximately < 5mm size in a jaw crusher. Repeated passes through a 7" roller mill produced sand-sized material. This was seived to produce size fractions between -35 and 100 mesh. The fractions were passed through a Frantz-type magnetic separator to produce rough mica concentrates. These were cleaned up by repeated careful magnetic separation. Five specimens (three size fractions each) were resistant to complete separation. These were concentrated using heavy liquid. Sodium polytungstate solution was made up to the apppropriate specific gravity and the micas collected in a separating funnel. Repeated washing in an ultrasonic bath with distilled water produced the final separate.

Analyses required were a complete silicate analysis including Li, Fe^{2+}, F, Cl and H_2O^+. Because of limited sample size it was necessary to choose the laboratory that could be sufficiently parsimonious with the material. ALS Vancouver used their procedures: Fe VOL05: HF digestion followed by the Wilson titration method for fluorine; Cl-IC861: KOH fusion followed by ion chromatography; F-IC861, KOH fusion and ion chromatography for F, with F-ELE 82 for over-limit values and OAIR06: H_2O^+ by LECO furnace.

The fusion / ICPMS programme of ALS called for too great a weight of material. Bureau Veritas in Perth, Western Australia offer a fusion / LA-ICPMS technique that can deal with smaller samples, so they produced the major and trace element results as well as three acid digestion and ICPAES for lithium.

RESULTS

A table of the combined analyses is given below. The interpretation of the whole-rock and mica analyses will be presented in a paper, the first draft of which has been written, but some results are as follows. The micas are particularly Fe-rich (Mg/Fe = 0.0101 – 0.0383), which is typical for A-type granites. The ratio of [Fe^{2+} / Fe*] i.e., ferrous to total iron, is between 0.706 and 0.944. This indicates that this is a moderately to highly reduced granite. Lower values are likely a consequence of slight alteration. The halogen and combined water values obtained enable relative fugacities for the magma to be estimated. The ratios of log [fHCl / fHF] obtained are comparable with those reported for the tin granites of the Erzegebirge. Here fractionation is indicated by decreasing [Mg/ (Mg+Fe)] ratio in the mica. One obvious trend is increase in Cl activity relative to F with fractionation, a parameter indicating promotion of tin transport in the hydrothermal phase.

DISCUSSION

The Seagull batholith is identified as an A-type granite whose presently exposed lithofacies are enriched in F and B. These elements would have allowed the solidus temperature of the magma to have been reduced to perhaps 650°C, with time for protracted action between hydrothermal fluids and magma, resulting in extraction of high field strength elements into the fluid phase. Hydrothermal fluids would then have been able to produce the Sn ± Ta-Nb mineralization found in the periphery of the intrusion. Further (ongoing) interpretation of the analyses might be able to identify the regions of the batholith that show increased potential for such mineralization. The presence of the JC prospect above a buried apophysis of the batholith and the small just-exposed stocks including the STQ, to the east indicate that the the 'roof' of the batholith is shallow-dipping and further mineralization could occur in the aureole.

FOLLOWING ILLUSTRATIONS:

Table 1. Analyses of Seagull micas.

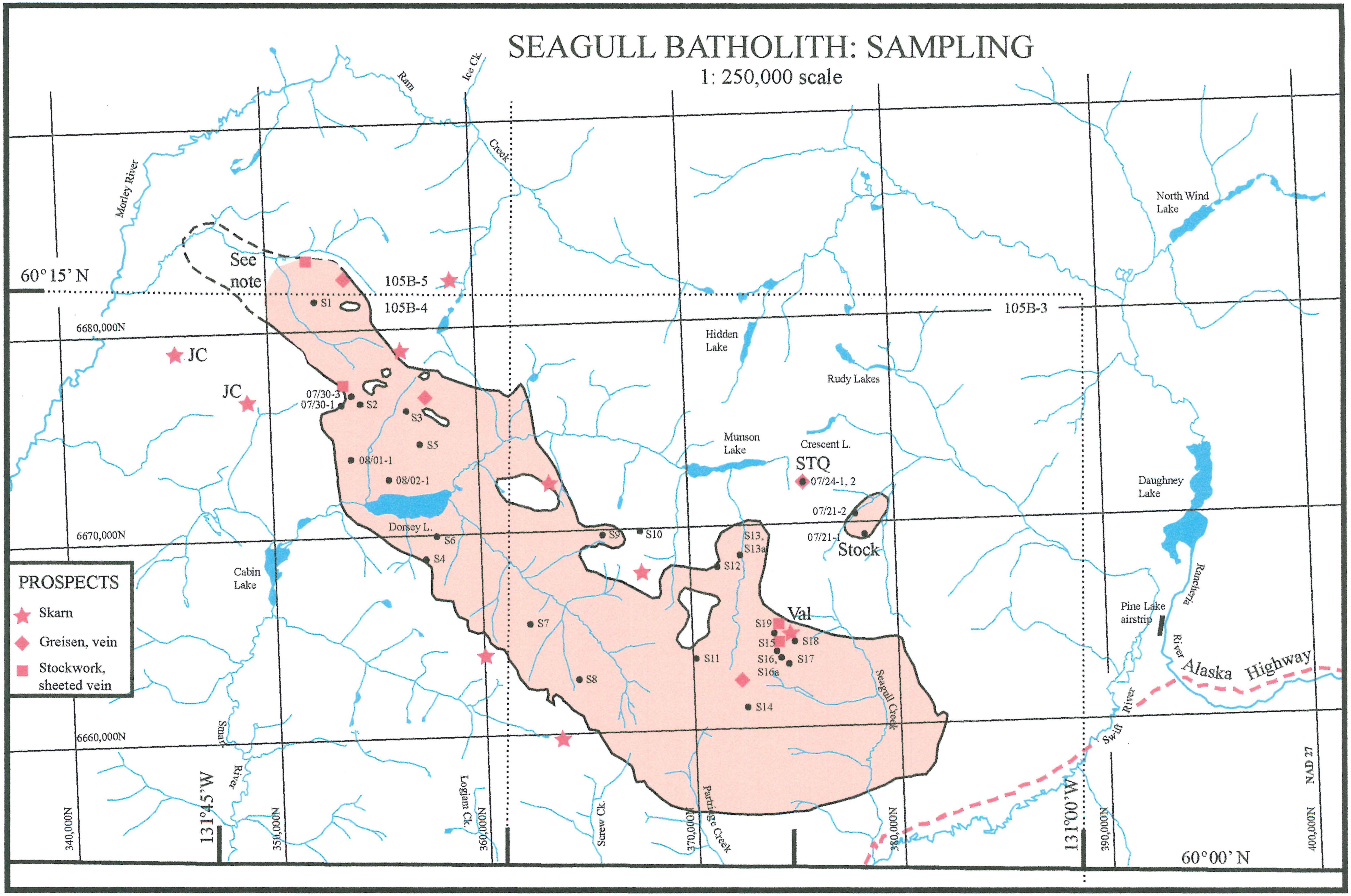
Fig. 1. Sampling of the batholith. Five-figure sample numbers are for original 1992 sampling. Note that the NW extension of the batholith as shown in GSC mapping does not exist: it is a result of 'telescopic geology'. The ridges to the NW are of metamorphics with large roches moutonées of granite on their crests.

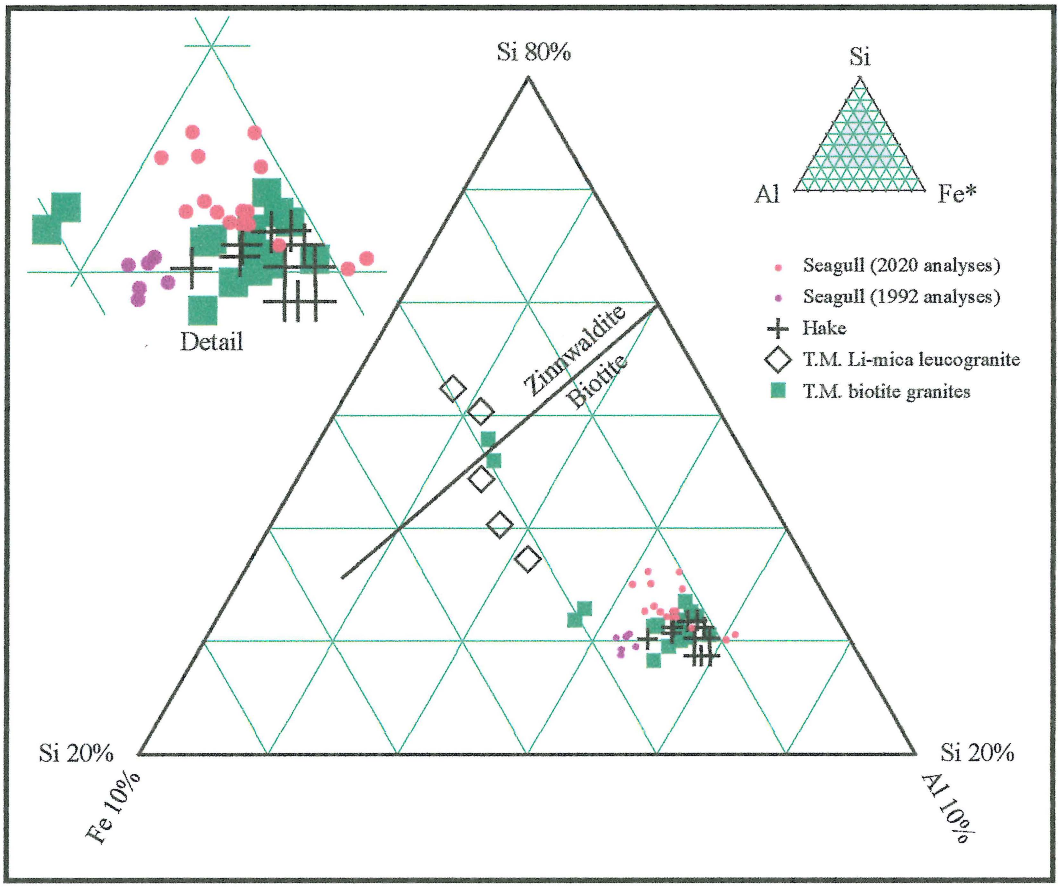
Fig. 2. Compositions of the Seagull and Thirtymile micas. The current work plus results of the 1992 work are shown.

Figs. 3 & 4. Relative fugacity ratios for the Seagull magma.

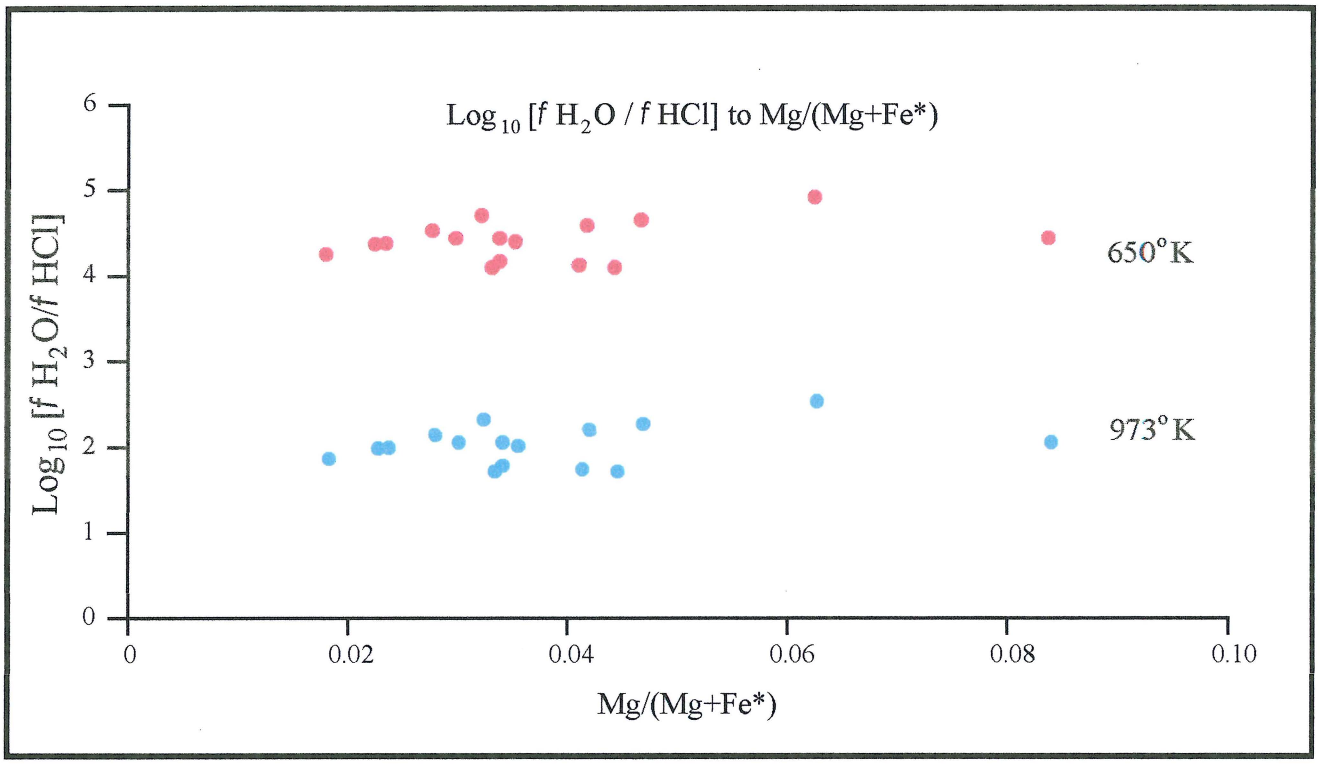
L/facies	mega	por	mega	mega	mega	mega	mega	mega
Specimen	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**
SiO2	36.39	39.92	40.17	37.05	37.81	40.33	41.71	41.71
Al2O3	14.78	18.83	15.90	17.52	18.18	15.04	17.23	18.31
TiO2	3.12	2.51	2.78	2.35	2.53	3.28	2.06	2.58
Fe2O3	9.72	2.18	2.27	3.72	4.46	2.66	3.32	5.99
FeO	21.00	20.50	23.10	22.40	20.50	21.30	19.85	18.60
MnO	0.28	0.20	0.22	0.19	0.25	0.27	0.24	0.23
MgO	1.34	0.89	1.50	1.43	1.16	2.80	1.01	1.52
CaO	0.05	0.07	0.22	0.11	0.18	0.62	0.41	0.27
Na2O	0.19	0.30	0.59	0.19	0.27	0.54	0.58	0.29
K2O	7.60	8.38	7.77	8.64	8.21	6.69	7.71	8.05
Rb2O	0.18	0.25	0.17	0.23	0.21	0.10	0.23	0.20
Li2O	0.32	0.70	0.29	0.64	0.45	0.13	0.52	0.48
Cs (ppm)	119	113	109	125	100		155	116
P2O5	0.04	0.04	0.09	0.05	0.12		0.15	0.29
Cl	0.43	0.22	0.41	0.29	0.29	0.22	0.23	0.17
F	1.13	1.99	1.38	1.87	1.33	1.01	1.65	1.55
H2O+	2.28	2.14	1.88	1.40	2.44	2.63	1.96	2.75
Total	98.85	99.12	98.73	98.09	98.38	97.61	98.85	102.98
F,Cl=O	0.57	0.89	0.67	0.85	0.62	0.47	0.74	0.69
Total	98.28	98.23	98.06	97.24	97.75	97.14	98.11	102.29
FORMULA IONS								
Si	5.94	5.49	6.57	6.44	6.10	6.28	5.23	6.34
Al (IV)	2.07	2.51	1.43	1.56	1.90	1.72	2.77	1.66
Al (VI)	0.78	0.00	1.64	2.04	1.55	1.04	0.12	1.61
Ti	0.38	0.26	0.34	0.31	0.31	0.38	0.26	0.29
Fe (3)	1.19	0.15	0.28	0.49	0.54	0.31	0.56	0.68
Fe (2)	2.86	4.71	3.16	3.26	2.76	2.77	4.98	2.36
Mn	0.04	0.05	0.03	0.03	0.03	0.04	0.06	0.03
Mg	0.33	0.36	0.37	0.37	0.28	0.65	0.25	0.34
Li	0.22	0.77	0.19	0.45	0.29	0.08	0.26	0.29
Ca	0.01	0.02	0.04	0.02	0.03	0.10	0.10	0.04
Na	0.06	0.16	0.19	0.06	0.08	0.16	0.29	0.09
K	1.58	2.94	1.62	1.92	1.69	1.33	3.87	1.56
Rb	0.02	0.04	0.02	0.03	0.02	0.01	0.11	0.02
F	0.58	1.73	0.71	1.03	0.68	0.49	0.41	0.74
Cl	0.12	0.10	0.11	0.09	0.08	0.06	0.06	0.04
OH	2.48	3.92	2.05	1.62	2.62	2.73	0.98	2.79

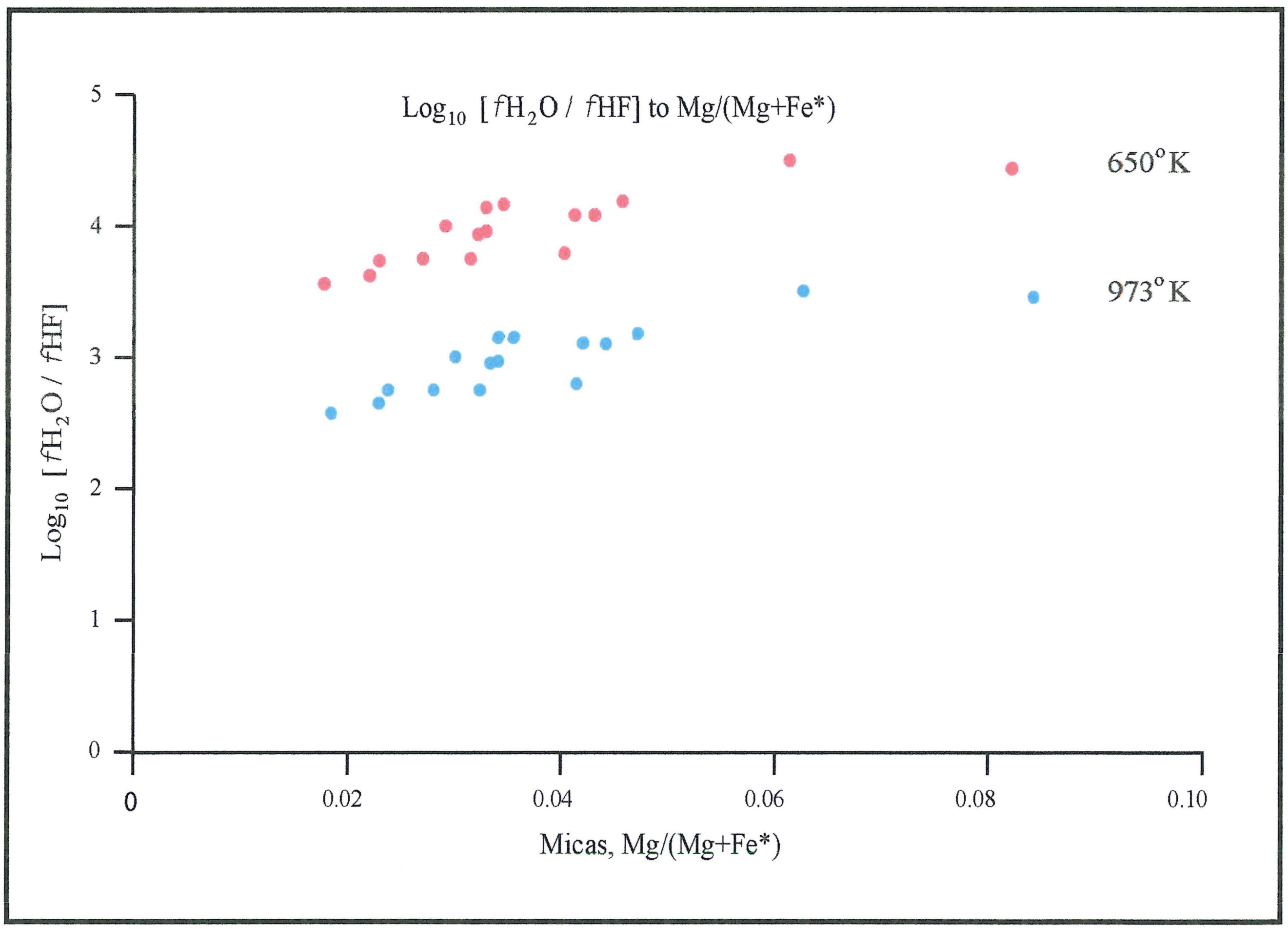
	mega S9	por S10	fine-gr S11	fine-gr S12	mega S13A	mega S14	fine gr S15	mega S17
SiO2	35.83	37.07	38.40	37.44	37.81	37.35	38.65	35.80
Al2O3	17.13	17.68	18.61	19.30	17.52	18.24	17.90	15.70
TiO2	2.59	2.67	2.01	2.07	2.31	2.17	1.96	2.55
Fe2O3	6.17	2.74	1.51	3.98	2.43	2.83	1.88	2.34
FeO	21.20	23.10	22.90	20.30	23.60	22.80	24.10	27.50
MnO	0.23	0.24	0.20	0.22	0.24	0.20	0.21	0.19
MgO	1.51	2.20	0.73	1.03	0.95	0.79	0.62	1.34
CaO	0.30	0.61	0.10	0.09	0.18	0.11	0.13	0.34
Na2O	0.24	0.40	0.23	0.40	0.24	0.20	0.35	0.21
K2O	7.69	6.08	9.04	8.24	8.61	8.88	8.96	6.62
Rb2O	0.25	0.13	0.37	0.30	0.28	0.36	0.34	0.18
Li2O	0.59	0.44	0.79	0.67	0.63	0.72	0.70	0.48
Cs (ppm)	184	126	343	282	146	182	150	82
P2O5	0.22	0.40	0.01	0.05	0.06	0.02	0.02	0.04
Cl	0.20	0.12	0.19	0.11	0.15	0.22	0.22	0.33
F	1.80	1.05	2.59	2.36	2.30	2.33	2.60	1.96
H2O+	2.73	3.87	1.49	1.81	1.63	1.69	1.25	3.18
Total	98.66	98.80	99.17	98.36	98.93	98.91	99.90	98.76
F,Cl=O	0.80	0.47	1.13	0.57	1.00	1.03	1.14	0.90
Total	97.86	97.86	98.04	98.28	97.93	97.88	98.75	97.86
FORMULA IONS								
Si	6.03	5.68	6.92	5.27	6.69	6.64	7.01	6.20
Al (IV)	1.97	2.32	1.08	2.73	1.31	1.36	0.99	1.80
Al (VI)	1.42	0.88	2.87	0.48	2.35	2.46	2.83	1.40
Ti	0.33	0.31	0.27	0.22	0.31	0.29	0.27	0.33
Fe (3)	0.78	0.32	0.20	0.42	0.32	0.38	0.26	0.30
Fe (2)	2.98	2.96	3.45	2.39	3.49	3.39	3.65	3.98
Mn	0.03	0.03	0.03	0.03	0.04	0.03	0.03	0.03
Mg	0.38	0.50	0.20	0.22	0.25	0.21	0.17	0.35
Li	0.40	0.27	0.57	0.38	0.45	0.51	0.51	0.33
Ca	0.05	0.10	0.02	0.01	0.03	0.02	0.03	0.06
Na	0.08	0.12	0.08	0.11	0.08	0.07	0.12	0.07
K	1.65	1.19	2.08	1.48	1.94	2.01	2.07	1.46
Rb	0.03	0.01	0.04	0.03	0.03	0.04	0.04	0.02
F	0.95	0.51	1.48	1.05	1.29	1.31	1.49	1.07
Cl	0.06	0.03	0.06	0.03	0.04	0.07	0.07	0.10
OH	3.06	3.96	1.79	1.70	1.92	2.00	1.51	3.67

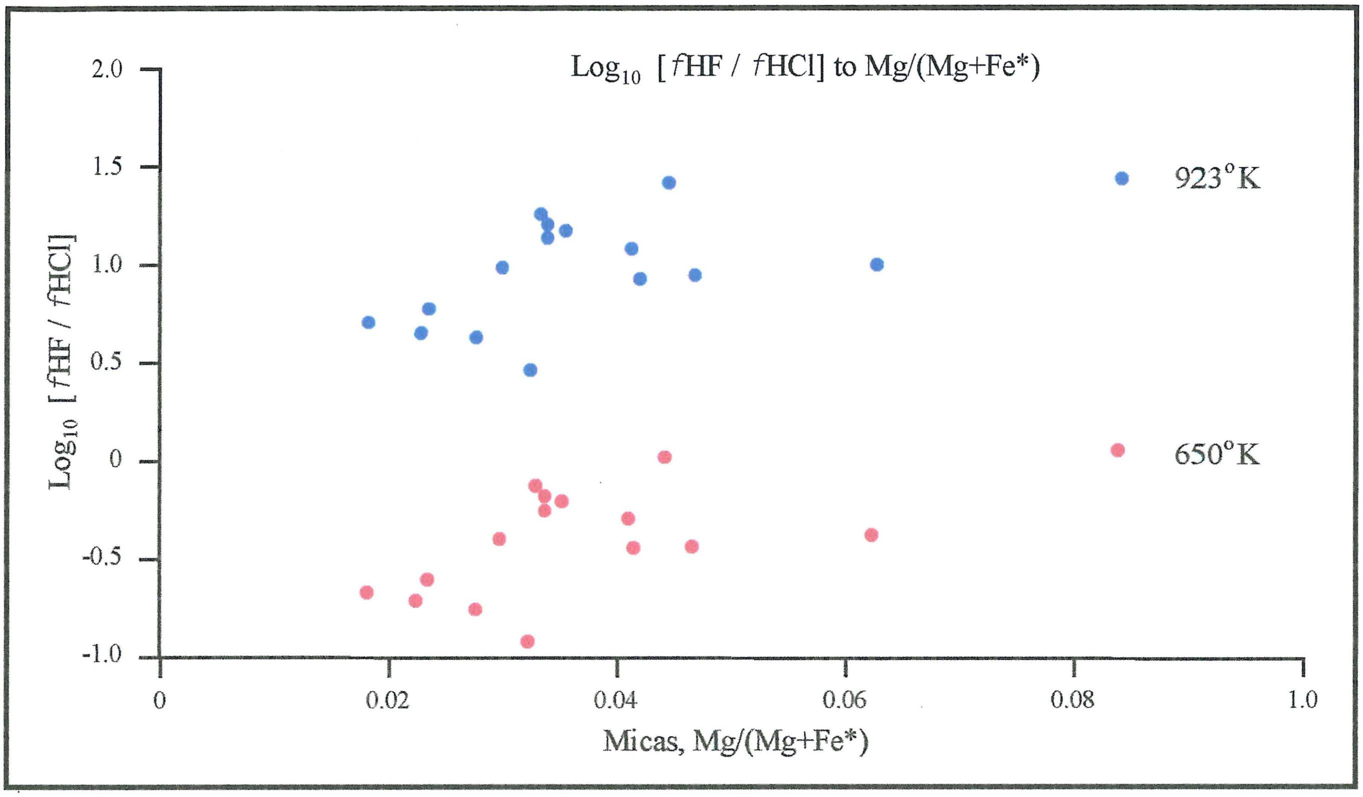

SEAGULL BATHOLITH: SAMPLING
1: 250,000 scale
PROSPECTS
Skarn
Greisen, vein
Stockwork, sheeted vein
60° 15' N
60° 00' N
131°45'W
131°00'W
NAD 27
6680,000N
6670,000N
6660,000N
340,000N
350,000N
360,000N
370,000N
380,000N
390,000N
400,000N
105B-5
105B-4
105B-3
See note
JC
JC
STQ
Val
Stock
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13, S13a
S14
S15
S16, S16a
S17
S18
S19
07/30-3
07/30-1
08/01-1
08/02-1
07/24-1, 2
07/21-2
07/21-1
Morley River
Ram
Ice Ck.
Creek
Hidden Lake
Rudy Lakes
Munson Lake
Crescent L.
North Wind Lake
Daughney Lake
Dorsey L.
Cabin Lake
Smart River
Logjam Ck.
Screw Ck.
Partridge Creek
Seagull Creek
Pine Lake airstrip
Rancheria River
Swift River
Alaska Highway



Micas: atomic proportions of Si, Fe* and Al


Log10 [f H2O / f HCl] to Mg/(Mg+Fe*)
Log10 [f H2O/f HCl]
Mg/(Mg+Fe*)
650°K
973°K
0
1
2
3
4
5
6
0
0.02
0.04
0.06
0.08
0.10


Log10 [fH2O / fHF] to Mg/(Mg+Fe*)
Log10 [fH2O / fHF]
Micas, Mg/(Mg+Fe*)
650°K
973°K
0
1
2
3
4
5
0
0.02
0.04
0.06
0.08
0.10


Log10 [fHF / fHCl] to Mg/(Mg+Fe*)
923°K
650°K
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Log10 [fHF / fHCl]
0
0.02
0.04
0.06
0.08
1.0
Micas, Mg/(Mg+Fe*)

YMEP PROJECT 19-051 SEAGULL BATHOLITH: EXPENSES

Date	**Company**	**Item**	**Amount**
3rd Jan	Fisher Scientific	Glassware	269.44
4th Feb	Geoliquids	Polytungstate	822.34
4th Mar	Westlabs	Glassware	170.00
22nd May	Westlabs	Glassware	189.95
26th May	Fisher Scientific		91.52
23rd Mar	ALS	Analysis	1625.51
6th Apr	Bureau Veritas	Analysis	698.41
10th Jun	Bureau Veritas	Analysis	382.53
	Report preparation		500.00
	TOTAL		4749.70

Timothy Liverton

7th January 2021