GM 71807

2019-2020 works, Lac Baude (rare earths)

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LAC BAUDE (RARE EARTHS)

2019-2020 WORKS

S.N.R.C: 31P/03

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SUMMARY

The Lac Baude property is 100% owned by Fancamp exploration Ltd. It is located about 70 km to the NNW of the city of Shawinigan in Mauricie Quebec. In 2017, Fancamp Exploration Ltd was looking for rare earth element (REE) showings nested in pegmatites. The Grenville province was targeted primarily because it is relatively little explored for its potential in rare earths.

The region in question hosts allanite mineralization within granitic pegmatite. Prospecting work revealed the significant presence of certain rare earth elements and more particularly the oxides of neodymium and praseodymium. Large crystals of allanite have been found in a pegmatite that measure up to 15 X 10 X 4cm. They can occupy more than 35% of the volume of the rock.

This property is easily accessible by new forest roads that cross the Saint-Maurice wildlife reserve.

The results of various studies clearly show the good rare earth potential of the Lac Baude property. Both gravity and hydrometallurgical surveys have shown that the recovery of allanite in the pegmatite is optimal. The acid wash test at 20°C on Lac Baude ore can extract significant percentage of REEs. An acid leaching at 60°C can extract more than 90 % of the REEs from Lac Baude Ore.

We indicate in the appendix 1 the preliminary results of the 4 particle size fractions processed on the Mosley table carried out in 2019 in Corem laboratories in Quebec. Although the concentrate grades are rather low, the recoveries are very interesting (87 to 93%) on three particle size fractions.

The preliminary maximum grades (samples 787952 and 63491) recorded indicate that the Lac Baude Showing is economical ranging from 1500US $ to 2000US $. We now know that there are very rich zones concentrated in massive allanite stringers in the pegmatite. The drilling will tell us how many and what dimensions these enriched zones may be present in the host rock. Above all, he will tell us that it is the average grade of REE in the pegmatite to estimate an economic resource.

OWNERSHIP, LOCATION AND ACCESS:

The Lac Baude property is located 75 km north-northwest of the city of Shawinigan in Mauricie. To reach the property you have to take Highway 55 towards La Tuque (figure 1). From Shawinigan, we drive 11.7 km north to a roundabout. Take the 2nd exit towards Qc 155N towards La Tuque. We travel 45.8 km to Rivière Matawin. Shortly after this town, we take a bridge on the left to cross the Saint-Maurice river. The Matawin reception post of the Saint-Maurice wildlife reserve, which is on the west shore, asks us to stop before paying for a right of way to travel in the reserve. After crossing the post, follow the signs to get to the reception area of Lac Normand located 47.5 km northwest of the Matawin post. From Lac Normand, take the directions to get to Lac Baude. You can also take a forest road south of Lac Normand to access the property's land (Figures 1 and 2).

Figure 1: Lac Baude Property Location

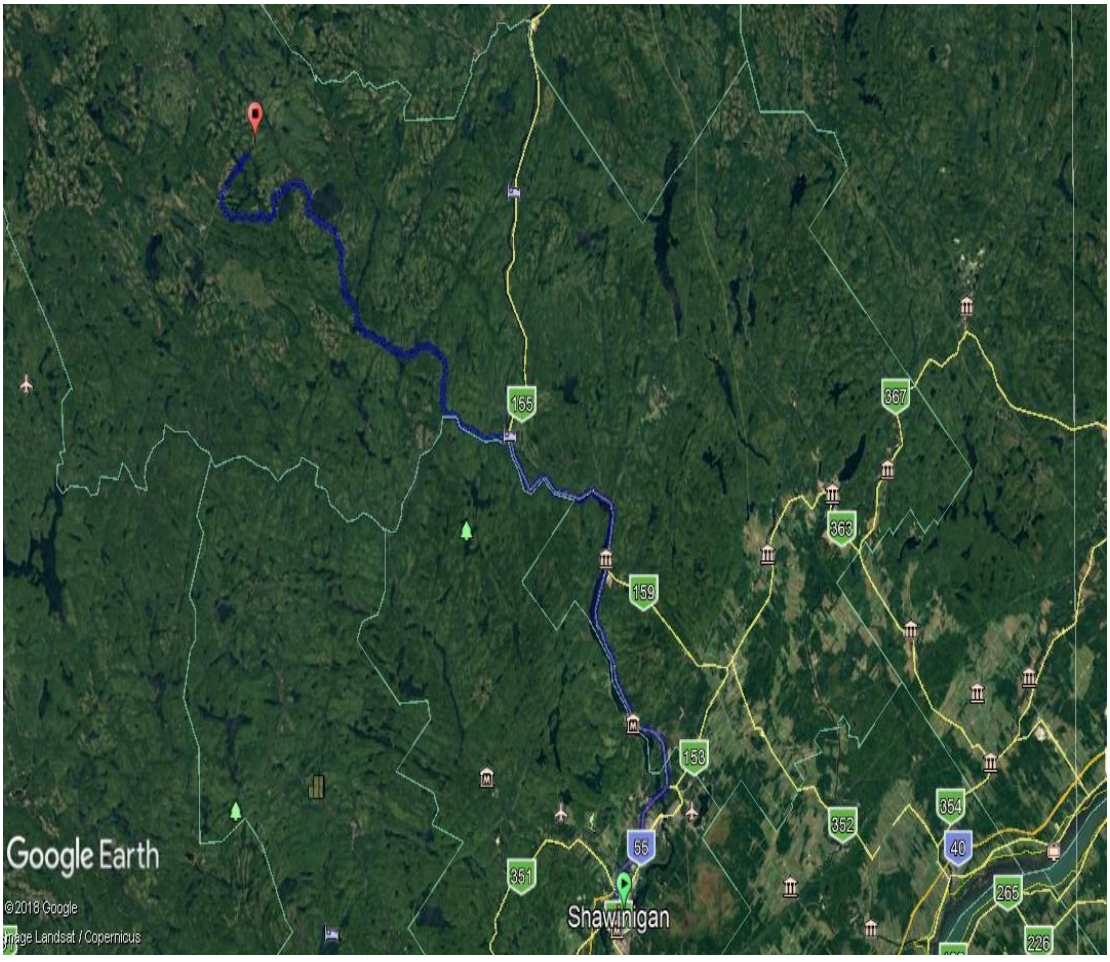
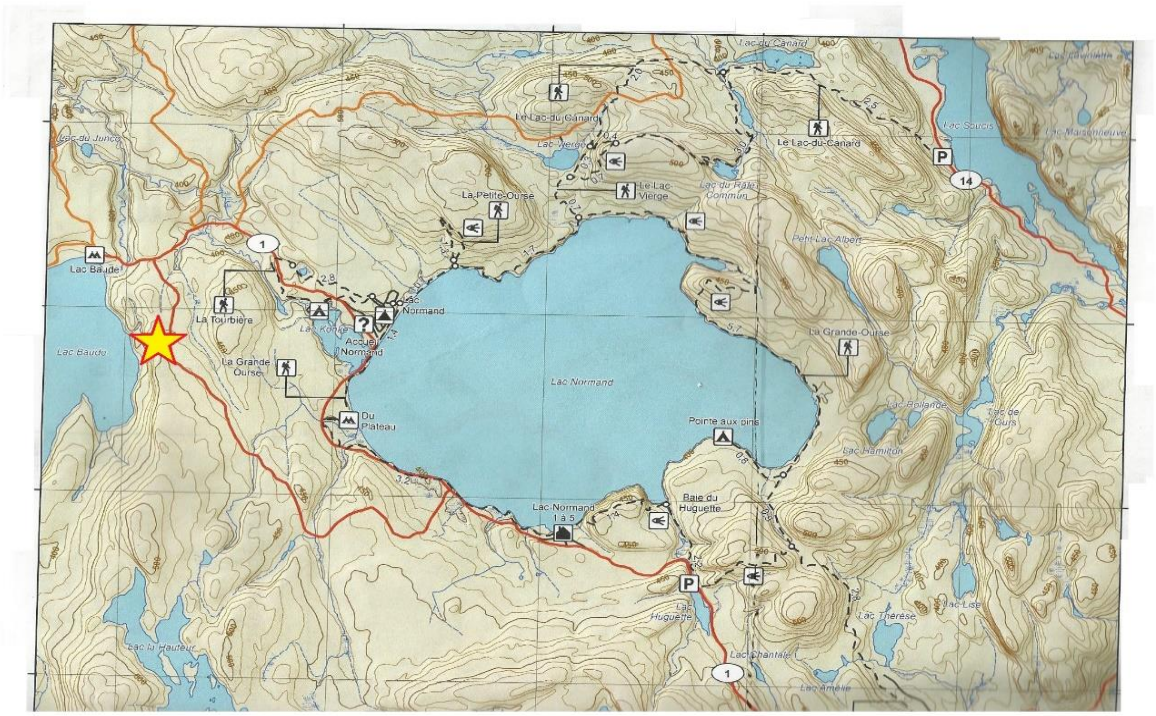


Figure 2: Lac Baude Area



MINING TITLES

The Lac Baude property covers an area of 820 hectares including 14 mining titles which are all contiguous. These claims are located in the Mékinac region and in the Normand township (figure 3) The property is included in the 31P / 03 sheet and was acquired by Fancamp Exploration Ltd at the beginning of 2017. Table 1 informs us on the status of the mining titles and shows the amount of work required of $ 1200 for each of these claims and for a total of 15,600$.

Figure 3: Claim Map

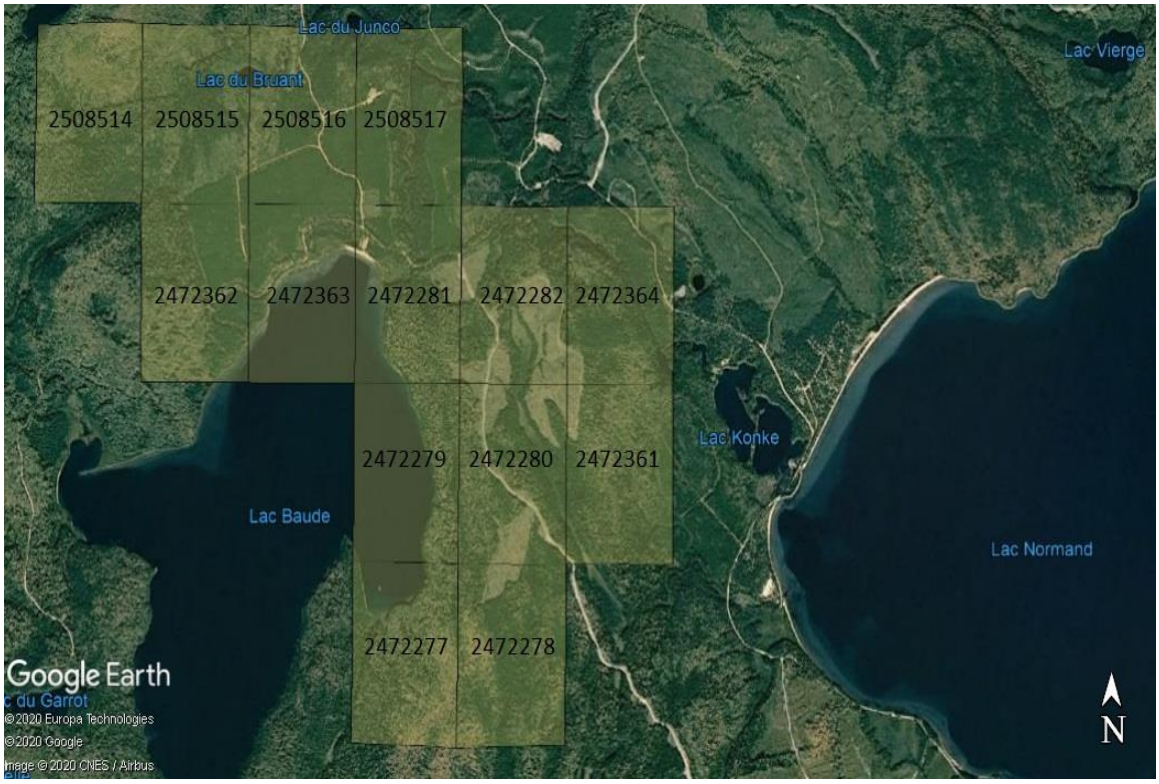


Table 1 : Title Number List

NTS Sheet	Area	Title No	Expiration Date	Excess Work	Required Work
NTS 31P03	58,62	2472277	2022-01-08 23:59	0	1200
NTS 31P03	58,62	2472278	2022-01-08 23:59	0	1200
NTS 31P03	58,61	2472279	2022-01-08 23:59	2960	1200
NTS 31P03	58,61	2472280	2022-01-08 23:59	2445	1200
NTS 31P03	58,6	2472281	2022-01-08 23:59	2445	1200
NTS 31P03	58,6	2472282	2022-01-08 23:59	0	1200
NTS 31P03	58,61	2472361	2022-01-08 23:59	0	1200
NTS 31P03	58,6	2472362	2022-01-08 23:59	0	1200
NTS 31P03	58,6	2472363	2022-01-08 23:59	0	1200
NTS 31P03	58,6	2472364	2022-01-08 23:59	0	1200
NTS 31P03	58,59	2508514	2023-01-09 23:59	0	1200
NTS 31P03	58,59	2508515	2023-01-09 23:59	0	1200
NTS 31P03	58,59	2508516	2023-01-09 23:59	0	1200
NTS 31P03	58,59	2508517	2023-01-09 23:59	0	1200
TOTAL	**820,43**			**7850$**	**15600$**

PREVIOUS WORKS

The Lac Baude Rare-Earth Showing was discovered in 1893 during regional mapping by the Geological Survey of Canada. This discovery was attributed to N.J. Giroux of the GSC, who mapped this region between the years 1891 and 1893. The report presented by R.W. Ells describes this Showing as follows:

N*ear the north end of the lake* (Lac Baude) *there is a cliff about 150 feet high, the base of which consists of a very coarse granite. The rock is reddish and holds much magnetic iron in grains. This tarnishes to a purple. The reddish granite contains also the rather rare mineral allanite, over somewhat large areas, to the extent of thirty-five percent of the mass. The allanite crystals are of unusually large size. The containing granite, which has the aspect of an eruptive mass, is overlain by bands of hornblende-gneiss which are separated by layers of reddish quartz and feldspar rock.*"

In 1919, GSC geologist R. Harvie described this area as:

"*Book-like masses of allanite with crystals up to 6" X 4" X 1 1/2". "Tabular crystals of allanite are scattered through the granite of the cliff face", "3 inches in length being common".*
"*Prominent radiating fractures around larger crystals...assist in identifying the allanite and in extracting the mineral from the rock*". *"90 lbs of the mineral were collected from the cliff face and talus pile".*

At that time, access was difficult to access, and only by canoe. You have to take different lakes, rivers and take several portages. The initial discovery is located about 150 meters from the eastern shore of Lake Baude. There are many boulders piled up along an embankment and at the foot of a steep cliff more than 15 meters high.

Other information on this clue comes from letters written by R. Harvie in the year 1919 and is addressed to A.O. Dufresne, head of the Quebec Department of Mines (GM 01127). Another document was filed later in 1921 from the Canadian Journal of Mines: Notes sur un deposit allanite du lac Baude (GM 18837).

Later in the 1940s, access to this territory was greatly favored by the forestry industry. Thus, Mr. J.M. Yates acquired a property located between Lake Normand and Lac Baude. It will dynamite the ETR mineralized zone which is exposed on the steep face of a cliff east of Lac Baude (GM 18620). This place where there was blasting can still be seen today, since many large angular boulders can be seen detached from the cliff. Mr. Yates will sign an option with "Quebec Industries Ltd". The latter will take a bulk sample of approximately 4.5 metric tonnes for its analysis. A report will be tabled by K.M. Brown (GM 18621). His work focuses on a massive 1 "to 2" wide allanite vein and will describe this area this way:

"*The fracture zone was blasted lightly and a bench was established across the allanite mineralization, approximately 30" wide. The bench was advanced for a distance of 10 feet. Massive allanite was picked from the broken material and bagged separately*".

The bulk sample totaling 4.527 kg includes approximately 4% of allanite crystals. The bulk sample initially contains 0.86% rare earths. After gravimetric concentration, a concentrate of 172 kg is obtained which will titrate 9.16% of total rare earths. In this report it is not stated which rare earth elements were analyzed but it is only mentioned that the thorium and uranium contents are low.

Mr. Brown's conclusion of Metallurgical Industries Ltd. was not to further research this property of Mr. Yates. He specified in his final report that market conditions for cerium were not there and that he questioned the low gravity recovery.

Between 1949 and 1967, J, M. Yates drilled numerous holes in a sand deposit containing iron-titanium. This place forms the shores of Lake Normand located east of Lac Baude. In addition to drilling in the sand, he will perform vertical drilling on the REE showing of Lac Baude. Hole No 25B which will reach 26 ’deep was positioned at the foot of the cliff. A coarse-grained pegmatite containing allanite was intersected. From 0 to 6 feet massive allanite has been reported, and from 6 "to 18" the reddish granite contains biotite fades and up to 1% allanite crystals (GM 20900).

We must wait until 1988 before hearing about this index again. Indeed, the Consulting Prospect Group Inc. files a report on drilling and sampling work (GM 48573). Geologist Glenn Griesbach mentions that the research took place in three days and concentrated mainly around Lake Normand towards the end of July 88. At that time, we were rather looking at the gold potential in the titano-ferrous sands. In the old reports of Mr. Yates, he mentioned gold anomalies found in the lake sands. The second goal was to find the allanite showing near Lac Baude. We practice 6 vertical boreholes in the placer of Normandy Lake, varying from 5 "to 25" deep. These boreholes cross layers of silt to coarse sands. Depending on the test results, some concentrates return to analysis from 0.29 g/t Au to 0.46g/t Au. It seems that these gold anomalies would not be directly related to the content of oxides in the sediment concentrates.

We finally find the REE index for Lac Baude, which was initially poorly located on the available maps. Finally, about 40 pounds of rock are taken which will be used for future analyzes.

GEOLOGICAL CONTEXT:

One of the first geological maps of Lac Baude sector was published in 1893 after the regional mapping by the Geological Survey of Canada. The region is mainly occupied by migmatites or granitized gneisses. They are moderately to highly metamorphosed rocks resulting from partial crustal anataxis. They are formed of light-colored beaches, assimilated to the part of the rock having melted and which constitutes the mobilise; beaches of dark color, constituting the part of the rock having remained solid. There are several outcrops located in the eastern part of Lac Baude. We observed a pink granite on the east shore of the lake which is in contact with a hornblende gneiss. This pink granite was found more than a kilometer north at the outlet of Lac Baude. We cannot say whether it is the same intrusion. The contact between the hornblende gneiss and the pink granite has a slight inclination at 15°O towards the south-east.

A coarse-grained pink pegmatite is found associated with the pink granite probably at a late stage of crystallization. This pegmatite is the one that mineralized on the property and is located just east of the granite. The migmatite which extends over the vast majority of the property is strongly magnetic and certainly masks on aeromagnetic surveys this pegmatite which contains magnetite.

Through the granite, we can see the pegmatite which intersects hornblende gneiss. It has been noticed that generally the pegmatite is in the form of fairly vertical dykes. Fine-grained felsic dykes were found in the pegmatite of Lake Baude which intersect it in several places and more precisely near the mineralized zone. There are dykes in several places that follow east-west orientations. The pegmatite in the area is generally coarse textured reddish in color. There are typically grains of magnetite so that they can be easily mistaken for allanite crystals without the presence of a magnet and or spectrometer.

A large dyke of granitic pegmatite reaching a power up to 10m thick. The dyke largely forms the wall of a steep cliff bordering much of the eastern shore of Lac Baude. It stretches over a line over 1km long. The cliff wall can easily reach a height of over 20 meters. There are several large blocks of pegmatite torn from the wall which, upon falling, have built a large pile at the foot of the cliff. The blocks are centimeter to metric in size. This dyke macroscopically shows large crystals of allanite and biotite These first are in the form of masses and elongated These rods with a fibro-radiated texture.

Detailed map No 1 (out of text) shows us that the mineralized zone is typically found within a coarse-grained pink pegmatite. The pegmatite would form a dyke that intersects pink granite to the east and layers of quartzo-feldspathic hornblende migmatite to the west.

The REE mineralized zone extends **over 750 meters in length** and by an average thickness of about **7 meters in width**. The appearance of the pegmatite according to our observations in the sub-vertical terrain, which suggests that it is the presence of a dyke. The concentration of rare earth minerals contained in the pegmatite varies from weakly disseminated to a shear zone highly enriched in allanite along an N-S shear.

2019 WORKS

2019 DRILLING PROGRAM

The drilling program of 119m was carried out in two phases, the first starting in August and ending in October 2019. The Roby drilling company in Val d'Or completed three short holes of BQ dimension. The accessible water source was fairly far from drilling sites is more than 1000m. The diameter of the core was about BQ. The artisanal type drill has been used previously and successfully on Appalachian rocks. The composition and crystallography of Grenvillian rocks has been a serious obstacle to reaching the desired target. The drill, which was too light and not very powerful, prevented from crossing the migmatite before reaching the mineralized pegmatite.

We experienced another constraint, that of the very rugged topography It is currently impossible to access the foot of the cliff. We have to cross an area prohibited to logging. It affects two small tributaries and which affects an area where there are two small tributaries. Apparently, it was occupied by former Amerindian camps. The mineralized zone is accessible from above the cliff, which forms a fairly wide and continuous plateau. The pegmatite seems according to the observations on the field of vertical or sub-vertical dip.

Hole BA-19-01 inclined at -45 planned to intercept the mineralized zone at a depth of approximately 100m. The borehole was drilled quite far east of the ridge of the cliff. A problem arose and the hole was abandoned only 9m deep (table). A second borehole (BA19-02) was placed just a little north of the neck of the first borehole. It reached a small dyke of mineralized pegmatite about 0.5m wide. The zone is weakly mineralized in cerium, lanthanum, neodymium and samarium (table) Drilling was interrupted due to lack of sufficient water. The casing was left in place. We had planned a return in October to continue the drilling campaign. On the return in October, it was impossible to get back into the casing and continue drilling up to about 100m before reaching the main mineralized.

Hole BA19-03 was located about 50m north of BA19-02. The position was canceled to move about 30 meters further north and closer to the west of the mineralized zone. Hole BA19-04 inclined at -45 passed through a very hard migmatite very rich in silica. Again, the small pegmatite dyke was crossed 20.8m from the surface. Although the area is very narrow, the fact remains that it is very enriched. Sample 787952 returned more than 1.2% La, 2.3% Ce, 0.24% Pr, 0.8% Nd and 0.1% in Sm (table) The drill was unable to drill the pegmatite beyond 44m. The output was around 0.2m per hour. The thrust on the hydraulic head was insufficient.

In conclusion, the program has shown that there is at least one other dyke of mineralized pegmatite. Moreover, which could explain the presence of numerous metrics and very angular mineralized blocks strewing the floor of the plateau. These boulders may be too far from the main known rare earth source at Lake Baude.

Finally, in the future, a high-performance drill will be required to successfully reach the mineralized pegmatite about 100m to the west under the cliff.

Table 2 DDH Program

DDH	Zone	UTM Easting	UTM Northing	Lenght (m)
BA19-01	18	630250	5215560	9
BA19-02	18	630250	5215560	66
BA-19-03	18	630240	5215600	Canceled
BA-19-04	18	630224	5215624	44
Total				**119m**

Figure 4: Cross-section BA19-02

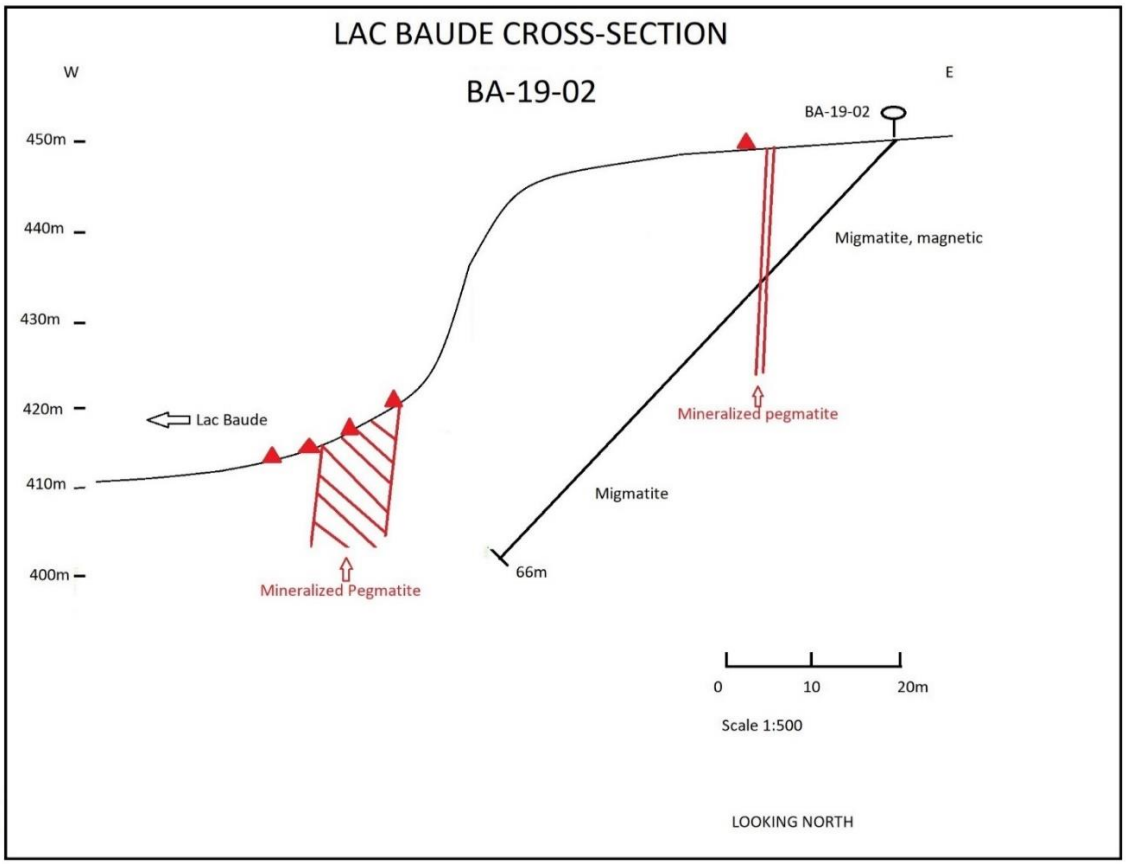


Figure 5: Cross-Section BA19-04

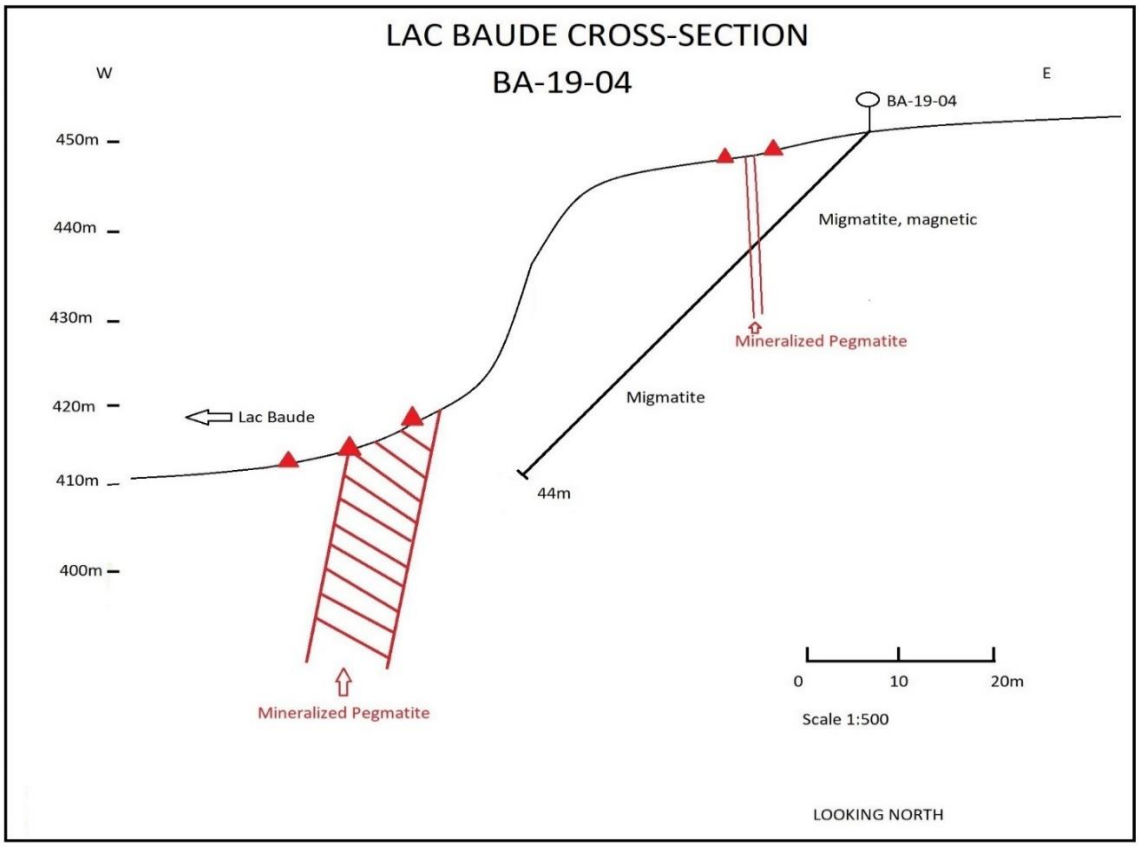


Table 3: 2019 DDH Results

Hole	Sample #	From	To	Width (m)	La ppm	Ce ppm	Pr ppm	Nd ppm	Sm ppm
BA-19-02	854819	18,6	19,1	0,5	5,6	8,8	1,09	4,3	1
BA-19-02	854820	19,1	19,6	0,5	4,7	8,9	1,16	4,9	1,5
BA-19-02	854821	19,6	20,1	0,5	1030	2370	279	1010	187
BA-19-02	854822	20,1	20,7	0,6	12,9	29,3	4,34	19,6	6,6
BA-19-04	787951	20,3	20,8	0,5	35,2	66,7	7,75	32,8	7,7
BA-19-04	787952	20,8	21	0,2	12100	23000	2480	8140	1050
BA-19-04	787953	21	21,5	0,5	15,4	28,9	3,53	14,1	3,9

Photo 1: Diamond Drill Hole BA19-02

Photo 2: Diamond Drill Hole BA19-04

2019 GRAVIMETRIC TESTS

Test 1: Mosley table Corem:

We indicate in the appendix 1 the preliminary results of the 4 particle size fractions processed on the Mosley table carried out in 2019 in Corem laboratories in Quebec. Although the concentrate grades are rather low, the recoveries **are very interesting (87 to 93%)** on three particle size fractions. The best results the best results were obtained on the 180-250 micron fraction Adding too much manual wash water to the 350-500-micron fraction affected recovery (44 to 67%). In addition, here is a table of analyzes of concentrates, tails, calculated head grades, and analyzed head grades for 7 REEs (La, Ce, Pr, Nd, Yb, Dy & Sm). The calculated head grade averages correspond to the analyzed head grades, so tests and analyzes are valid. As expected, the REE head grades are rather low (max.: 918 ppm Ce).

Test 2: Super Panner Collège de Thetford:

A gravimetric test was attempted with the Super Panner was carried out at the laboratories of the College of Thetford to compare the results with those obtained at Corem. Four different fractions of concentrate and allanite rejects were recovered. This test has shown that there is a big difference between the shaker table and the Super Panner. It is possible that the manipulation on the Super Panner was more or less successful. Table 4 indicates that the recovery (+ 30%) was recorded on the 350-500-micron fraction

Table 4: Super Panner Tests

YEAR	SAMPLE	DEVICE	DESCRIPTION	La	Ce	Pr	Nd	Sm
				ppm	ppm	ppm	ppm	ppm
2019	854814	Super panner	Composite 2019 (feed)	465	918	102	346	51,9
2019	854801	Super panner	Tail 1 (125-180µm)	139	281	30,6	103	16,6
2019	854802	Super panner	Tail 2 (125-180µm)	378	743	81,1	281	42,7
2019	854803	Super panner	Concentrate (125-180µm)	801	1610	169	576	86,6
2019	854804	Super panner	Tail 1 (180-250µm)	125	256	28	95,2	15,9
2019	854805	Super panner	Tail 2 (180-250µm)	380	732	81	282	42
2019	854806	Super panner	Concentrate (180-250µm)	637	1290	140	469	70,8
2019	854807	Super panner	Tail 1 (250-350µm)	117	233	25,8	87,8	13,9
2019	854808	Super panner	Tail 2 (250-350µm)	541	1100	115	393	57,5
2019	854809	Super panner	Concentrate (250-350µm)	869	1720	184	643	93,9
2019	854810	Super panner	Tail 1 (350-500µm)	314	604	66,4	229	34,4
2019	854811	Super panner	Tail 2 (350-500µm)	689	1370	148	506	71,7
2019	854812	Super panner	Concentrate (350-500µm)	1330	2560	271	914	136

Test 3: Rare Earth Extraction from Allanite ore from Lac Baude

Romain Barbaroux, Chemist, Ph.D was mandated in 2019 to perform a hydrometallurgical test on one of the samples of the mineralized zone (FNC-01) This test was an extraction and precipitation of a rare earth concentrate from an allanite ore The process proposed should be capable of producing an ETR oxide concentrate which can be used in the chemical industry. The work will be carried out according to the following stages: Carrying out of the chemical process and analysis of the results. Preliminary report targets were: Optimization of the steps of the chemical process for treating FNC-01 (63394) ore. Results and drafting of a preliminary report. Proposal of a final process for processing FNC-01 ore on a laboratory scale. Proposal for a pilot scale-up work for the final FNC-01 ore processing process.

Table 5: FNC-01 Elements Concentration (Sample 63394)

Tableau 1. Chemical characteristics of FNC-01

elements	Concentration (%)
Fe	0.4
F	0.06
ThO2	0.28
U3O8	0.00
La2O3	2.47
CeO2	4.97
Pr6O11	0.51
Nd2O3	1.57
Sm2O3	0.21
Eu2O3	0.01
Gd2O3	0.11
Td4O7	0.01
Dy2O3	0.06
Ho2O3	0.01
Er2O3	0.02
Tm2O3	0.00
Yb2O3	0.01
HfO2	0.00
Y2O3	0.25
ZrO2	0.05

Table 6: Results for Acid Wash Extraction

	Pourcentage extraction à 20 °C (%)	Pourcentage extraction à 60 °C (%)	Pourcentage extraction à 90 °C (%)
CeO2	79.6	93.1	91.8
La2O3	79.4	93.2	91.9
Nd2O3	78.7	93.6	92.8
Pr6O11	83.7	100	100
Sm2O3	80.5	100	100
Y2O3	78.9	100	94.4
ThO2	75.6	91.7	65.4

Conclusion for Acid Wash Extraction:

The acid wash at 20°C on Lac Baude ore can extract significant percentage of REEs. An acid leaching at 60°C can extract more than 90 % of the REEs from Lac Baude Ore. The proposed process can produce a LREE concentrate. This LREE concentrate can be valued in lot of different industries

Other Test carried out in 2017:

According to various sources the presence of the elements of fluorine and beryllium can cause recovery problems in a rare earth ore. Two rich samples of REE were sent in 2017 and were titrated for F and Be. The results are very low (table 7)

Table 7: Results for F and Be Elements on Lac Baude Ore

Report Number: A17-08328		
Report Date: 3/11/2017		
Analyte Symbol	F	Be
Unit Symbol	%	ppm
Detection Limit	0,01	1
Analysis Method	FUS-ISE	FUS-ICP
63394	0,03	4
63397	0,06	42

2020 WORKS

Trenching Program

During the summer of 2020, occasional visits were aimed at checking the lateral extensions of the main rare earth zone. A program of 4 trenches (A-B-C-D) oriented E-W and a total length of about 400m had been planned north of the study area. The goal for opening the trenches to the north was to know the northern limit of the mineralization. According to the field data the area turns slightly towards the NNE and leaves the cliff ridge. With the arrival of the Covid 19 pandemic the program was canceled and postponed later.

Soil Geochemistry Survey

We decided to change the approach and conduct a soil geochemistry survey. The collection of soil samples gave results which appear to be consistent with observations in the field. Cerium and lanthanum anomalies were recorded above the mineralized zone (see table 7 and map at 1: 500).

It is possible that the overburden is more important towards the north so that the anomalies do not extend very far from the known zone It is also possible that the mineralized zone disappears towards the north to appear later a reconnaissance camp was undertaken to the south in order to verify the extension of the zone According to the readings with the scintillometer the zone would extend towards the south for a great distance **The zone would now measure more than 750m and possibly more than 800m.** The foot of the cliff is made up of huge blocks, some of which are mineralized. It is easy to follow the area of interest by tracing these blocks. They are rarer towards the south and could indicate the southern limit of the mineralized zone. The latest scintillometer readings show that the zone widens and would reach more than 7m wide.

Table 8: Soil Anomalies

Sample	La	Ce	Pr	Nd	Sm
	ppm	ppm	ppm	ppm	ppm
787852	73,6	176	19,1	74,4	17,5
787853	78,9	178	16,6	59,2	15,8
787854	21,7	44	5,35	21,5	14,3
787855	25,9	71,2	6,79	28,1	10,1
787856	31	76,9	8,24	34,4	4,5
787857	42,4	89	11,6	47,6	6,2
787858	22	50,1	5,33	21,6	7,4
787859	32,5	62,5	9,21	36,7	10
787860	22,9	45,3	5,36	21,8	4,3
787861	23,8	47,2	5,76	21,9	7,8

Grab Sampling:

Few rock samples have been taken south of the mineralized zone It was difficult to extract good samples taken from large mineralized blocks and the results are not very conclusive (table 9) However, the scintillometer readings showed that there would be the presence of allanite in these blocks. It is proposed to continue mining exploration south of the last showings. It is possible that the mineralized zone below lies further west of the cliff.

Table 9: Grab Samples Results

Sample	Zone	UTM East	UTM North	La	Ce	Pr	Nd	Sm
				ppm	ppm	ppm	ppm	ppm
787949	18	630258	5115255	3,7	8,6	1,13	4,7	1,6
787950	18	630250	5115269	9,5	21,7	2,97	13,5	4,8

DISCUSSION OF THE 2019-2020 RESULTS

The most enriched Rare Earths are those of the light group, more particularly those of neodymium and praseodymium oxides. At 2019 prices, lightweight ETRs reached 94US$ for Nd2O3 and 121US$ for Pr6O11 (Tables 10-11-1)

During the prospecting campaigns, more than thirty samples were taken along the cliff in the mineralized zone over a distance of approximately 750 meters. Over 30% of these samples returned significant rare earth values. A list of the samples and their positions are also presented on the inset maps and on the tables. Several lithogeochemical samples were run on the McPhar scintillometer.

We also tried to do a gravimetric concentration test of the best samples. The results show that these rare earths can be **concentrated (87 to 93%).** It was also noted that the rare earths in Lake Baude are not very enriched in minerals such as uranium and thorium (see 2018 report).

The acid wash at 20°C on Lac Baude ore can extract significant percentage of REEs. An acid leaching at 60°C can extract more **than 90 % of the REEs** from Lac Baude Ore

The zone would now measure more than 750m and possibly more than 800m.The latest readings show that the zone widens and would reach more than 7m wide toward the South of the Property

Table 10: REE Price in US$ for 2019

Oxides	Price/kg (US$)
CeO2	5,99
La2O3	7,8
Nd2O3	94,4
Pr6O11	121,6
Sm2O3	28,14

Table 11: REE Conversion to Oxide (%) and Grades (kg/t)

Element Kilo per ton	Sample 787952	Sample 63491	Conversion to Oxide	Oxide	Sample 787952 Kilo per ton	Sample 63491 Kilo per ton
Ce kg/t	23	46	1,17	CeO2	26,9 kg/t	53,8 kg/t
La kg/t	12,1	23,4	1,17	La2O3	14,15kg/t	26,9kg/t
Nd kg/t	8,1	9,6	1,16	Nd2O3	9,4kg/t	11,1kg/t
Pr kg/t	2,4	2,7	1,17	Pr6O11	2,8kg/t	3,15kg/t
Sm kg/t	1,05	1,4	1,15	Sm2O3	1,2kg/t	1,61kg/t

Table 12: Economic Values in US$ (2019)

Oxides	Price/kg/t (US$) Sample 787952	Price/kg/t (US$) Sample 63491
CeO2	161	322
La2O3	110	210
Nd2O3	887	1048
Pr6O11	338	375
Sm2O3	34	45
TOTAL US$	**1530**	**2000**

CONCLUSION AND RECOMMANDATION

The results of various studies clearly show the good rare earth potential of the Lac Baude property. Both gravity and hydrometallurgical surveys have shown that the recovery of allanite in the pegmatite is optimal. The preliminary maximum grades (samples 787952 and d 63491) recorded indicate the Lac Baude showing is economical ranging from 1500US$ to 2000US$ Table 12).

Geochemical and radiometric surveys would greatly assist in monitoring the area if it extends beyond the last outcrops containing allanite. These surveys could be completed before the start of a proposed drilling campaign. This diamond drilling program would finally make it possible to know the true dimensions of the main mineralized zone so far estimated according to field data taken and taken at the surface.

We now know that there are very rich zones concentrated in massive allanite stringers in the pegmatite. The drilling will tell us how many and what dimensions these enriched zones may be present in the host rock. Above all, he will tell us that it is the average grade of REE in the pegmatite to estimate an economic resource.

Finally, we are proposing a drilling program for the year 2021. A first phase of 1000m drilling is recommended early in the spring of 2021.

_____

Jean Bernard, P.Geo

OGQ 1593

QUALIFICATION CERTIFICATE:

1. I live at 3625 Boulevard Frontenac-Est # 306, Thetford Mines G6H 4G3.

2. I graduated from the University of Quebec in Montreal where I obtained a Bachelor of Earth Sciences (B.Sc.) in 1979.

3. I have practiced my profession continuously since that day;

4. I have been a member of the Ordre des géologues du Québec since 2011 (member # 1593);

5. I have worked in the mining industry for over 35 years;

6. I organized, planned and supervised the works that were carried out during the year 2019-2020 on the Lac Baude property owned by Fancamp Exploration Ltd;

7. I am not independent because I have the possibility of exercising a certain number of shares of Fancamp Exploration Ltd until 2024

8. I declare that the information contained in this technical report conforms and corresponds to the best of my knowledge;

Jean Bernard P.Geo

OGQ 1593

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BA-19-01

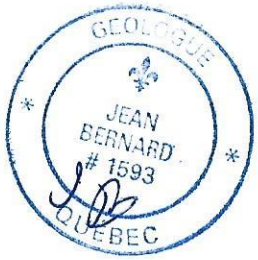
Drill Hole No.	BA-19-01	Grid Co-ordinates		Collar Dip	-45°	Line Number				Date Log Started	Octo
Property	Lac Baude	UTM Eastings	630250	Dip down hole		Date Hole Started	25 August 2019			Date Log Finished	Octo
Location	Mékinac	UTM Northings	5215560	Core Size	BQ	Date Completed	25 August 2019			Logged By	Jea
Direction	270° Azm	Collar Elevation	450	% Recovery	100	Length	9m				

Footage				Sample #	Interval						
From	To	Rock Type	Description		From	To	Width	La	Ce	Pr	Nd
0	2,8m	Casing									
2,8m	9m	Migmatite	Dark green to grey, massive, several pink feldspar clusters between 3 to 5m, very magnetic rock								
	9m	EOH	End of hole broken rod, resumed drilling hole at 0.5m to the west								

BA-19-02

Hole No.	BA-19-02	Grid Co-ordinates		Collar Dip	-45	Line Number				Date Log Started	October 10 2019
ty	Lac Baude	UTM Eastings	630250	Dip down hole		Date Hole Started	25 August 2019			Date Log Finished	October 10 2019
on	Mékinac	UTM Northings	5215560	Core Size	BQ	Date Completed	27 August 2019			Logged By	Jean Bernard
ion	270° Azm	Collar Elevation	450	% Recovery	100	Length	66m				

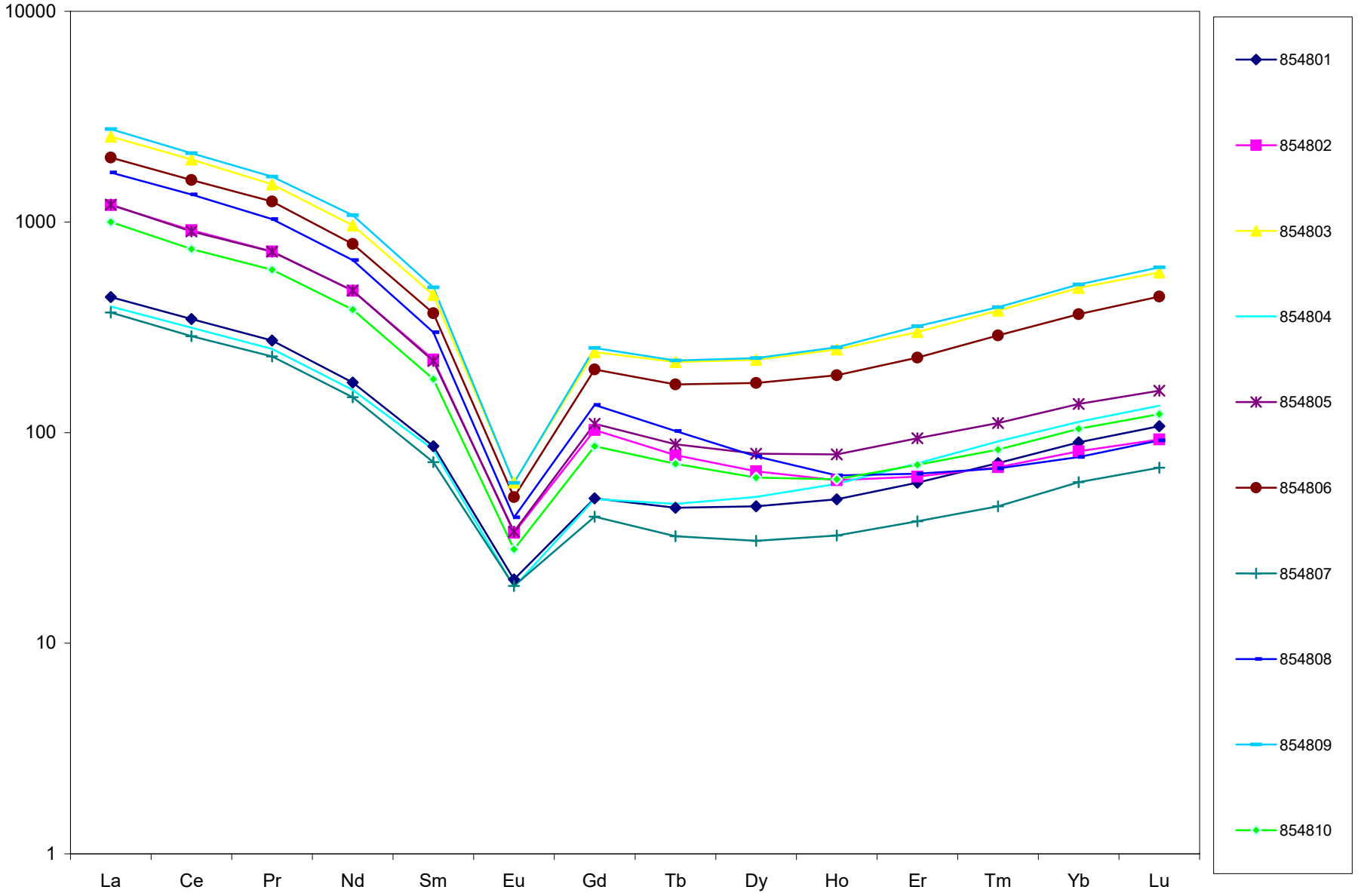
Footage				Sample #	Interval							
	To	Rock Type	Description		From	To	Width	La	Ce	Pr	Nd	Sm
	2,8m	Casing		854817			Blank	35,4	71,8	8,62	32	6,3
n	18,6m	Migmatite	Green to dark green to dark grey, more feldspar clusters foliated to 80 C/A	854818			Standard	11800	15600	2630	9460	1480
				854819	18,6	19,1	0,5	5,6	8,8	1,09	4,3	1
				854820	19,1	19,6	0,5	4,7	8,9	1,16	4,9	1,5
m	20,7m	Pegmatite	Pink with grey inclusions. Intertwined crystals of quartz and feldspar	854821	19,6	20,1	0,5	1030	2370	279	1010	187
			Few yellow-green crystals et some allanite between 19,6 to 20,1m	854822	20,1	20,7	0,6	12,9	29,3	4,34	19,6	6,6
			Upper contact: 45 C/A Lower contact: 35 C/A									
m	66m	Migmatite	Dark grey, to peppered, magnetic, foliated at 85 C/A Green olive bands foliated at 35 C/A									
n		EHO	Stopped, lack of water, left casing in place									



BA-19-04

Drill Hole No.	BA-19-04	Grid Co-ordinates	Zone 18	Collar Dip	-45°	Line Number				Date Log Started	Octob
Property	Lac Baude	UTM Eastings	630224	Dip down hole		Date Hole Start	7 October 2019			Date Log Finished	Octob
Location	Mékinac	UTM Northings	5215624	Core Size	BQ	Date Completed	10 October 2019			Logged By	Jea
Direction	270 ° Azm	Collar Elevation	440m	% Recovery	98	Length	44m				

Footage				Interval							
From	To	Rock Type	Description	Sample #	From	To	Width	La	Ce	Pr	Nd
0	2m	Casing		787951	20,3	20,8	0,5	35,2	66,7	7,75	32,8
				787952	20,8	21	0,2	12100	23000	2480	8140
2m	20,3m	Migmatite	Dark green to grey massive, homgeneous, magnetic.	787953	21	21,5	0,5	15,4	28,9	3,53	14,1
20,3m	21,5m	Pegmatite	Pink, massive rock coarse grained. Intertwined crystals of quartz and and feldspar. Black a crystals allanite between 20,8 to 21m.								
21,5m	44m	Migmatite	Dark green to grey massive, homogeneous, magnetic foliated to 75 C/A.								
44m		EOH	Stopped, the drill is not powerful enough and too light. Rock too hard.								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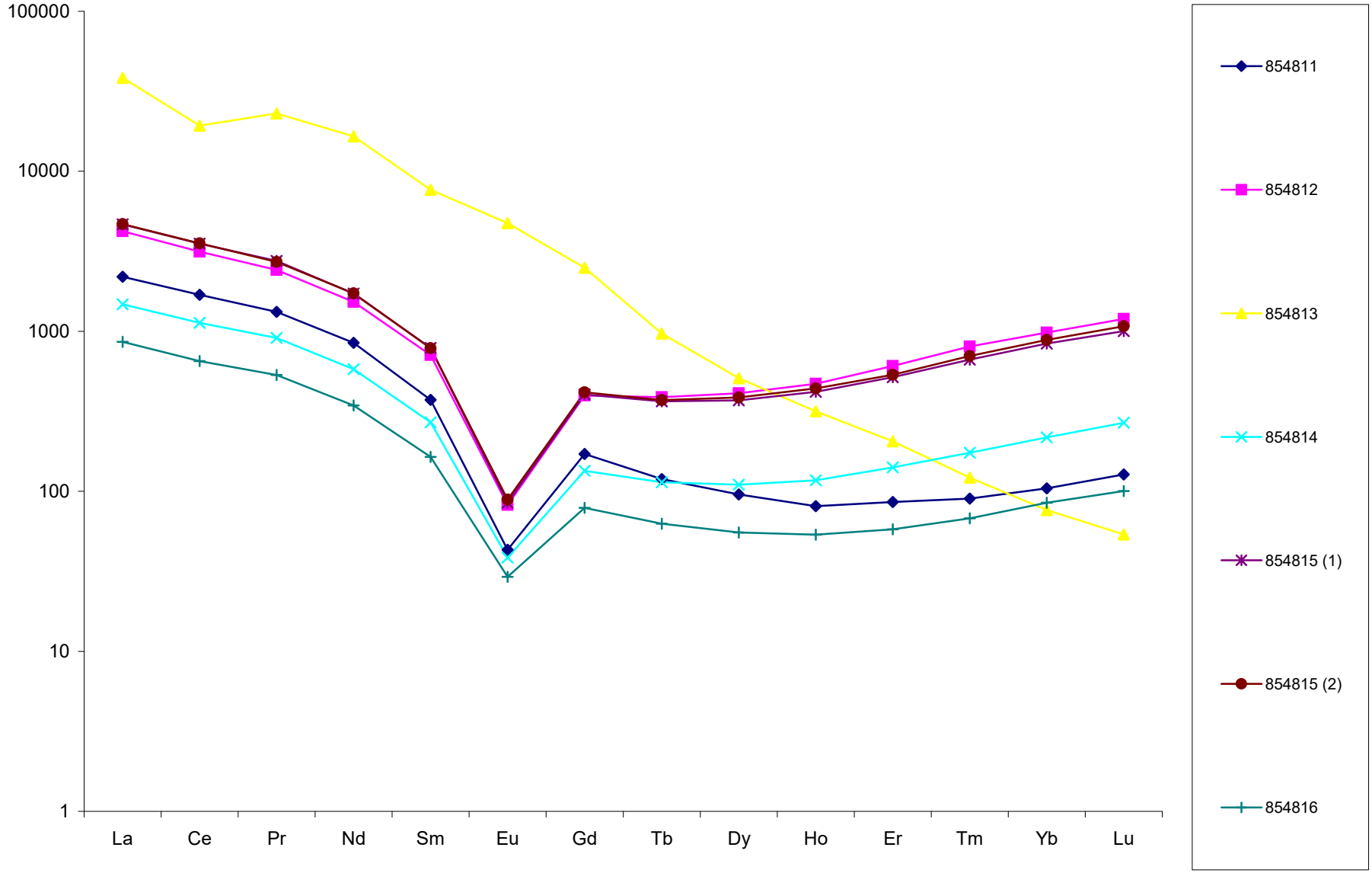
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854816

Quality Analysis ... *Innovative Technologies*

Date Submitted: 11-Sep-19
Invoice No.: A19-12151
Invoice Date: 20-Sep-19
Your Reference: BAUDE LAKE

Fancamp Exploration Ltd.
340 Victoria Ave
Westmount QC H3Z 2M8
Canada

ATTN: Peter H. Smith

CERTIFICATE OF ANALYSIS

16 Rock samples were submitted for analysis.

The following analytical package(s) were requested:

8-REE Assay Package	QOP WRA/ QOP WRA 4B2 (Major/Trace Elements Fusion ICPOES/ICPMS)

REPORT **A19-12151**

Notes:

Total includes all elements in % oxide to the left of total.

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control Coordinator

ACTIVATION LABORATORIES LTD.
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Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01		0.01	1	1	5	20	1	20	10	30	1	1	5
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	GRAV	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854801	64.37	14.54	8.56	0.171	1.62	1.41	4.05	3.70	1.029	0.04	1.03	100.5	7	44	46	40	15	< 20	100	280	55	3	8
854802	71.50	14.43	2.78	0.058	0.52	2.01	5.13	2.06	0.278	0.06	0.67	99.49	4	50	21	20	5	< 20	40	70	39	2	8
854803	70.42	13.37	5.23	0.092	0.59	2.35	4.67	1.82	0.637	0.16	0.55	99.88	5	47	46	40	7	< 20	80	80	42	3	14
854804	62.03	14.75	10.15	0.202	1.95	1.29	3.86	4.26	1.241	0.05	0.88	100.7	8	41	53	40	18	< 20	50	320	57	3	8
854805	71.22	14.48	3.29	0.062	0.52	1.98	5.01	2.06	0.337	0.05	0.62	99.62	4	50	22	20	5	< 20	40	80	38	2	8
854806	70.24	13.76	4.37	0.078	0.54	2.16	4.74	1.85	0.492	0.08	0.62	98.93	4	47	36	30	5	< 20	60	70	41	3	11
854807	68.35	14.55	5.82	0.115	1.11	1.51	4.59	3.17	0.678	0.04	0.69	100.6	5	46	29	30	10	< 20	30	180	46	2	6
854808	73.52	13.91	2.68	0.057	0.50	2.00	4.91	1.92	0.294	0.04	0.59	100.4	4	50	20	30	4	< 20	30	70	39	2	8
854809	69.66	12.92	5.20	0.099	0.59	2.28	4.58	1.72	0.560	0.09	0.56	98.25	5	46	45	30	2	< 20	50	80	45	3	8
854810	71.08	14.35	4.20	0.084	0.76	1.71	4.75	2.56	0.489	0.05	0.64	100.7	4	47	25	30	7	< 20	30	130	42	3	7
854811	72.90	13.59	3.26	0.069	0.56	1.99	4.83	1.97	0.356	0.05	0.59	100.2	4	50	21	30	5	< 20	20	80	41	3	8
854812	69.41	12.31	7.52	0.117	0.62	2.19	4.32	1.72	0.823	0.07	0.49	99.59	5	45	64	40	8	< 20	50	110	49	4	12
854813	19.91	8.68	58.21	0.375	1.41	1.27	0.20	0.11	3.264	3.35	0.98	97.76	151	16	258	400	16	80	90	1130	100	22	76
854814	69.35	14.07	5.12	0.098	0.84	1.99	4.74	2.53	0.576	0.09	0.72	100.1	5	49	34	30	8	< 20	40	140	45	3	9
854815	70.55	13.49	4.10	0.104	0.70	2.45	4.60	1.91	0.698	0.11	0.72	99.43	6	47	33	40	7	< 20	60	110	48	4	23
854816	70.26	14.08	4.24	0.081	1.06	2.12	4.78	2.52	0.540	0.11	0.76	100.6	5	48	31	40	9	< 20	40	110	40	2	9

Analyte Symbol	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1
Method Code	FUS-MS	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854801	493	136	94	151	132	2	0.5	< 0.2	17	< 0.5	34.2	563	< 0.4	139	281	30.6	103	16.6	1.45	12.6	2.2	14.5	3.4
854802	107	171	111	163	46	< 2	0.6	< 0.2	6	< 0.5	4.9	398	< 0.4	378	743	81.1	281	42.7	2.41	26.6	3.8	21.3	4.2
854803	94	173	477	1359	443	< 2	4.5	< 0.2	11	< 0.5	4.0	358	< 0.4	801	1610	169	576	86.6	4.19	62.4	10.6	71.9	17.4
854804	589	130	112	136	194	3	< 0.5	< 0.2	21	< 0.5	41.1	620	0.9	125	256	28.0	95.2	15.9	1.34	12.5	2.3	16.1	4.0
854805	117	170	156	381	107	< 2	1.3	< 0.2	7	< 0.5	5.3	398	< 0.4	380	732	81.0	282	42.0	2.45	28.5	4.3	25.8	5.5
854806	93	173	378	889	339	< 2	2.8	< 0.2	9	< 0.5	3.9	364	< 0.4	637	1290	140	469	70.8	3.57	51.7	8.3	55.9	13.1
854807	344	149	64	100	83	< 2	< 0.5	< 0.2	11	< 0.5	22.6	514	< 0.4	117	233	25.8	87.8	13.9	1.35	10.3	1.6	10.0	2.3
854808	100	173	125	333	31	< 2	1.0	< 0.2	7	< 0.5	4.4	367	< 0.4	541	1100	115	393	57.5	2.86	35.0	5.0	25.1	4.4
854809	84	174	536	1021	398	< 2	3.2	0.2	11	< 0.5	3.6	343	< 0.4	869	1720	184	643	93.9	4.17	65.4	10.8	73.3	17.8
854810	219	157	118	193	104	2	0.6	< 0.2	9	< 0.5	13.1	444	< 0.4	314	604	66.4	229	34.4	2.02	22.3	3.5	19.9	4.2
854811	119	170	158	473	67	< 2	1.4	< 0.2	9	< 0.5	6.2	367	< 0.4	689	1370	148	506	71.7	3.12	44.3	5.8	31.0	5.7
854812	97	174	967	1904	1090	< 2	5.6	0.2	16	< 0.5	4.6	328	< 0.4	1330	2560	271	914	136	5.94	103	19.0	133	32.9
854813	3	2088	425	364	1610	71	4.0	2.1	39	1.4	< 0.5	1726	2.8	12100	15700	2580	9890	1470	342	646	47.5	166	22.1
854814	205	164	231	453	231	< 2	1.4	< 0.2	11	< 0.5	12.5	443	< 0.4	465	918	102	346	51.9	2.78	34.8	5.6	35.7	8.2
854815	115	184	827	1704	908	2	5.4	0.2	14	< 0.5	5.6	356	< 0.4	1470	2880	306	1030	151	6.27	106	18.0	123	30.0
854816	196	185	101	238	83	< 2	0.7	< 0.2	8	< 0.5	11.0	579	< 0.4	270	530	59.7	206	31.5	2.11	20.5	3.1	18.0	3.8

Analyte Symbol	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854801	12.3	2.29	18.7	3.46	8.9	16.2	3	2.4	58	43.1	29.0
854802	13.2	2.19	17.0	2.99	11.9	6.3	1	0.8	34	93.4	14.9
854803	63.8	12.1	101	18.6	72.3	47.7	14	0.6	130	177	146
854804	15.2	2.90	23.4	4.33	7.4	21.3	4	3.0	77	41.1	34.6
854805	20.0	3.56	28.4	5.11	22.5	12.2	3	0.9	48	90.8	34.2
854806	48.3	9.26	75.9	14.3	50.7	35.8	11	0.6	99	148	105
854807	8.1	1.43	12.1	2.20	5.4	10.2	2	1.7	38	37.6	11.9
854808	13.6	2.16	15.9	2.96	23.2	5.4	1	0.7	30	108	15.8
854809	68.1	12.6	105	19.7	60.3	47.5	14	0.4	133	184	168
854810	15.0	2.66	21.7	3.96	12.3	14.6	3	1.1	37	65.3	23.9
854811	18.2	2.88	21.7	4.11	34.1	9.5	2	0.7	32	120	20.8
854812	129	25.8	204	38.6	111	107	31	0.6	189	277	268
854813	43.7	3.90	15.9	1.74	11.3	22.6	6	0.2	137	518	18.5
854814	30.0	5.58	45.2	8.65	28.2	24.5	7	1.0	73	105	63.0
854815	112	21.9	179	33.5	99.2	89.9	26	0.7	204	280	251
854816	12.3	2.17	17.7	3.25	12.9	9.7	2	1.0	37	63.5	20.3

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	0.01	1	1	5	20	1	20	10	30	1	1	5	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
NIST 694 Meas	10.86	1.90	0.75	0.010	0.35	44.21	0.88	0.57	0.120	30.21				1668									
NIST 694 Cert	11.2	1.80	0.790	0.0116	0.330	43.6	0.860	0.510	0.110	30.2				1740									
DNC-1 Meas	47.46	18.45	9.59	0.150	9.94	11.07	1.92	0.23	0.480	0.07		31		155									
DNC-1 Cert	47.15	18.34	9.97	0.150	10.13	11.49	1.890	0.234	0.480	0.070		31		148									
GBW 07113 Meas	69.67	12.88	3.21	0.140	0.14	0.57	2.45	5.34	0.280	0.04		5	4	< 5									
GBW 07113 Cert	72.8	13.0	3.21	0.140	0.160	0.590	2.57	5.43	0.300	0.0500		5.00	4.00	5.00									
TDB-1 Meas															260			330	150				
TDB-1 Cert															251			323	155				
W-2a Meas	52.56	15.19	10.68	0.170	6.26	10.69	2.21	0.62	1.090	0.11		35	< 1	275	90	41		110		16	1		19
W-2a Cert	52.4	15.4	10.7	0.163	6.37	10.9	2.14	0.626	1.06	0.140		36.0	1.30	262	92.0	43.0		110		17.0	1.00		21.0
DTS-2b Meas																	3730						
DTS-2b Cert																	3780						
SY-4 Meas	50.54	20.86	6.23	0.110	0.51	7.89	7.00	1.70	0.290	0.14		1	3	6					100	35			54
SY-4 Cert	49.9	20.69	6.21	0.108	0.54	8.05	7.10	1.66	0.287	0.131		1.1	2.6	8.0					93	35			55.0
BIR-1a Meas	48.36	15.63	11.17	0.170	9.58	13.22	1.81	0.02	0.970	0.03		44	< 1	340		53	190	130	70	16			
BIR-1a Cert	47.96	15.50	11.30	0.175	9.700	13.30	1.82	0.030	0.96	0.021		44	0.58	310		52	170	125	70	16			
ZW-C Meas																			1040	93			8860
ZW-C Cert																			1050.000	99			8500
OREAS 101b (Fusion) Meas																45		420					
OREAS 101b (Fusion) Cert																47		420					
NCS DC86318 Meas																							387
NCS DC86318 Cert																							369.42
SARM 3 Meas																							
SARM 3 Cert																							
USZ 25-2006 Meas																			630				
USZ 25-2006 Cert																			600				
USZ 42-2006 Meas																	< 20		480				
USZ 42-2006 Cert																	13.18		469				
REE-1 Meas															300			80				114	
REE-1 Cert															277			79.7				124	
854815 Orig	70.48	13.56	4.11	0.104	0.70	2.44	4.61	1.91	0.705	0.11	99.45	6	47	33	40	7	< 20	60	110	48	4	22	116
854815 Dup	70.61	13.42	4.09	0.104	0.70	2.46	4.59	1.91	0.692	0.11	99.41	6	47	33	40	7	< 20	60	100	47	4	24	113
Method Blank	0.01	< 0.01	< 0.01	0.003	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	< 0.01		< 1	< 1	< 5	< 20	< 1	< 20	< 10	< 30	< 1	< 1	< 5	< 2
Method Blank	0.01	< 0.01	0.01	0.003	0.01	0.01	< 0.01	< 0.01	0.001	< 0.01		< 1	< 1	< 5									

Analyte Symbol	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
NIST 694 Meas																							
NIST 694 Cert																							
DNC-1 Meas	142	15	36								107												
DNC-1 Cert	144.0	18.0	38								118												
GBW 07113 Meas	40	43	386								495												
GBW 07113 Cert	43.0	43.0	403								506												
TDB-1 Meas													16.4	38.5		23.1		2.00					
TDB-1 Cert													17	41		23		2.1					
W-2a Meas	192	19	85		7						174	< 0.4	10.3	22.7			3.1	1.10		0.6	3.7	0.8	
W-2a Cert	190	24.0	94.0		0.600						182	0.0300	10.0	23.0			3.30	1.00		0.630	3.60	0.760	
DTS-2b Meas																							
DTS-2b Cert																							
SY-4 Meas	1208	109	544							1.5	347		60.9	129	14.9	58.6	12.9	1.98	14.7	2.7	18.9	4.3	14.0
SY-4 Cert	1191	119	517							1.5	340		58	122	15.0	57	12.7	2.00	14.0	2.6	18.2	4.3	14.2
BIR-1a Meas	106	15	15								9		0.7	2.0		2.4	1.1	0.56	2.0				
BIR-1a Cert	110	16	18								6		0.63	1.9		2.5	1.1	0.55	2.0				
ZW-C Meas				204				1290	4.6	260			29.8	105	9.20	24.2	6.5		4.6				
ZW-C Cert				198				1300.000	4.2	260			30.0	97	9.5	25.0	6.6		4.70				
OREAS 101b (Fusion) Meas					19								786	1350	122	370	47.0	7.80		5.0	31.1	6.2	18.4
OREAS 101b (Fusion) Cert					21								789	1331	127	378	48	7.77		5.37	32.1	6.34	18.7
NCS DC86318 Meas										11.1			1960	421	719	3240	1660	19.0	2330	498	3090	587	1670
NCS DC86318 Cert										10.28			1960	430	740	3430	1720	18.91	2095	470	3220	560	1750
SARM 3 Meas				958																			
SARM 3 Cert				978																			
USZ 25-2006 Meas													19200	30900	2780	8410	880	213					
USZ 25-2006 Cert													19300	29000	2800	8800	900	211.00					
USZ 42-2006 Meas					35								21700	29500	2410	6620	533	93.0					
USZ 42-2006 Cert					34.40								21100	27600	2300	6500	539	87.22					
REE-1 Meas										1.1			1750	4170		1480		24.8	453		884	212	707
REE-1 Cert										1.07			1661	3960		1456		23.5	433		847	208	701
854815 Orig	185	817	1719	889	2	5.5	0.2	14	< 0.5	5.6	356	< 0.4	1470	2870	309	1030	151	6.13	104	17.9	120	29.3	110
854815 Dup	184	836	1689	927	2	5.3	0.2	14	< 0.5	5.6	356	< 0.4	1470	2880	304	1030	150	6.41	108	18.2	125	30.8	114
Method Blank	< 2	< 2	< 4	< 1	< 2	< 0.5	< 0.2	< 1	< 0.5	< 0.5	< 3	< 0.4	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Method Blank	< 2	< 2	< 4								< 3												

Analyte Symbol	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
NIST 694 Meas										
NIST 694 Cert										
DNC-1 Meas										
DNC-1 Cert										
GBW 07113 Meas										
GBW 07113 Cert										
TDB-1 Meas		3.1							2.6	
TDB-1 Cert		3.4							2.7	
W-2a Meas		2.0	0.31	2.5		1	< 0.1		2.3	0.5
W-2a Cert		2.10	0.330	2.60		0.300	0.200		2.40	0.530
DTS-2b Meas										
DTS-2b Cert										
SY-4 Meas	2.21	15.1	2.19	10.7	0.9			10	1.3	
SY-4 Cert	2.3	14.8	2.1	10.6	0.9			10	1.4	
BIR-1a Meas		1.7		0.6						
BIR-1a Cert		1.7		0.60						
ZW-C Meas					85.5	332	34.1			18.6
ZW-C Cert					82	320	34			20.0
OREAS 101b (Fusion) Meas	2.67	17.4	2.61						36.3	404
OREAS 101b (Fusion) Cert	2.66	17.6	2.58						37.1	396
NCS DC86318 Meas	263	1750	248						65.2	
NCS DC86318 Cert	270	1840	260.0						67.0	
SARM 3 Meas										
SARM 3 Cert										
USZ 25-2006 Meas								1110		
USZ 25-2006 Cert								1100		
USZ 42-2006 Meas		17.0						1610	922	
USZ 42-2006 Cert		17.85						1600	946	
REE-1 Meas				468						
REE-1 Cert				479						
854815 Orig	21.3	174	32.4	99.0	86.5	25	0.7	203	280	247
854815 Dup	22.5	184	34.7	99.4	93.3	27	0.7	205	280	255
Method Blank	< 0.05	< 0.1	< 0.04	< 0.2	< 0.1	< 1	< 0.1	< 5	< 0.1	< 0.1
Method Blank										

Quality Analysis ... *Innovative Technologies*

Date Submitted: 24-Sep-19
Invoice No.: A19-13004
Invoice Date: 03-Oct-19
Your Reference: BAUDE LAKE

Fancamp Exploration Ltd.
340 Victoria Ave
Westmount QC H3Z 2M8
Canada

ATTN: Peter H. Smith

CERTIFICATE OF ANALYSIS

6 Rock samples were submitted for analysis.

The following analytical package(s) were requested:		Testing Date:
8-REE Assay Package	QOP WRA/ QOP WRA 4B2 (Major/Trace Elements Fusion ICPOES/ICPMS)	2019-09-30 16:03:03

REPORT **A19-13004**

Notes:

Total includes all elements in % oxide to the left of total.

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control Coordinator

ACTIVATION LABORATORIES LTD.
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E-MAIL Ancaster@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01		0.01	1	1	5	20	1	20	10	30	1	1	5
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	GRAV	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854817	64.32	14.56	6.49	0.097	2.28	3.72	1.95	2.86	0.870	0.16	3.33	100.7	16	2	123	110	18	40	40	90	18	2	< 5
854818	19.87	8.49	55.02	0.391	1.38	1.37	0.17	0.13	3.148	3.21	1.25	94.44	152	17	255	400	18	90	90	1170	107	19	87
854819	73.34	14.11	1.08	0.010	0.23	0.96	3.79	4.79	0.060	0.02	0.46	98.86	< 1	4	< 5	< 20	1	< 20	< 10	< 30	24	1	< 5
854820	73.27	14.09	0.89	0.012	0.14	0.95	3.90	4.71	0.011	< 0.01	0.56	98.55	< 1	7	< 5	< 20	1	< 20	< 10	< 30	28	2	< 5
854821	71.98	13.07	2.82	0.027	0.18	0.71	2.66	5.64	0.129	< 0.01	0.64	97.86	2	6	7	30	1	< 20	< 10	< 30	40	5	8
854822	69.03	13.70	4.52	0.063	1.06	2.12	3.92	3.03	0.451	0.05	0.72	98.66	7	10	28	30	8	< 20	< 10	90	33	2	< 5

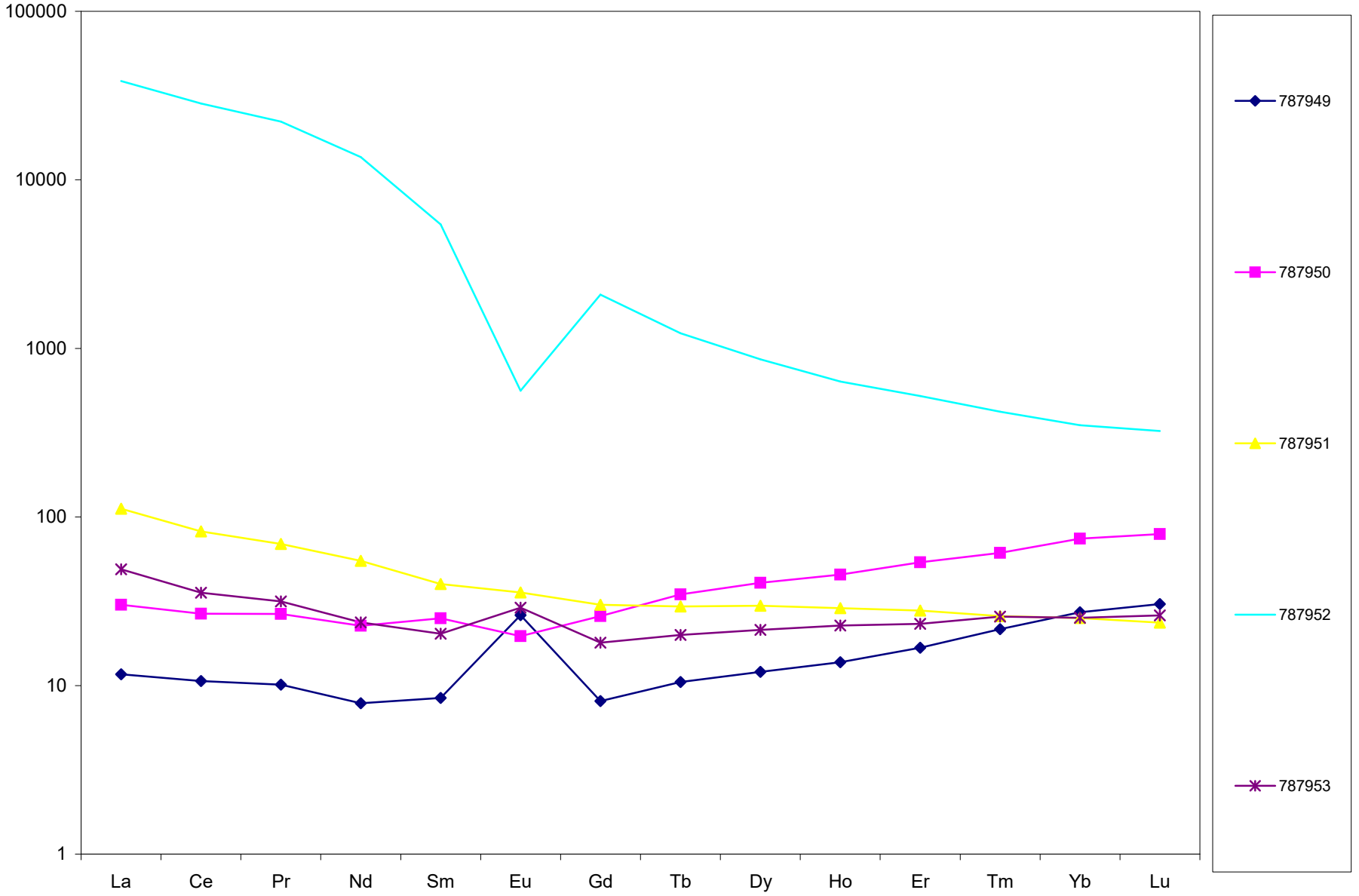
Analyte Symbol	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1
Method Code	FUS-MS	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854817	91	178	24	272	11	< 2	1.0	< 0.2	2	< 0.5	2.2	721	< 0.4	35.4	71.8	8.62	32.0	6.3	1.43	5.3	0.8	4.7	0.9
854818	4	1942	440	373	1420	79	3.7	2.2	39	2.0	< 0.5	1614	3.8	11800	15600	2630	9460	1480	334	613	50.0	164	21.0
854819	199	133	8	50	6	< 2	0.5	< 0.2	< 1	< 0.5	0.6	663	< 0.4	5.6	8.8	1.09	4.3	1.0	1.73	0.9	0.2	1.2	0.3
854820	236	105	24	7	11	< 2	< 0.5	< 0.2	1	< 0.5	1.0	479	< 0.4	4.7	8.9	1.16	4.9	1.5	1.21	2.0	0.5	3.6	0.9
854821	293	109	338	15	130	2	< 0.5	< 0.2	4	< 0.5	2.1	582	< 0.4	1030	2370	279	1010	187	7.07	118	16.6	82.3	14.5
854822	232	111	74	57	31	< 2	< 0.5	< 0.2	8	< 0.5	8.6	298	< 0.4	12.9	29.3	4.34	19.6	6.6	1.38	8.1	1.8	12.2	2.7

Analyte Symbol	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
854817	2.6	0.37	2.3	0.38	7.0	0.8	< 1	0.6	14	8.4	1.7
854818	35.8	3.36	15.4	1.70	9.3	20.1	3	0.2	160	529	17.4
854819	1.0	0.15	1.0	0.16	1.4	0.2	< 1	0.9	23	1.1	0.7
854820	2.9	0.47	3.3	0.54	0.3	0.6	< 1	1.1	22	1.9	2.7
854821	38.5	5.02	30.2	4.41	1.4	3.7	2	1.3	34	542	27.8
854822	8.6	1.34	9.4	1.46	2.9	2.2	< 1	1.2	21	18.4	9.0

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	0.01	1	1	5	20	1	20	10	30	1	1	5	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas	47.72	18.19	9.74	0.140	9.96	11.37	1.92	0.23	0.480	0.07		31		156									
DNC-1 Cert	47.15	18.34	9.97	0.150	10.13	11.49	1.890	0.234	0.480	0.070		31		148									
GBW 07113 Meas	73.49	12.73	3.23	0.140	0.14	0.58	2.36	5.33	0.280	0.03		5	4	< 5									
GBW 07113 Cert	72.8	13.0	3.21	0.140	0.160	0.590	2.57	5.43	0.300	0.0500		5.00	4.00	5.00									
TDB-1 Meas															260		90	340	150				
TDB-1 Cert															251		92	323	155				
W-2a Meas	52.63	15.41	10.82	0.170	6.24	11.13	2.14	0.62	1.090	0.13		36	< 1	282	100	42	70	110	80	17	1		19
W-2a Cert	52.4	15.4	10.7	0.163	6.37	10.9	2.14	0.626	1.06	0.140		36.0	1.30	262	92.0	43.0	70.0	110	80.0	17.0	1.00		21.0
DTS-2b Meas															14600	128	3670						
DTS-2b Cert															15500	120	3780						
SY-4 Meas	49.96	20.90	6.17	0.110	0.50	7.97	7.06	1.71	0.280	0.11		< 1	3	6									
SY-4 Cert	49.9	20.69	6.21	0.108	0.54	8.05	7.10	1.66	0.287	0.131		1.1	2.6	8.0									
BIR-1a Meas	48.72	15.62	11.35	0.170	9.58	13.40	1.86	0.02	0.970	0.05		43	< 1	341		53	180	130	80	15			
BIR-1a Cert	47.96	15.50	11.30	0.175	9.700	13.30	1.82	0.030	0.96	0.021		44	0.58	310		52	170	125	70	16			
ZW-C Meas																			1000	91			8850
ZW-C Cert																			1050.000	99			8500
OREAS 101b (Fusion) Meas																44		420					
OREAS 101b (Fusion) Cert																47		420					
NCS DC86318 Meas																							374
NCS DC86318 Cert																							369.42
SARM 3 Meas																							
SARM 3 Cert																							
USZ 42-2006 Meas																	< 20		470				
USZ 42-2006 Cert																	13.18		469				
REE-1 Meas															300			80				112	
REE-1 Cert															277			79.7				124	
854822 Orig	69.34	13.48	4.48	0.062	1.05	2.13	3.88	3.00	0.444	0.05	98.64	7	10	28	30	8	< 20	< 10	90	33	2	< 5	233
854822 Dup	68.72	13.91	4.56	0.063	1.06	2.12	3.97	3.05	0.457	0.05	98.69	7	10	28	30	8	< 20	< 10	90	32	2	< 5	231
Method Blank	< 0.01	< 0.01	< 0.01	0.003	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	< 0.01		< 1	< 1	< 5	< 20	< 1	< 20	< 10	< 30	< 1	< 1	< 5	< 2

Analyte Symbol	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas	142	15	32								106												
DNC-1 Cert	144.0	18.0	38								118												
GBW 07113 Meas	41	46	405								498												
GBW 07113 Cert	43.0	43.0	403								506												
TDB-1 Meas													16.8	39.4		24.4		2.10					
TDB-1 Cert													17	41		23		2.1					
W-2a Meas	192	20	83		< 2				0.7		177	< 0.4	10.6	23.1		12.9	3.3			0.6	3.9	0.8	
W-2a Cert	190	24.0	94.0		0.600				0.790		182	0.0300	10.0	23.0		13.0	3.30			0.630	3.60	0.760	
DTS-2b Meas																							
DTS-2b Cert																							
SY-4 Meas	1210	116	529								344												
SY-4 Cert	1191	119	517								340												
BIR-1a Meas	108	13	13								9		0.7	1.9		2.5	1.1	0.54	2.0				
BIR-1a Cert	110	16	18								6		0.63	1.9		2.5	1.1	0.55	2.0				
ZW-C Meas				196				1320	4.3	261			29.9	106	9.70	25.3	6.9		4.6				
ZW-C Cert				198				1300.000	4.2	260			30.0	97	9.5	25.0	6.6		4.70				
OREAS 101b (Fusion) Meas					19								791	1390	127	382	49.0	8.07		5.5	31.5	6.3	18.9
OREAS 101b (Fusion) Cert					21								789	1331	127	378	48	7.77		5.37	32.1	6.34	18.7
NCS DC86318 Meas										10.9			1970	412	732	3330	1660	19.2	2240		3170	587	1690
NCS DC86318 Cert										10.28			1960	430	740	3430	1720	18.91	2095		3220	560	1750
SARM 3 Meas				923																			
SARM 3 Cert				978																			
USZ 42-2006 Meas					36								20800	27900	2320	6280		84.0					
USZ 42-2006 Cert					34.40								21100	27600	2300	6500		87.22					
REE-1 Meas										1.1			1660	3960		1410		23.9	417		852	203	683
REE-1 Cert										1.07			1661	3960		1456		23.5	433		847	208	701
854822 Orig	109	74	56	31	< 2	< 0.5	< 0.2	8	< 0.5	8.6	296	< 0.4	13.0	29.8	4.36	20.3	6.6	1.40	8.1	1.8	12.5	2.7	8.6
854822 Dup	113	73	59	31	< 2	< 0.5	< 0.2	8	< 0.5	8.5	301	< 0.4	12.8	28.9	4.32	19.0	6.5	1.37	8.1	1.7	12.0	2.6	8.6
Method Blank	< 2	< 2	< 4	< 1	< 2	< 0.5	< 0.2	< 1	< 0.5	< 0.5	< 3	< 0.4	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Analyte Symbol	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas										
DNC-1 Cert										
GBW 07113 Meas										
GBW 07113 Cert										
TDB-1 Meas		3.3							2.7	
TDB-1 Cert		3.4							2.7	
W-2a Meas		2.0	0.31	2.6	0.5	< 1	0.2			0.5
W-2a Cert		2.10	0.330	2.60	0.500	0.300	0.200			0.530
DTS-2b Meas										
DTS-2b Cert										
SY-4 Meas										
SY-4 Cert										
BIR-1a Meas		1.6		0.6						
BIR-1a Cert		1.7		0.60						
ZW-C Meas					81.6	333	34.2			19.1
ZW-C Cert					82	320	34			20.0
OREAS 101b (Fusion) Meas	2.74	17.7	2.65						35.2	402
OREAS 101b (Fusion) Cert	2.66	17.6	2.58						37.1	396
NCS DC86318 Meas	263	1770	254						66.5	
NCS DC86318 Cert	270	1840	260.0						67.0	
SARM 3 Meas										
SARM 3 Cert										
USZ 42-2006 Meas								1710	1010	
USZ 42-2006 Cert								1600	946	
REE-1 Meas				491						
REE-1 Cert				479						
854822 Orig	1.36	9.4	1.47	2.9	2.2	< 1	1.2	21	18.9	9.6
854822 Dup	1.32	9.4	1.45	2.9	2.1	< 1	1.2	20	17.9	8.5
Method Blank	< 0.05	< 0.1	< 0.04	< 0.2	< 0.1	< 1	< 0.1	< 5	< 0.1	< 0.1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Quality Analysis ... *Innovative Technologies*

Report No.: **A20-06274**
Report Date: **03-Jul-20**
Date Submitted: **17-Jun-20**
Your Reference: **BAUDE LAKE**

Fancamp Exploration Ltd.
505 Blv Frontenac Est, suite 2
Thetford Minies Quebec G6G 1N5
Canada

ATTN: Jean Bernard

CERTIFICATE OF ANALYSIS

12 Rock and Soil samples were submitted for analysis.

The following analytical package(s) were requested:		Testing Date:
8-REE Assay Package	QOP WRA/ QOP WRA 4B2 (Major/Trace Elements Fusion ICPOES/ICPMS)	2020-06-25 15:24:40

REPORT **A20-06274**

Notes:

Total includes all elements in % oxide to the left of total.

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control Coordinator

ACTIVATION LABORATORIES LTD.
41 Bittern Street, Ancaster, Ontario, Canada, L9G 4V5
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E-MAIL Ancaster@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01		0.01	1	1	5	20	1	20	10	30	1	1	5
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	GRAV	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
787850	73.55	13.44	1.99	0.027	0.60	0.83	2.38	6.72	0.303	0.11	0.69	100.6	2	< 1	19	< 20	4	< 20	< 10	40	17	1	< 5
787851	58.89	14.00	6.88	0.105	1.25	2.89	3.07	2.83	1.042	0.28	7.56	98.79	11	2	92	30	8	< 20	< 10	70	22	1	< 5
787852	60.71	14.47	6.13	0.091	1.30	3.05	3.19	2.88	0.975	0.27	7.00	100.1	11	2	75	30	9	< 20	20	140	21	1	< 5
787853	56.80	12.34	7.14	0.098	1.20	2.58	2.93	2.79	1.457	0.21	11.30	98.84	9	2	106	40	8	< 20	< 10	70	23	1	< 5
787854	57.19	14.68	7.55	0.076	0.85	2.24	2.78	2.59	1.131	0.15	9.60	98.83	9	2	100	30	6	< 20	< 10	70	23	1	< 5
787855	59.06	14.02	6.63	0.090	1.08	2.62	3.18	2.84	1.001	0.17	7.95	98.64	10	2	84	30	6	< 20	< 10	60	21	< 1	< 5
787856	62.56	13.94	6.89	0.099	1.14	2.84	3.26	2.91	1.276	0.20	5.22	100.3	10	2	98	30	9	< 20	< 10	50	22	1	< 5
787857	60.55	13.94	5.95	0.151	1.50	3.44	3.35	2.82	2.008	0.32	4.65	98.68	14	2	85	30	9	< 20	< 10	70	19	1	< 5
787858	58.78	12.72	7.79	0.082	0.86	2.25	2.87	2.84	1.157	0.30	10.97	100.6	8	2	100	30	7	< 20	< 10	40	25	1	< 5
787859	60.13	14.24	7.12	0.100	1.19	2.79	3.27	2.84	1.237	0.12	6.53	99.57	11	2	90	40	6	< 20	< 10	60	21	< 1	< 5
787860	57.10	13.15	8.69	0.079	0.79	2.14	2.83	2.81	1.241	0.26	9.46	98.56	8	2	121	30	6	< 20	< 10	50	30	1	< 5
787861	63.91	12.84	5.26	0.078	0.67	2.09	2.79	2.91	1.286	0.14	6.45	98.43	7	2	80	30	3	< 20	< 10	40	25	< 1	< 5

Analyte Symbol	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1
Method Code	FUS-MS	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
787850	217	257	20	142	5	< 2	0.5	< 0.2	1	< 0.5	0.9	1584	< 0.4	230	448	44.7	144	17.5	1.81	9.1	1.0	4.7	0.8
787851	63	358	52	781	21	3	2.6	< 0.2	2	< 0.5	< 0.5	988	< 0.4	86.1	83.8	22.4	87.5	15.8	2.42	12.7	1.9	10.9	2.1
787852	65	393	46	662	18	2	2.2	< 0.2	2	< 0.5	0.6	1041	2.8	73.6	176	19.1	74.4	14.3	2.38	11.5	1.7	9.8	1.9
787853	84	319	36	1077	32	< 2	3.5	< 0.2	3	< 0.5	0.8	942	< 0.4	78.9	178	16.6	59.2	10.1	1.75	8.0	1.2	7.2	1.4
787854	56	333	24	871	20	< 2	2.7	< 0.2	2	< 0.5	< 0.5	965	< 0.4	21.7	44.0	5.35	21.5	4.5	1.38	4.2	0.7	4.5	1.0
787855	61	340	29	653	18	< 2	1.9	< 0.2	1	< 0.5	< 0.5	977	< 0.4	25.9	71.2	6.79	28.1	6.2	1.80	5.5	0.9	5.6	1.2
787856	66	372	36	864	21	< 2	2.9	< 0.2	2	< 0.5	0.5	1016	< 0.4	31.0	76.9	8.24	34.4	7.4	1.76	6.7	1.1	6.8	1.4
787857	59	367	52	1409	34	< 2	4.6	< 0.2	3	< 0.5	< 0.5	954	< 0.4	42.4	89.0	11.6	47.6	10.0	2.14	9.2	1.5	9.2	2.0
787858	69	339	25	639	20	< 2	2.0	< 0.2	2	< 0.5	0.7	992	< 0.4	22.0	50.1	5.33	21.6	4.3	1.47	4.2	0.7	4.6	0.9
787859	60	361	36	1048	24	2	3.1	< 0.2	2	< 0.5	< 0.5	965	< 0.4	32.5	62.5	9.21	36.7	7.8	1.95	6.9	1.1	6.8	1.5
787860	61	341	22	771	21	< 2	2.6	< 0.2	2	< 0.5	0.5	1037	< 0.4	22.9	45.3	5.36	21.8	4.3	1.36	4.0	0.6	4.0	0.8
787861	62	337	22	1130	23	< 2	3.1	< 0.2	2	< 0.5	< 0.5	1040	< 0.4	23.8	47.2	5.76	21.9	4.7	1.54	3.9	0.6	4.2	0.9

Analyte Symbol	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
787850	2.0	0.27	1.5	0.23	3.4	0.2	< 1	0.9	26	49.0	0.6
787851	5.9	0.86	5.8	0.92	18.3	1.2	< 1	0.3	10	6.4	2.5
787852	5.3	0.75	5.3	0.83	15.5	1.1	< 1	0.3	19	8.1	2.1
787853	4.2	0.62	4.2	0.74	25.3	1.6	< 1	0.3	9	16.7	2.1
787854	3.0	0.47	3.3	0.59	20.5	1.2	< 1	0.2	13	4.2	1.6
787855	3.4	0.54	3.8	0.59	14.9	1.2	< 1	0.2	12	4.0	1.5
787856	4.2	0.63	4.4	0.73	19.5	1.1	< 1	0.2	8	5.5	1.6
787857	5.9	0.90	6.4	1.05	32.0	2.0	< 1	0.2	15	7.4	2.7
787858	3.0	0.45	3.3	0.57	14.7	1.3	< 1	0.2	12	3.6	1.3
787859	4.4	0.64	4.5	0.69	25.2	1.5	2	0.2	14	4.8	1.9
787860	2.5	0.39	2.9	0.48	17.3	1.2	< 1	0.3	13	5.1	1.5
787861	2.8	0.42	3.1	0.53	24.8	1.6	2	0.2	18	4.2	1.6

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	0.01	1	1	5	20	1	20	10	30	1	1	5	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas	47.40	18.71	9.93	0.150	10.13	11.51	1.96	0.23	0.490	0.06		31		158									
DNC-1 Cert	47.15	18.34	9.97	0.150	10.13	11.49	1.890	0.234	0.480	0.070		31		148									
GBW 07113 Meas	71.14	12.87	3.21	0.140	0.14	0.60	2.52	5.43	0.280	0.04		5	4	< 5									
GBW 07113 Cert	72.8	13.0	3.21	0.140	0.160	0.590	2.57	5.43	0.300	0.0500		5.00	4.00	5.00									
TDB-1 Meas															250		90	330	150				21
TDB-1 Cert															251		92	323	155				23
W-2a Meas	52.98	15.35	10.74	0.170	6.27	11.09	2.23	0.62	1.070	0.11		35	< 1	276									
W-2a Cert	52.4	15.4	10.7	0.163	6.37	10.9	2.14	0.626	1.06	0.140		36.0	1.30	262									
DTS-2b Meas															15700	129	3750						
DTS-2b Cert															15500	120	3780						
SY-4 Meas	50.80	20.54	6.16	0.110	0.50	8.17	7.01	1.67	0.290	0.13		1	3	8					100	36			56
SY-4 Cert	49.9	20.69	6.21	0.108	0.54	8.05	7.10	1.66	0.287	0.131		1.1	2.6	8.0					93	35			55.0
BIR-1a Meas	47.98	15.86	11.37	0.170	9.68	13.63	1.85	0.02	0.960	0.02		44	< 1	340		54	180	130	70	15			
BIR-1a Cert	47.96	15.50	11.30	0.175	9.700	13.30	1.82	0.030	0.96	0.021		44	0.58	310		52	170	125	70	16			
ZW-C Meas															60				970	92			8390
ZW-C Cert															56.0				1050	99			8500
NCS DC86318 Meas																							396
NCS DC86318 Cert																							369.42
SARM 3 Meas																							
SARM 3 Cert																							
USZ 25-2006 Meas																35	70		630				
USZ 25-2006 Cert																32.5	70.8		600				
USZ 42-2006 Meas																5	< 20	20	500				65
USZ 42-2006 Cert																7.89	13.18	27.37	469				67.12
REE-1 Meas															290			80				118	1080
REE-1 Cert															277			79.7				124	1050
787861 Orig	64.11	12.69	5.24	0.077	0.67	2.11	2.77	2.92	1.250	0.14	98.42	7	2	82	30	3	< 20	< 10	40	25	< 1	< 5	62
787861 Dup	63.72	12.99	5.28	0.079	0.67	2.08	2.81	2.90	1.323	0.13	98.43	7	2	78	30	3	< 20	< 10	40	25	< 1	< 5	62
787861 Orig															20	5	< 20	< 10	40	24	1	< 5	63
787861 Dup	64.82	13.49	5.26	0.076	0.70	2.10	2.87	2.99	1.333	0.13	100.2	7	2	81	30	5	< 20	< 10	40	24	1	< 5	64
Method Blank															< 20	< 1	< 20	< 10	< 30	< 1	< 1	< 5	< 2
Method Blank	< 0.01	< 0.01	0.01	0.003	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	0.01		< 1	< 1	< 5	< 20	< 1	< 20	< 10	< 30	< 1	< 1	< 5	< 2

Analyte Symbol	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas	148	16	33								107												
DNC-1 Cert	144.0	18.0	38								118												
GBW 07113 Meas	42	46	387								501												
GBW 07113 Cert	43.0	43.0	403								506												
TDB-1 Meas													16.2	38.1		23.3		2.00					
TDB-1 Cert													17	41		23		2.1					
W-2a Meas	195	19	88								176												
W-2a Cert	190	24.0	94.0								182												
DTS-2b Meas																							
DTS-2b Cert																							
SY-4 Meas	1185	117	547	14						1.6	345		59.7	126	14.8	57.6	12.9	2.01	14.6	2.8	19.2	4.5	14.4
SY-4 Cert	1191	119	517	13						1.5	340		58	122	15.0	57	12.7	2.00	14.0	2.6	18.2	4.3	14.2
BIR-1a Meas	111	14	14						0.6		8		0.6	1.8		2.3	1.1	0.50					
BIR-1a Cert	110	16	18						0.58		6		0.63	1.9		2.5	1.1	0.55					
ZW-C Meas				196				1240	4.3	252			28.3	96.5	8.90	23.5	6.4		4.3				
ZW-C Cert				198				1300	4.2	260			30.0	97	9.5	25.0	6.6		4.70				
NCS DC86318 Meas										11.4			1950	417	722	3200	1640	19.1	2330	506	3180	596	1720
NCS DC86318 Cert										11.88			1960	432	737	3429	1725	18.91	2168	468	3224	560	1750
SARM 3 Meas				994																			
SARM 3 Cert				978																			
USZ 25-2006 Meas													18400	29400	2610		830	200					
USZ 25-2006 Cert													19300	29000	2800		900	211.00					
USZ 42-2006 Meas				35	37								22600	30900	2490	6850	545	94.0					
USZ 42-2006 Cert				31.00	34.40								21100	27600	2300	6500	539	87.22					
REE-1 Meas								515		1.1			1670	3970	432	1440	386	24.2	439	113	883	210	703
REE-1 Cert								498		1.07			1661	3960	435	1456	381	23.5	433	106	847	208	701
787861 Orig	331	21	1029	22	< 2	2.7	< 0.2	2	< 0.5	< 0.5	1049	< 0.4	22.9	45.2	5.59	21.5	4.8	1.59	3.8	0.6	4.1	0.9	2.7
787861 Dup	343	22	1231	24	< 2	3.5	< 0.2	2	< 0.5	< 0.5	1031	< 0.4	24.7	49.1	5.93	22.3	4.6	1.49	3.9	0.6	4.2	0.9	2.8
787861 Orig				21	< 2	2.5	< 0.2	2	< 0.5	< 0.5		< 0.4	21.1	42.1	5.02	19.4	4.2	1.47	3.6	0.6	3.9	0.8	2.5
787861 Dup	370	23	1116	24	< 2	3.4	< 0.2	2	< 0.5	< 0.5	1099	< 0.4	20.8	41.7	5.09	20.5	4.4	1.48	3.9	0.6	4.2	0.9	2.6
Method Blank				< 1	< 2	< 0.5	< 0.2	< 1	< 0.5	< 0.5		< 0.4	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Method Blank	< 2	< 2	< 4	< 1	< 2	< 0.5	< 0.2	< 1	< 0.5	< 0.5	< 3	< 0.4	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Analyte Symbol	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
DNC-1 Meas										
DNC-1 Cert										
GBW 07113 Meas										
GBW 07113 Cert										
TDB-1 Meas		3.2							2.9	
TDB-1 Cert		3.4							2.7	
W-2a Meas										
W-2a Cert										
DTS-2b Meas										
DTS-2b Cert										
SY-4 Meas	2.32	15.3	2.23	10.5	0.9			10	1.2	0.8
SY-4 Cert	2.3	14.8	2.1	10.6	0.9			10	1.4	0.8
BIR-1a Meas		1.6	0.27	0.5				< 5		
BIR-1a Cert		1.7	0.3	0.60				3		
ZW-C Meas					80.1	316	33.5			18.4
ZW-C Cert					82	320	34			20.0
NCS DC86318 Meas	266	1770	255						67.7	
NCS DC86318 Cert	271	1844	264						67.0	
SARM 3 Meas										
SARM 3 Cert										
USZ 25-2006 Meas		50.8						1060		
USZ 25-2006 Cert		54.5						1100		
USZ 42-2006 Meas		18.1						1630	1000	
USZ 42-2006 Cert		17.85						1600	946	
REE-1 Meas	109	695		468					768	150
REE-1 Cert	106	678		479					719	137
787861 Orig	0.40	3.0	0.49	24.6	1.5	2	0.3	18	4.1	1.6
787861 Dup	0.43	3.2	0.58	25.0	1.6	2	0.2	18	4.3	1.6
787861 Orig	0.39	2.7	0.48	18.7	1.2	< 1	0.2	17	3.8	1.5
787861 Dup	0.40	2.9	0.54	25.0	1.3	< 1	0.2	14	4.1	1.5
Method Blank	< 0.05	< 0.1	< 0.04	< 0.2	< 0.1	< 1	< 0.1	< 5	< 0.1	< 0.1
Method Blank	< 0.05	< 0.1	< 0.04	< 0.2	< 0.1	< 1	< 0.1	< 5	< 0.1	< 0.1

Quality Analysis ... *Innovative Technologies*

Report No.: **A20-12885**
Report Date: **20-Nov-20**
Date Submitted: **16-Oct-20**
Your Reference: **WELLS**

Fancamp Exploration Ltd.
340 Victoria Ave
Westmount QC H3Z 2M8
Canada

ATTN: Peter H. Smith

CERTIFICATE OF ANALYSIS

49 Rock samples were submitted for analysis.

The following analytical package(s) were requested:		Testing Date:
1A2	QOP AA-Au (Au - Fire Assay AA)	2020-11-20 14:22:31
8-REE Assay Package	QOP WRA/ QOP WRA 4B2 (Major/Trace Elements Fusion ICPOES/ICPMS)	2020-10-29 15:23:25
UT-7	QOP Sodium Peroxide (Sodium Peroxide Fusion ICPOES + ICPMS)	2020-10-27 13:28:06

REPORT **A20-12885**

Notes:

If value exceeds upper limit we recommend reassay by fire assay gravimetric-Code 1A3

Total includes all elements in % oxide to the left of total.

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control Coordinator

ACTIVATION LABORATORIES LTD.
41 Bittern Street, Ancaster, Ontario, Canada, L9G 4V5
TELEPHONE +905 648-9611 or +1.888.228.5227 FAX +1.905.648.9613
E-MAIL Ancaster@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	Total	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As
Unit Symbol	%	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01		0.01	1	1	5	20	1	20	10	30	1	1	5
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	GRAV	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
P134464																							
P134465																							
P134466																							
P134467																							
P134468																							
P134469																							
P134470																							
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P134267																							
P134268																							
P134269																							
P134270																							
P134271																							
P134272																							
787949	63.59	19.61	1.83	0.024	0.53	1.01	4.66	7.81	0.006	0.03	1.13	100.2	< 1	18	< 5	< 20	2	< 20	< 10	< 30	29	2	6
787950	73.20	14.91	1.08	0.012	0.15	2.23	5.36	1.32	0.034	0.01	0.52	98.83	< 1	36	< 5	30	1	< 20	< 10	< 30	33	2	5
787951	69.14	15.51	1.51	0.018	0.24	0.82	3.73	7.08	0.103	0.08	0.67	98.91	3	4	5	20	1	< 20	10	30	22	1	< 5
787952	62.01	13.43	5.37	0.221	0.37	2.75	2.35	4.59	0.497	0.04	1.83	93.46	17	14	72	40	3	< 20	< 10	80	194	30	76
787953	70.47	15.29	1.90	0.054	0.13	0.92	4.01	6.20	0.445	0.05	0.46	99.92	1	5	< 5	40	1	< 20	10	< 30	20	< 1	< 5
854930																							
854931																							
854932																							
894533																							

Analyte Symbol	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	2	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1
Method Code	FUS-MS	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
P134464																							
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P134267																							
P134268																							
P134269																							
P134270																							
P134271																							
P134272																							
787949	227	188	28	59	28	< 2	< 0.5	< 0.2	< 1	< 0.5	4.9	1291	< 0.4	3.7	8.6	1.13	4.7	1.6	1.88	2.1	0.5	3.9	1.0
787950	44	145	82	66	96	3	< 0.5	< 0.2	< 1	< 0.5	1.2	140	< 0.4	9.5	21.7	2.97	13.5	4.8	1.42	6.7	1.7	13.2	3.2
787951	232	194	54	104	8	14	< 0.5	< 0.2	2	< 0.5	0.9	1432	< 0.4	35.2	66.7	7.75	32.8	7.7	2.57	7.8	1.4	9.7	2.0
787952	172	638	1057	101	12	2	< 0.5	0.8	13	< 0.5	0.7	983	< 0.4	12100	23000	2480	8140	1050	40.5	541	60.3	280	44.6
787953	212	173	42	456	49	4	1.3	< 0.2	3	< 0.5	0.8	1197	< 0.4	15.4	28.9	3.53	14.1	3.9	2.09	4.6	1.0	6.9	1.6
854930																							
854931																							
854932																							
894533																							

Analyte Symbol	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.05	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1	0.01	5	10	3	3	2	0.01	2	0.8	0.2	30	0.1
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
P134464												5.34	10	30	687	9	< 2	0.32	< 2	3.7	1.6	120	138
P134465												7.22	< 5	100	1510	16	< 2	0.26	< 2	3.3	1.1	110	540
P134466												3.50	< 5	20	1180	< 3	< 2	0.10	< 2	1.1	1.0	110	113
P134467												3.98	< 5	< 10	994	6	26	0.09	< 2	1.2	0.7	100	129
P134468												3.19	< 5	< 10	59	272	5	0.16	< 2	2.4	0.6	110	81.8
P134469												5.90	< 5	< 10	304	4	3	0.09	< 2	< 0.8	1.0	100	166
P134470												8.60	< 5	< 10	20	67	5	0.12	< 2	1.1	7.2	100	37.2
P134471												3.69	< 5	< 10	291	83	2	0.06	< 2	< 0.8	38.0	100	93.1
P134472												0.65	< 5	< 10	9	< 3	< 2	0.06	< 2	1.1	2.0	150	11.3
P134473												2.99	7	< 10	411	< 3	< 2	0.02	< 2	1.2	1.1	110	115
P134474												0.07	< 5	< 10	< 3	< 3	< 2	0.05	< 2	< 0.8	0.7	130	3.9
P134475												1.41	< 5	< 10	759	< 3	< 2	0.05	< 2	< 0.8	0.7	130	33.4
P134476												3.51	< 5	10	203	122	< 2	0.16	< 2	2.4	0.5	140	58.5
P134477												4.12	7	< 10	322	11	< 2	0.18	< 2	3.2	0.9	110	119
P134478												8.43	9	< 10	256	17	< 2	0.59	< 2	9.2	1.0	70	355
P134479												1.22	7	< 10	107	4	11	0.04	< 2	< 0.8	0.6	120	31.3
P134480												6.06	7	< 10	1000	8	3	0.32	< 2	4.7	1.0	80	345
P134481												5.69	< 5	20	211	11	4	0.31	< 2	4.4	1.2	80	169
P134482												7.47	< 5	20	2180	27	< 2	0.15	< 2	1.5	1.3	90	307
P134483												8.91	5	< 10	1500	19	6	0.19	< 2	2.3	0.9	70	601
P134484												8.54	< 5	< 10	1000	6	< 2	0.14	< 2	< 0.8	1.2	70	406
P134485												4.99	5	< 10	3060	< 3	< 2	0.09	< 2	3.7	0.7	90	131
P134486												6.09	< 5	20	847	10	2	0.26	< 2	1.7	0.7	80	127
P134487												7.56	< 5	40	528	18	< 2	0.45	< 2	8.8	1.5	100	229
P134488												8.78	< 5	< 10	1630	182	8	0.44	< 2	13.8	1.4	80	393
P134489												9.72	< 5	< 10	917	26	< 2	0.74	< 2	18.7	1.5	60	487
P134490												7.58	< 5	< 10	858	11	< 2	0.46	< 2	2.5	0.7	100	102
P134491												8.52	< 5	< 10	2620	4	< 2	0.07	< 2	< 0.8	1.2	60	897
P134492												1.95	< 5	< 10	16	6	< 2	0.15	< 2	1.1	1.0	120	126
P134493												3.06	< 5	< 10	228	< 3	< 2	0.03	< 2	< 0.8	0.8	170	525
P134494												8.58	< 5	< 10	2690	< 3	< 2	0.10	< 2	< 0.8	0.4	60	244
P134495												8.81	< 5	< 10	77	25	< 2	0.77	< 2	11.2	2.0	70	42.5
P134265												8.77	< 5	< 10	87	18	< 2	0.65	< 2	26.9	0.5	70	56.2
P134266												4.82	< 5	< 10	1010	3	< 2	0.06	< 2	< 0.8	1.9	100	217
P134267												8.96	< 5	< 10	3500	17	< 2	0.49	< 2	8.5	1.4	60	453
P134268												5.93	5	10	646	28	< 2	0.47	< 2	6.3	1.7	130	166
P134269												9.03	< 5	< 10	795	11	< 2	0.35	< 2	1.4	0.5	80	170
P134270												9.77	< 5	< 10	907	7	< 2	0.22	< 2	< 0.8	0.5	60	303
P134271												6.98	< 5	< 10	458	33	< 2	0.41	< 2	3.7	0.9	100	131
P134272												10.4	< 5	< 10	134	22	< 2	0.69	< 2	10.7	0.4	50	319
787949	3.6	0.69	5.7	0.98	8.7	5.4	2	0.6	45	5.4	13.3												
787950	11.4	1.96	15.5	2.56	7.7	10.1	3	0.2	52	39.9	59.6												
787951	5.9	0.83	5.2	0.76	2.7	0.2	< 1	1.1	21	2.8	0.9												
787952	111	13.5	72.8	10.5	4.5	< 0.1	< 1	0.8	36	1290	16.9												
787953	4.9	0.82	5.3	0.84	12.1	2.0	< 1	1.0	17	1.9	1.0												
854930																							
854931																							
854932																							
894533																							

Analyte Symbol	Cu	Dy	Er	Eu	Fe	Ga	Gd	Ge	Ho	Hf	In	K	La	Li	Mg	Mn	Mo	Nb	Nd	Ni	Pb	Pr	Rb
Unit Symbol	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	0.3	0.1	0.1	0.05	0.2	0.1	0.7	0.2	10	0.2	0.1	0.4	3	0.01	3	1	2.4	0.4	10	0.8	0.1	0.4
Method Code	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
P134464	5	< 0.3	< 0.1	0.5	0.60	20.0	0.4	2.7	< 0.2	< 10	< 0.2	1.5	2.3	192	0.06	337	7	18.0	2.1	20	10.3	0.5	345
P134465	4	< 0.3	< 0.1	0.4	0.59	21.6	0.3	4.1	< 0.2	< 10	< 0.2	4.1	1.9	509	0.09	310	4	26.0	1.0	20	15.8	0.3	1020
P134466	6	< 0.3	< 0.1	0.4	0.66	9.3	< 0.1	2.4	< 0.2	< 10	< 0.2	2.8	0.6	155	0.02	154	4	4.0	< 0.4	20	18.3	0.1	541
P134467	< 2	< 0.3	< 0.1	0.3	0.42	10.0	< 0.1	2.6	< 0.2	< 10	< 0.2	2.7	0.5	136	0.02	263	7	15.3	0.4	20	8.1	0.3	567
P134468	< 2	< 0.3	< 0.1	< 0.1	0.21	12.3	0.4	2.5	< 0.2	< 10	< 0.2	0.5	1.4	837	0.02	153	5	48.3	1.3	20	1.5	0.2	136
P134469	< 2	< 0.3	< 0.1	< 0.1	0.35	16.8	< 0.1	4.2	< 0.2	< 10	< 0.2	4.5	< 0.4	1470	< 0.01	126	5	10.0	< 0.4	20	14.0	< 0.1	1360
P134470	25	< 0.3	< 0.1	< 0.1	0.74	50.1	0.1	6.1	< 0.2	< 10	< 0.2	0.3	0.4	> 10000	< 0.01	645	7	42.1	< 0.4	20	6.7	< 0.1	85.5
P134471	57	< 0.3	< 0.1	0.3	0.31	16.8	< 0.1	4.6	< 0.2	< 10	< 0.2	1.6	< 0.4	4160	0.01	237	5	19.3	< 0.4	10	11.5	< 0.1	465
P134472	< 2	< 0.3	< 0.1	< 0.1	0.22	2.8	< 0.1	4.3	< 0.2	< 10	< 0.2	< 0.1	< 0.4	515	< 0.01	254	7	198.1	0.5	120	< 0.8	0.3	24.7
P134473	< 2	< 0.3	< 0.1	< 0.1	0.56	13.9	0.1	4.8	< 0.2	< 10	< 0.2	1.7	0.4	2650	0.04	281	5	9.4	< 0.4	20	8.6	0.1	399
P134474	3	< 0.3	< 0.1	< 0.1	0.22	0.4	< 0.1	3.7	< 0.2	< 10	< 0.2	< 0.1	< 0.4	77	< 0.01	25	5	5.5	< 0.4	20	9.3	< 0.1	5.0
P134475	< 2	< 0.3	< 0.1	0.2	0.22	2.5	< 0.1	5.2	< 0.2	< 10	< 0.2	1.4	< 0.4	76	< 0.01	37	7	< 2.4	< 0.4	20	23.4	< 0.1	266
P134476	5	< 0.3	< 0.1	0.1	0.65	13.6	0.3	2.6	< 0.2	< 10	< 0.2	1.2	1.4	165	0.03	126	9	79.6	1.1	40	14.1	0.4	349
P134477	4	< 0.3	< 0.1	< 0.1	0.43	17.9	0.2	3.6	< 0.2	< 10	< 0.2	1.5	1.3	1590	0.04	233	5	12.9	1.3	20	25.3	0.3	391
P134478	< 2	< 0.3	< 0.1	0.5	0.56	28.0	0.7	2.9	< 0.2	< 10	< 0.2	1.2	4.6	553	0.11	313	2	49.8	3.6	10	15.6	1.2	413
P134479	11	< 0.3	< 0.1	0.1	0.58	4.4	< 0.1	3.5	< 0.2	< 10	< 0.2	0.6	< 0.4	153	< 0.01	152	6	34.2	< 0.4	10	22.1	< 0.1	164
P134480	3	< 0.3	0.1	0.3	0.62	20.7	0.5	2.9	< 0.2	< 10	< 0.2	2.0	2.7	463	0.09	501	3	41.6	4.2	< 10	24.2	0.9	526
P134481	< 2	0.3	< 0.1	0.1	0.71	20.4	0.4	3.0	< 0.2	< 10	< 0.2	0.9	3.0	481	0.12	549	2	34.9	1.9	20	9.9	0.6	347
P134482	< 2	< 0.3	< 0.1	0.4	0.69	23.0	0.4	3.3	< 0.2	< 10	< 0.2	4.6	0.8	494	0.08	328	5	75.1	0.9	10	17.9	0.2	984
P134483	2	< 0.3	0.1	0.5	0.56	23.5	0.2	3.8	< 0.2	< 10	< 0.2	7.1	1.6	568	0.10	324	3	25.7	1.1	20	24.4	0.3	2070
P134484	< 2	< 0.3	< 0.1	0.3	0.72	25.5	< 0.1	4.1	< 0.2	< 10	< 0.2	7.3	< 0.4	882	0.04	213	2	11.2	0.4	10	33.5	0.1	2610
P134485	11	< 0.3	< 0.1	0.7	0.63	13.6	0.2	2.3	< 0.2	< 10	< 0.2	4.9	2.0	139	0.02	107	4	10.5	1.5	30	23.4	0.6	945
P134486	< 2	< 0.3	< 0.1	0.3	0.41	16.0	0.2	3.0	< 0.2	< 10	< 0.2	2.3	1.2	214	0.04	363	1	14.2	< 0.4	30	34.5	0.3	500
P134487	< 2	0.7	< 0.1	0.2	0.52	24.4	0.6	3.1	< 0.2	< 10	< 0.2	1.8	4.1	367	0.07	510	4	23.7	4.9	10	10.5	1.1	447
P134488	< 2	1.0	0.3	0.4	0.74	28.0	1.5	3.1	< 0.2	< 10	< 0.2	3.6	6.0	590	0.10	787	4	40.6	7.3	10	39.1	1.8	874
P134489	< 2	1.7	0.4	0.6	0.93	31.7	2.2	3.4	< 0.2	< 10	< 0.2	2.1	8.3	805	0.15	883	2	48.0	11.0	20	15.4	2.2	716
P134490	< 2	< 0.3	< 0.1	0.3	0.52	16.3	0.2	2.6	< 0.2	< 10	< 0.2	3.2	1.0	116	0.05	202	3	4.3	1.1	10	15.1	0.3	579
P134491	< 2	< 0.3	< 0.1	0.5	0.79	21.2	< 0.1	2.9	< 0.2	< 10	< 0.2	8.4	< 0.4	742	0.14	459	2	43.1	< 0.4	20	41.8	< 0.1	2330
P134492	< 2	0.3	0.2	< 0.1	0.31	9.0	0.4	4.3	< 0.2	< 10	< 0.2	0.2	0.5	180	0.02	1080	4	44.1	0.6	20	5.4	0.2	116
P134493	3	< 0.3	< 0.1	< 0.1	0.93	16.2	< 0.1	4.8	< 0.2	< 10	< 0.2	1.6	< 0.4	785	0.06	364	11	21.5	< 0.4	20	3.5	< 0.1	716
P134494	< 2	< 0.3	< 0.1	0.5	0.28	20.8	< 0.1	3.0	< 0.2	< 10	< 0.2	8.6	0.5	80	0.02	84	2	9.0	< 0.4	10	30.4	< 0.1	1960
P134495	< 2	0.5	0.2	0.5	0.32	27.2	1.5	3.1	< 0.2	< 10	< 0.2	0.4	5.3	53	0.03	826	3	11.3	6.5	110	62.9	1.7	85.2
P134265	11	1.1	0.2	0.5	0.43	25.6	3.1	3.1	< 0.2	10	< 0.2	0.3	12.8	79	0.03	300	3	5.8	16.1	10	10.7	3.1	106
P134266	57	< 0.3	< 0.1	0.3	0.52	12.5	< 0.1	2.8	< 0.2	< 10	< 0.2	4.3	0.4	116	0.04	172	4	54.1	< 0.4	30	46.9	< 0.1	842
P134267	3	0.8	0.3	1.1	0.66	26.3	1.8	2.8	< 0.2	< 10	< 0.2	5.8	3.4	342	0.12	477	2	35.7	5.0	10	26.7	1.4	1230
P134268	15	< 0.3	0.2	0.3	1.17	16.6	0.3	2.7	< 0.2	< 10	< 0.2	1.9	3.1	199	0.13	271	7	13.1	2.8	20	38.2	0.6	401
P134269	< 2	< 0.3	< 0.1	0.2	0.19	22.5	0.2	2.9	< 0.2	< 10	< 0.2	3.6	0.9	45	0.01	89	1	4.8	0.8	10	19.0	0.2	673
P134270	4	< 0.3	< 0.1	0.3	0.17	22.0	< 0.1	3.1	< 0.2	< 10	< 0.2	7.0	0.6	53	< 0.01	42	2	< 2.4	1.0	10	29.7	< 0.1	1330
P134271	< 2	< 0.3	< 0.1	0.2	0.49	22.6	0.3	2.6	< 0.2	< 10	< 0.2	1.2	2.6	145	0.03	161	5	8.0	1.7	20	17.1	0.7	287
P134272	3	0.4	0.3	0.3	0.50	36.4	0.9	2.7	< 0.2	< 10	< 0.2	0.8	4.5	365	0.08	255	1	21.6	3.6	10	29.6	1.2	421
787949																							
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787951																							
787952																							
787953																							
854930																							
854931																							
854932																							
894533																							

Analyte Symbol	S	Sb	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Au	Li
Unit Symbol	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	%
Lower Limit	0.01	2	8	0.01	0.1	0.5	3	0.2	0.1	6	0.1	0.01	0.1	0.1	0.1	5	0.7	0.1	0.1	30	5	0.01
Method Code	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FA-AA	FUS-Na2O2
P134464	< 0.01	< 2	< 8	> 30.0	0.4	5.0	407	5.2	< 0.1	< 6	1.7	0.02	2.6	< 0.1	0.7	16	< 0.7	1.3	0.2	40		
P134465	< 0.01	< 2	24	> 30.0	0.1	8.9	472	14.7	< 0.1	< 6	1.0	0.03	6.8	< 0.1	0.5	11	< 0.7	0.6	0.2	80		
P134466	< 0.01	< 2	15	> 30.0	0.4	2.4	232	1.9	< 0.1	< 6	0.5	< 0.01	4.7	< 0.1	0.3	7	< 0.7	0.4	< 0.1	30		
P134467	< 0.01	< 2	< 8	> 30.0	< 0.1	2.7	235	10.6	< 0.1	< 6	1.2	< 0.01	4.0	< 0.1	0.7	9	< 0.7	0.6	0.1	< 30		
P134468	< 0.01	< 2	< 8	> 30.0	0.5	5.6	172	9.2	< 0.1	12	1.2	< 0.01	0.7	< 0.1	0.6	10	< 0.7	< 0.1	< 0.1	40		
P134469	< 0.01	< 2	< 8	> 30.0	< 0.1	5.4	214	9.0	< 0.1	12	< 0.1	< 0.01	10.7	< 0.1	0.6	8	< 0.7	< 0.1	< 0.1	< 30		
P134470	0.02	< 2	< 8	> 30.0	< 0.1	21.6	71	106	< 0.1	10	0.3	< 0.01	0.5	< 0.1	2.2	< 5	< 0.7	0.3	0.1	70		1.28
P134471	0.01	< 2	< 8	> 30.0	< 0.1	13.1	101	25.0	< 0.1	8	0.2	< 0.01	4.0	< 0.1	1.0	10	0.9	< 0.1	0.1	< 30		
P134472	< 0.01	< 2	< 8	> 30.0	0.2	18.3	24	586	< 0.1	< 6	0.5	< 0.01	< 0.1	< 0.1	3.7	8	3.0	< 0.1	0.1	< 30		
P134473	< 0.01	< 2	< 8	> 30.0	0.3	6.4	104	3.0	< 0.1	< 6	0.6	0.01	2.5	< 0.1	0.3	10	1.7	< 0.1	0.2	60		
P134474	< 0.01	< 2	< 8	> 30.0	< 0.1	1.3	< 3	10.7	< 0.1	< 6	< 0.1	< 0.01	< 0.1	< 0.1	0.2	10	1.0	< 0.1	< 0.1	40		
P134475	< 0.01	< 2	< 8	> 30.0	< 0.1	1.0	126	0.6	< 0.1	< 6	< 0.1	< 0.01	1.8	< 0.1	0.1	6	< 0.7	0.2	< 0.1	40		
P134476	< 0.01	< 2	19	> 30.0	0.4	8.2	206	13.0	< 0.1	< 6	1.5	< 0.01	2.2	< 0.1	0.7	8	< 0.7	0.4	< 0.1	30		
P134477	0.02	< 2	12	> 30.0	0.3	10.0	258	4.8	< 0.1	< 6	0.7	0.04	3.1	< 0.1	0.5	12	< 0.7	1.3	0.1	< 30		
P134478	< 0.01	< 2	10	> 30.0	0.8	9.7	721	17.9	0.1	< 6	2.0	0.04	2.7	< 0.1	1.4	14	1.3	2.0	< 0.1	40		
P134479	0.02	< 2	< 8	> 30.0	< 0.1	3.0	66	15.6	< 0.1	< 6	0.3	< 0.01	1.2	< 0.1	0.7	6	1.1	0.2	0.3	< 30		
P134480	0.02	< 2	12	> 30.0	0.7	8.3	447	23.9	< 0.1	< 6	1.8	0.04	3.0	< 0.1	1.5	13	1.7	2.5	0.4	50		
P134481	0.02	< 2	< 8	> 30.0	0.5	8.7	389	9.6	< 0.1	< 6	1.4	0.05	2.4	< 0.1	0.8	15	0.7	1.0	< 0.1	70		
P134482	< 0.01	< 2	< 8	> 30.0	0.4	11.1	480	57.8	< 0.1	< 6	0.8	0.03	7.4	< 0.1	0.8	10	0.7	0.2	< 0.1	60		
P134483	0.01	< 2	< 8	> 30.0	0.5	8.4	539	10.1	< 0.1	< 6	0.5	0.04	15.8	< 0.1	0.5	13	6.2	0.7	< 0.1	70		
P134484	< 0.01	< 2	< 8	> 30.0	< 0.1	5.9	387	4.4	< 0.1	< 6	0.3	0.02	19.4	< 0.1	0.3	< 5	< 0.7	0.3	< 0.1	30		
P134485	< 0.01	< 2	< 8	> 30.0	0.6	2.0	419	5.6	< 0.1	< 6	1.5	< 0.01	7.3	< 0.1	0.2	16	1.3	0.6	0.2	30		
P134486	< 0.01	< 2	< 8	> 30.0	< 0.1	4.8	424	5.6	< 0.1	< 6	0.8	0.02	3.2	< 0.1	0.6	5	< 0.7	1.4	0.2	30		
P134487	< 0.01	< 2	< 8	> 30.0	0.4	4.7	516	8.3	0.1	7	2.9	0.03	3.5	< 0.1	1.2	8	< 0.7	2.2	0.2	40		
P134488	< 0.01	< 2	< 8	> 30.0	1.8	8.6	649	18.0	0.2	< 6	4.8	0.04	7.1	< 0.1	2.9	5	< 0.7	4.2	0.1	70		
P134489	0.01	< 2	19	> 30.0	2.7	13.5	706	14.1	0.3	< 6	5.7	0.06	5.0	< 0.1	2.6	9	< 0.7	6.9	0.3	80		
P134490	< 0.01	< 2	< 8	> 30.0	< 0.1	1.4	633	1.7	< 0.1	< 6	0.7	0.02	4.4	< 0.1	0.7	6	< 0.7	0.5	< 0.1	< 30		
P134491	< 0.01	< 2	12	> 30.0	< 0.1	13.0	543	7.8	< 0.1	< 6	0.2	0.05	17.6	< 0.1	0.3	8	< 0.7	0.2	< 0.1	60		
P134492	< 0.01	< 2	< 8	> 30.0	0.2	6.4	74	36.8	< 0.1	< 6	2.3	< 0.01	0.7	< 0.1	3.9	< 5	< 0.7	2.0	< 0.1	60		
P134493	< 0.01	< 2	< 8	> 30.0	< 0.1	14.0	125	11.4	< 0.1	< 6	2.1	0.02	4.5	< 0.1	0.8	6	< 0.7	0.3	0.2	60		
P134494	< 0.01	< 2	< 8	> 30.0	< 0.1	3.9	636	3.1	< 0.1	< 6	0.1	< 0.01	14.8	< 0.1	0.2	6	< 0.7	0.4	0.1	< 30		
P134495	< 0.01	< 2	< 8	> 30.0	1.2	3.4	783	9.6	0.1	8	6.4	< 0.01	0.6	< 0.1	4.5	6	< 0.7	3.0	0.1	50		
P134265	< 0.01	< 2	< 8	> 30.0	3.6	2.5	739	2.6	0.3	8	23.0	< 0.01	0.6	< 0.1	6.3	6	< 0.7	3.9	0.3	< 30		
P134266	< 0.01	< 2	< 8	> 30.0	< 0.1	4.8	224	38.1	< 0.1	< 6	0.2	< 0.01	6.0	< 0.1	0.7	< 5	< 0.7	0.3	0.2	70		
P134267	< 0.01	< 2	< 8	> 30.0	1.8	7.6	652	13.3	0.2	8	1.5	0.05	9.7	< 0.1	1.8	7	< 0.7	5.0	0.2	50		
P134268	0.02	< 2	< 8	> 30.0	0.6	5.9	376	4.7	< 0.1	< 6	1.4	0.06	3.1	< 0.1	0.9	14	< 0.7	2.1	0.2	60		
P134269	< 0.01	< 2	10	> 30.0	0.5	1.8	558	2.8	< 0.1	12	0.9	< 0.01	5.2	< 0.1	0.7	< 5	< 0.7	0.2	< 0.1	< 30		
P134270	< 0.01	< 2	15	> 30.0	< 0.1	4.9	470	1.1	< 0.1	< 6	0.2	< 0.01	9.6	< 0.1	0.2	< 5	< 0.7	< 0.1	0.1	< 30		
P134271	< 0.01	< 2	< 8	> 30.0	0.2	3.6	636	3.9	< 0.1	< 6	1.4	0.01	1.9	< 0.1	0.6	< 5	< 0.7	1.0	0.2	80		
P134272	< 0.01	< 2	< 8	> 30.0	1.6	14.4	877	4.9	0.1	< 6	2.2	0.03	2.3	< 0.1	1.2	9	< 0.7	1.9	0.1	40		
787949																						
787950																						
787951																						
787952																						
787953																						
854930																					< 5	
854931																					5	
854932																					< 5	
894533																					< 5	

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
Unit Symbol	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	1	1	5	20	1	20	10	30	1	1	5	2	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP
NIST 694 Meas	11.47	1.90	0.74	0.014	0.33	42.94	0.89	0.55	0.117	30.22			1656										
NIST 694 Cert	11.2	1.80	0.790	0.0116	0.330	43.6	0.860	0.510	0.110	30.2			1740										
DNC-1 Meas	47.12	18.81	9.94	0.150	9.93	11.46	1.93	0.23	0.480	0.07	31		156										144
DNC-1 Cert	47.15	18.34	9.97	0.150	10.13	11.49	1.890	0.234	0.480	0.070	31		148										144.0
GBW 07113 Meas	67.32	12.60	3.16	0.141	0.14	0.59	2.48	5.37	0.275	0.03	5	4	5										40
GBW 07113 Cert	72.8	13.0	3.21	0.140	0.160	0.590	2.57	5.43	0.300	0.0500	5.00	4.00	5.00										43.0
PTM-1a Meas																							
PTM-1a Cert																							
W-2a Meas	52.64	15.41	10.89	0.170	6.23	11.11	2.24	0.63	1.080	0.13	36	< 1	281										194
W-2a Cert	52.4	15.4	10.7	0.163	6.37	10.9	2.14	0.626	1.06	0.140	36.0	1.30	262										190
NIST 696 Meas																							
NIST 696 Cert																							
DTS-2b Meas														15600	130	3680							
DTS-2b Cert														15500	120	3780							
GBW 07239 (NCS DC 70007) Meas																							
GBW 07239 (NCS DC 70007) Cert																							
GBW 07239 (NCS DC 70007) Meas																							
GBW 07239 (NCS DC 70007) Cert																							
SY-4 Meas	50.12	20.60	6.18	0.110	0.50	8.18	6.92	1.66	0.290	0.13	1	3	7		2			90	33			51	1203
SY-4 Cert	49.9	20.69	6.21	0.108	0.54	8.05	7.10	1.66	0.287	0.131	1.1	2.6	8.0		2.8			93	35			55.0	1191
Oreas 74a (Fusion) Meas																							
Oreas 74a (Fusion) Cert																							
Oreas 74a (Fusion) Meas																							
Oreas 74a (Fusion) Cert																							
BIR-1a Meas	48.12	15.79	11.31	0.170	9.48	13.47	1.83	0.02	0.950	0.02	43	< 1	338	390	50	170	130	60	14		< 5		108
BIR-1a Cert	47.96	15.50	11.30	0.175	9.700	13.30	1.82	0.030	0.96	0.021	44	0.58	310	370	52	170	125	70	16		0.44		110
ZW-C Meas																		1080	99			8830	
ZW-C Cert																		1050	99			8500	
OREAS 101a (Fusion) Meas																							
OREAS 101a (Fusion) Cert																							
OREAS 101b (Fusion) Meas															44	< 20	420						
OREAS 101b (Fusion) Cert															47	9	420						
NCS DC86318 Meas																						372	
NCS DC86318 Cert																						369.42	
AMIS 0129 Meas	9.58	2.75	58.77	0.348	2.00	0.82			22.70				2750										
AMIS 0129 Cert	9.57	2.75	62.31	0.36	2.07	0.80			22.94				2689										
NCS DC19003a Meas	3.84	4.42	70.42	0.353	3.17	1.06			12.82				3262										
NCS DC19003a Cert	3.96	4.40	75.45	0.364	3.17	1.05			12.96				3132										

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
Unit Symbol	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	1	1	5	20	1	20	10	30	1	1	5	2	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP
SARM 3 Meas																							
SARM 3 Cert																							
USZ 25-2006 Meas															34	70		620					
USZ 25-2006 Cert															32.5	70.8		600					
NCS DC86315 Meas																							
NCS DC86315 Cert																							
NCS DC86303 Meas																							
NCS DC86303 Cert																							
NCS DC86303 Meas																							
NCS DC86303 Cert																							
NCS DC86304 Meas																							
NCS DC86304 Cert																							
NCS DC86314 Meas																							
NCS DC86314 Cert																							
USZ 42-2006 Meas															4	< 20	20	450					
USZ 42-2006 Cert															7.89	13.18	27.37	469					
CPB-2 Meas																							
CPB-2 Cert																							
CZN-4 Meas																							
CZN-4 Cert																							
REE-1 Meas														290	1	30	80				114	1020	
REE-1 Cert														277	1.58	24.7	79.7				124	1050	
OREAS 922 (Peroxide Fusion) Meas																							
OREAS 922 (Peroxide Fusion) Cert																							
OREAS 621 (Peroxide Fusion) Meas																							
OREAS 621 (Peroxide Fusion) Cert																							
OREAS 621 (Peroxide Fusion) Meas																							
OREAS 621 (Peroxide Fusion) Cert																							
OREAS 251(FA-Ancaster) Meas																							
OREAS																							

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
Unit Symbol	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	1	1	5	20	1	20	10	30	1	1	5	2	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP
251(FA-Ancaster) Cert																							
CCU-1e Meas																							
CCU-1e Cert																							
CCU-1e Meas																							
CCU-1e Cert																							
Oreas 237 (fire Assay) Meas																							
Oreas 237 (fire Assay) Cert																							
OREAS 680 (Peroxide Fusion) Meas																							
OREAS 680 (Peroxide Fusion) Cert																							
OREAS 680 (Peroxide Fusion) Meas																							
OREAS 680 (Peroxide Fusion) Cert																							
OREAS 139 (Peroxide Fusion) Meas																							
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OREAS 139 (Peroxide Fusion) Meas																							
OREAS 139 (Peroxide Fusion) Cert																							
OREAS 624 (Peroxide Fusion) Meas																							
OREAS 624 (Peroxide Fusion) Cert																							
OREAS 624 (Peroxide Fusion) Meas																							
OREAS 624 (Peroxide Fusion) Cert																							
OREAS 124 (Peroxide Fusion) Meas																							
OREAS 124 (Peroxide Fusion) Cert																							
OREAS 124 (Peroxide Fusion) Meas																							
OREAS 124 (Peroxide Fusion) Cert																							
OREAS 352																							

Analyte Symbol	SiO2	Al2O3	Fe2O3(T)	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
Unit Symbol	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.01	0.01	0.01	0.001	0.01	0.01	0.01	0.01	0.001	0.01	1	1	5	20	1	20	10	30	1	1	5	2	2
Method Code	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP
Peroxide Fusion Meas																							
OREAS 352 Peroxide Fusion Cert																							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
P134469 Orig																							
P134469 Dup																							
P134477 Orig																							
P134477 Dup																							
P134491 Orig																							
P134491 Dup																							
P134268 Orig																							
P134268 Dup																							
894533 Orig																							
894533 Split PREP DUP																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank	0.01	< 0.01	0.01	0.003	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	< 0.01	< 1	< 1	< 5	< 20	< 1	< 20	< 10	< 30	< 1	< 1	< 5	< 2	< 2
Method Blank	< 0.01	< 0.01	0.01	0.003	< 0.01	< 0.01	0.01	< 0.01	< 0.001	< 0.01	< 1	< 1	< 5										< 2
Method Blank	< 0.01	< 0.01	< 0.01	< 0.001	< 0.01	< 0.01	< 0.01	< 0.01	< 0.001	< 0.01	< 1	< 1	< 5										< 2
Method Blank																							
Method Blank																							

Analyte Symbol	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.05
Method Code	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
NIST 694 Meas																							
NIST 694 Cert																							
DNC-1 Meas	16	36								109													
DNC-1 Cert	18.0	38								118													
GBW 07113 Meas	44	389								495													
GBW 07113 Cert	43.0	403								506													
PTM-1a Meas																							
PTM-1a Cert																							
W-2a Meas	19	91								179													
W-2a Cert	24.0	94.0								182													
NIST 696 Meas																							
NIST 696 Cert																							
DTS-2b Meas																							
DTS-2b Cert																							
GBW 07239 (NCS DC 70007) Meas																							
GBW 07239 (NCS DC 70007) Cert																							
GBW 07239 (NCS DC 70007) Meas																							
GBW 07239 (NCS DC 70007) Cert																							
SY-4 Meas	116	542	14						1.4	351		57.9	122	14.5	58.4	13.0	1.96	13.6	2.7	18.5	4.3	14.0	2.21
SY-4 Cert	119	517	13						1.5	340		58	122	15.0	57	12.7	2.00	14.0	2.6	18.2	4.3	14.2	2.3
Oreas 74a (Fusion) Meas																							
Oreas 74a (Fusion) Cert																							
Oreas 74a (Fusion) Meas																							
Oreas 74a (Fusion) Cert																							
BIR-1a Meas	14	15						< 0.5		9		0.6	1.9		2.4	1.1	0.51	1.8					
BIR-1a Cert	16	18						0.58		6		0.63	1.9		2.5	1.1	0.55	2.0					
ZW-C Meas							1400	4.9	278			31.8	105	10.2				4.7					
ZW-C Cert							1300	4.2	260			30.0	97	9.5				4.70					
OREAS 101a (Fusion) Meas																							
OREAS 101a (Fusion) Cert																							
OREAS 101b (Fusion) Meas				19								808	1410	125	389	50.0	7.89		5.2	30.9	6.2	18.7	2.71
OREAS 101b (Fusion) Cert				21								789	1331	127	378	48	7.77		5.37	32.1	6.34	18.7	2.66
NCS DC86318 Meas									10.7			2080	397	777	3310	1690	19.0	2270	508	3480		1810	270
NCS DC86318 Cert									11.88			1960	432	737	3429	1725	18.91	2168	468	3224		1750	271
AMIS 0129 Meas																							
AMIS 0129 Cert																							
NCS DC19003a Meas																							
NCS DC19003a Cert																							

Analyte Symbol	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.05
Method Code	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
SARM 3 Meas			947																				
SARM 3 Cert			978																				
USZ 25-2006 Meas												19200	29400	2800	8510	843	198						
USZ 25-2006 Cert												19300	29000	2800	8800	900	211.00						
NCS DC86315 Meas																							
NCS DC86315 Cert																							
NCS DC86303 Meas																							
NCS DC86303 Cert																							
NCS DC86303 Meas																							
NCS DC86303 Cert																							
NCS DC86304 Meas																							
NCS DC86304 Cert																							
NCS DC86314 Meas																							
NCS DC86314 Cert																							
USZ 42-2006 Meas			36	36								21900	28600	2470	6350	507	86.0						
USZ 42-2006 Cert			31.00	34.40								21100	27600	2300	6500	539	87.22						
CPB-2 Meas																							
CPB-2 Cert																							
CZN-4 Meas																							
CZN-4 Cert																							
REE-1 Meas							493		1.0			1740	4000	430	1470	394	24.3	417	113	877	210	703	109
REE-1 Cert							498		1.07			1661	3960	435	1456	381	23.5	433	106	847	208	701	106
OREAS 922 (Peroxide Fusion) Meas																							
OREAS 922 (Peroxide Fusion) Cert																							
OREAS 621 (Peroxide Fusion) Meas																							
OREAS 621 (Peroxide Fusion) Cert																							
OREAS 621 (Peroxide Fusion) Meas																							
OREAS 621 (Peroxide Fusion) Cert																							
OREAS 251(FA-Ancaster) Meas																							
OREAS 251(FA-Ancaster)																							

Analyte Symbol	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.05
Method Code	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
Cert																							
CCU-1e Meas																							
CCU-1e Cert																							
CCU-1e Meas																							
CCU-1e Cert																							
Oreas 237 (fire Assay) Meas																							
Oreas 237 (fire Assay) Cert																							
OREAS 680 (Peroxide Fusion) Meas																							
OREAS 680 (Peroxide Fusion) Cert																							
OREAS 680 (Peroxide Fusion) Meas																							
OREAS 680 (Peroxide Fusion) Cert																							
OREAS 139 (Peroxide Fusion) Meas																							
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OREAS 139 (Peroxide Fusion) Cert																							
OREAS 624 (Peroxide Fusion) Meas																							
OREAS 624 (Peroxide Fusion) Cert																							
OREAS 624 (Peroxide Fusion) Meas																							
OREAS 624 (Peroxide Fusion) Cert																							
OREAS 124 (Peroxide Fusion) Meas																							
OREAS 124 (Peroxide Fusion) Cert																							
OREAS 124 (Peroxide Fusion) Meas																							
OREAS 124 (Peroxide Fusion) Cert																							
OREAS 352 Peroxide Fusion Meas																							

Analyte Symbol	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	Bi	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	2	4	1	2	0.5	0.2	1	0.5	0.5	3	0.4	0.1	0.1	0.05	0.1	0.1	0.05	0.1	0.1	0.1	0.1	0.1	0.05
Method Code	FUS-ICP	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-ICP	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS
OREAS 352 Peroxide Fusion Cert																							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
P134469 Orig																							
P134469 Dup																							
P134477 Orig																							
P134477 Dup																							
P134491 Orig																							
P134491 Dup																							
P134268 Orig																							
P134268 Dup																							
894533 Orig																							
894533 Split PREP DUP																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank	< 2	< 4	< 1	< 2	< 0.5	< 0.2	< 1	< 0.5	< 0.5	< 3	< 0.4	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.05	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.05
Method Blank	< 2	< 4								< 3													
Method Blank	< 2	< 4								< 3													
Method Blank																							
Method Blank																							

Analyte Symbol	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1	0.01	5	10	3	3	2	0.01	2	0.8	0.2	30	0.1	2	0.3
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
NIST 694 Meas																							
NIST 694 Cert																							
DNC-1 Meas																							
DNC-1 Cert																							
GBW 07113 Meas																							
GBW 07113 Cert																							
PTM-1a Meas											2200								> 5000			> 10000	
PTM-1a Cert											2200								20500.00			249600.00	
W-2a Meas																							
W-2a Cert																							
NIST 696 Meas										> 25.0													
NIST 696 Cert										28.9													
DTS-2b Meas										0.22						0.09							
DTS-2b Cert										0.240						0.0900							
GBW 07239 (NCS DC 70007) Meas											9				< 2			62.6	15.2			56	
GBW 07239 (NCS DC 70007) Cert											1				1			60.3	13.5			49	
GBW 07239 (NCS DC 70007) Meas											12				< 2			60.0	13.2			46	
GBW 07239 (NCS DC 70007) Cert											1.0				1			60.3	13.5			49	
SY-4 Meas	14.7	2.13	10.1	0.9			10		0.8														
SY-4 Cert	14.8	2.1	10.6	0.9			10		0.8														
Oreas 74a (Fusion) Meas											57								577	1810		1210	
Oreas 74a (Fusion) Cert											50								581	1800.00		1240.000	
Oreas 74a (Fusion) Meas											56								539	1770		1160	
Oreas 74a (Fusion) Cert											50								581	1800.00		1240.000	
BIR-1a Meas	1.6	0.26	0.5				< 5																
BIR-1a Cert	1.7	0.3	0.60				3																
ZW-C Meas				87.2	328	33.1			20.4														
ZW-C Cert				82	320	34			20.0														
OREAS 101a (Fusion) Meas																		1260	50.2			407	30.0
OREAS 101a (Fusion) Cert																		1396	48.8			434	33.3
OREAS 101b (Fusion) Meas	17.7	2.63						36.2	399														
OREAS 101b (Fusion) Cert	17.6	2.58						37.1	396														
NCS DC86318 Meas	1790	253						66.0															
NCS DC86318 Cert	1844	264						67.0															
AMIS 0129 Meas																							
AMIS 0129 Cert																							
NCS DC19003a Meas																							
NCS DC19003a																							

Analyte Symbol	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1	0.01	5	10	3	3	2	0.01	2	0.8	0.2	30	0.1	2	0.3
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
Cert																							
SARM 3 Meas																							
SARM 3 Cert																							
USZ 25-2006 Meas	52.8						1120																
USZ 25-2006 Cert	54.5						1100																
NCS DC86315 Meas																							
NCS DC86315 Cert																							
NCS DC86303 Meas																					360		
NCS DC86303 Cert																					350		
NCS DC86303 Meas																					363		
NCS DC86303 Cert																					350		
NCS DC86304 Meas																							
NCS DC86304 Cert																							
NCS DC86314 Meas																					2950		
NCS DC86314 Cert																					2830		
USZ 42-2006 Meas	17.0						1610	995															
USZ 42-2006 Cert	17.85						1600	946															
CPB-2 Meas										0.07													
CPB-2 Cert										0.074													
CZN-4 Meas										0.08	390						2600		96.7			4040	
CZN-4 Cert										0.0715	356.000						2604.000		93.5			4030.000	
REE-1 Meas	698		461					756	140														
REE-1 Cert	678		479					719	137														
OREAS 922 (Peroxide Fusion) Meas										7.34			473		14	0.50		91.4	23.4	140	7.3	2190	5.7
OREAS 922 (Peroxide Fusion) Cert										7.59			481		11	0.49		88.0	20.9	90	7.5	2220	5.75
OREAS 621 (Peroxide Fusion) Meas										6.68	85		2740	< 3	4	1.91	290	57.4	33.7	110	4.0	3750	
OREAS 621 (Peroxide Fusion) Cert										6.63	85		2610	2	4	2.00	295	52.0	31.4	49	3.6	3680	
OREAS 621 (Peroxide Fusion) Meas											83		2570	< 3	4		271	57.4	26.6	120	4.4	3510	
OREAS 621 (Peroxide Fusion) Cert											85		2610	2	4		295	52.0	31.4	49	3.6	3680	
OREAS 251(FA-Ancaster)																							

Analyte Symbol	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1	0.01	5	10	3	3	2	0.01	2	0.8	0.2	30	0.1	2	0.3
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
Meas																							
OREAS 251(FA-Ancaster) Cert																							
CCU-1e Meas										0.14	1100						84		318			> 10000	
CCU-1e Cert										0.139	1010						74.2		301			229000	
CCU-1e Meas											1130						80		317			> 10000	
CCU-1e Cert											1010						74.2		301			229000	
Oreas 237 (fire Assay) Meas																							
Oreas 237 (fire Assay) Cert																							
OREAS 680 (Peroxide Fusion) Meas										7.24	113		682		< 2	5.55	8	37.4	323	2110	3.1	8900	2.8
OREAS 680 (Peroxide Fusion) Cert										7.19	120		649		1.66	5.80	8.18	38.7	334	2140	3.94	9040	3.07
OREAS 680 (Peroxide Fusion) Meas											116		661		< 2		8	40.9	321	2130	3.9	8980	2.9
OREAS 680 (Peroxide Fusion) Cert											120		649		1.66		8.18	38.7	334	2140	3.94	9040	3.07
OREAS 139 (Peroxide Fusion) Meas										3.67	320			3	6	1.14	276	49.7	24.7		3.5	266	
OREAS 139 (Peroxide Fusion) Cert										3.70	332			3.17	6.64	1.20	296	49.4	26.0		3.21	274	
OREAS 139 (Peroxide Fusion) Meas											326			3	6		267	49.0	24.6		3.2	256	
OREAS 139 (Peroxide Fusion) Cert											332			3.17	6.64		296	49.4	26.0		3.21	274	
OREAS 624 (Peroxide Fusion) Meas										4.29	126		1060		19	1.42	136	33.2	279		1.7	> 10000	
OREAS 624 (Peroxide Fusion) Cert										4.32	115		1070		21.3	1.49	133	32.9	273		1.32	30800	
OREAS 624 (Peroxide Fusion) Meas											124		1090		21		125	32.4	280		1.0	> 10000	
OREAS 624 (Peroxide Fusion) Cert											115		1070		21.3		133	32.9	273		1.32	30800	
OREAS 124 (Peroxide Fusion) Meas													1090	< 3				51.5		90			2.9
OREAS 124 (Peroxide Fusion) Cert													1020	1.83				47.6		51.0			2.82
OREAS 124 (Peroxide Fusion) Meas													1070	< 3				50.4		100			3.0
OREAS 124 (Peroxide Fusion)													1020	1.83				47.6		51.0			2.82

Analyte Symbol	Yb	Lu	Hf	Ta	W	Tl	Pb	Th	U	Al	As	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Dy
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.1	0.04	0.2	0.1	1	0.1	5	0.1	0.1	0.01	5	10	3	3	2	0.01	2	0.8	0.2	30	0.1	2	0.3
Method Code	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-MS	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2
Cert																							
OREAS 352 Peroxide Fusion Meas										0.49						1.40							
OREAS 352 Peroxide Fusion Cert										0.418						1.45							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
P134469 Orig										5.84	< 5	< 10	296	4	3	0.09	< 2	< 0.8	1.2	100	162	< 2	< 0.3
P134469 Dup										5.97	< 5	< 10	313	4	3	0.09	< 2	< 0.8	0.9	100	170	< 2	< 0.3
P134477 Orig										4.03	6	< 10	323	12	< 2	0.20	< 2	3.4	1.1	120	118	5	< 0.3
P134477 Dup										4.21	7	< 10	321	10	< 2	0.17	< 2	3.0	0.8	100	120	3	0.3
P134491 Orig										8.52	< 5	< 10	2800	5	< 2	0.08	< 2	< 0.8	1.1	70	943	< 2	< 0.3
P134491 Dup										8.52	< 5	< 10	2450	4	< 2	0.06	< 2	< 0.8	1.3	60	850	< 2	< 0.3
P134268 Orig										5.93	5	20	648	28	< 2	0.47	< 2	6.3	1.9	110	169	16	< 0.3
P134268 Dup										5.93	5	10	644	28	< 2	0.48	< 2	6.4	1.5	140	164	13	0.4
894533 Orig																							
894533 Split PREP DUP																							
Method Blank										< 0.01	< 5	< 10	< 3	< 3	< 2	< 0.01	< 2	< 0.8	< 0.2	50	0.4	4	< 0.3
Method Blank											< 5	< 10	< 3	< 3	< 2		< 2	< 0.8	0.6	50	< 0.1	< 2	< 0.3
Method Blank										< 0.01	< 5	< 10	< 3	< 3	< 2	< 0.01	< 2	< 0.8	0.4	50	0.1	< 2	< 0.3
Method Blank											8	< 10	8	< 3	< 2		< 2	< 0.8	0.3	60	0.4	< 2	< 0.3
Method Blank											< 5	< 10	< 3	< 3	< 2		< 2	< 0.8	< 0.2	50	< 0.1	4	< 0.3
Method Blank	< 0.1	< 0.04	< 0.2	< 0.1	< 1	< 0.1	< 5	< 0.1	< 0.1														
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							

Analyte Symbol	Er	Eu	Fe	Ga	Gd	Ge	Ho	Hf	In	K	La	Li	Mg	Mn	Mo	Nb	Nd	Ni	Pb	Pr	Rb	S	Sb
Unit Symbol	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	0.1	0.1	0.05	0.2	0.1	0.7	0.2	10	0.2	0.1	0.4	3	0.01	3	1	2.4	0.4	10	0.8	0.1	0.4	0.01	2
Method Code	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2
NIST 694 Meas																							
NIST 694 Cert																							
DNC-1 Meas																							
DNC-1 Cert																							
GBW 07113 Meas																							
GBW 07113 Cert																							
PTM-1a Meas																		> 10000				22.9	
PTM-1a Cert																		474400.00				22.4	
W-2a Meas																							
W-2a Cert																							
NIST 696 Meas																							
NIST 696 Cert																							
DTS-2b Meas													> 30.0										
DTS-2b Cert													29.8										
GBW 07239 (NCS DC 70007) Meas				23.7		13.0					37.9			> 10000	1150		31.2	30	21.9	8.2			
GBW 07239 (NCS DC 70007) Cert				23.1		12.4					37.4			11500	1100		29.8	20.9	26.1	7.40			
GBW 07239 (NCS DC 70007) Meas				24.4		12.9					36.8			> 10000	1100		31.0	30	29.4	8.4			
GBW 07239 (NCS DC 70007) Cert				23.1		12.4					37.4			11500	1100		29.8	20.9	26.1	7.40			
SY-4 Meas																							
SY-4 Cert																							
Oreas 74a (Fusion) Meas			13.4															> 10000				7.33	
Oreas 74a (Fusion) Cert			13.7															32400.00				7.25	
Oreas 74a (Fusion) Meas																		> 10000					
Oreas 74a (Fusion) Cert																		32400.00					
BIR-1a Meas																							
BIR-1a Cert																							
ZW-C Meas																							
ZW-C Cert																							
OREAS 101a (Fusion) Meas	15.9	7.6	11.1		43.7		6.2			2.3	801		1.14	988	21		359			113			
OREAS 101a (Fusion) Cert	19.5	8.06	11.06		43.4		6.46			2.34	816		1.23	964	21.9		403			134			
OREAS 101b (Fusion) Meas																							
OREAS 101b (Fusion) Cert																							
NCS DC86318 Meas																							
NCS DC86318 Cert																							
AMIS 0129 Meas																							
AMIS 0129 Cert																							
NCS DC19003a Meas																							
NCS DC19003a																							

Analyte Symbol	Er	Eu	Fe	Ga	Gd	Ge	Ho	Hf	In	K	La	Li	Mg	Mn	Mo	Nb	Nd	Ni	Pb	Pr	Rb	S	Sb
Unit Symbol	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	0.1	0.1	0.05	0.2	0.1	0.7	0.2	10	0.2	0.1	0.4	3	0.01	3	1	2.4	0.4	10	0.8	0.1	0.4	0.01	2
Method Code	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2
Cert																							
SARM 3 Meas																							
SARM 3 Cert																							
USZ 25-2006 Meas																							
USZ 25-2006 Cert																							
NCS DC86315 Meas																3476.6							
NCS DC86315 Cert																3640.000							
NCS DC86303 Meas												2140									1360		
NCS DC86303 Cert												2100									1330		
NCS DC86303 Meas												2150									1360		
NCS DC86303 Cert												2100									1330		
NCS DC86304 Meas																							
NCS DC86304 Cert																							
NCS DC86314 Meas												> 10000									> 5000		
NCS DC86314 Cert												18100.00									11400		
USZ 42-2006 Meas																							
USZ 42-2006 Cert																							
CPB-2 Meas			6.84										0.07										
CPB-2 Cert			7.065										0.0683										
CZN-4 Meas																			1870			> 25.0	
CZN-4 Cert																			1861.0000			33.07	
REE-1 Meas																							
REE-1 Cert																							
OREAS 922 (Peroxide Fusion) Meas	3.9	1.4	5.93	21.9	7.1		1.2	< 10	< 0.2	2.5	46.3	37	1.60	831		15.2	38.0	50	58.7	10.8	178	0.38	
OREAS 922 (Peroxide Fusion) Cert	3.38	1.52	5.71	21.2	6.94		1.20	5.93	0.3	2.60	45.6	29	1.61	880		15.2	38.9	40	64.0	10.6	167	0.389	
OREAS 621 (Peroxide Fusion) Meas			3.80	25.9					2.1	2.2	30.2		0.51	568	16	11.8	26.6		> 5000	6.5	86.2	4.43	155
OREAS 621 (Peroxide Fusion) Cert			3.71	26.5					1.9	2.23	26.1		0.516	554	14	10.4	24.2		13300	6.64	89.0	4.51	146
OREAS 621 (Peroxide Fusion) Meas				24.5					1.9		27.4			541	16	10.7	20.1		> 5000	5.8	87.7		137
OREAS 621 (Peroxide Fusion) Cert				26.5					1.9		26.1			554	14	10.4	24.2		13300	6.64	89.0		146
OREAS 251(FA-Ancaster)																							

Analyte Symbol	Er	Eu	Fe	Ga	Gd	Ge	Ho	Hf	In	K	La	Li	Mg	Mn	Mo	Nb	Nd	Ni	Pb	Pr	Rb	S	Sb
Unit Symbol	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	0.1	0.1	0.05	0.2	0.1	0.7	0.2	10	0.2	0.1	0.4	3	0.01	3	1	2.4	0.4	10	0.8	0.1	0.4	0.01	2
Method Code	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2
Meas																							
OREAS 251(FA-Ancaster) Cert																							
CCU-1e Meas			> 30.0										0.71	104					> 5000			> 25.0	116
CCU-1e Cert			30.7										0.706	96.0					7030			35.3	104
CCU-1e Meas														101					> 5000				108
CCU-1e Cert														96.0					7030				104
Oreas 237 (fire Assay) Meas																							
Oreas 237 (fire Assay) Cert																							
OREAS 680 (Peroxide Fusion) Meas	1.3	1.1	11.9	16.4	3.7		0.6			1.2	18.5	10	3.69	1250		6.9	19.4	> 10000	2520	4.7	79.0	5.06	20
OREAS 680 (Peroxide Fusion) Cert	1.74	1.30	11.9	16.5	3.77		0.580			1.29	18.6	14.5	3.71	1240		5.09	20.8	21500	2580	4.99	76.0	5.14	19.7
OREAS 680 (Peroxide Fusion) Meas	1.7	1.2		16.7	4.9		0.6				19.0	16		1210		6.8	22.7	> 10000	2570	5.1	79.0		17
OREAS 680 (Peroxide Fusion) Cert	1.74	1.30		16.5	3.77		0.580				18.6	14.5		1240		5.09	20.8	21500	2580	4.99	76.0		19.7
OREAS 139 (Peroxide Fusion) Meas	1.3		11.3	10.1					0.6	3.2	24.9	36	0.48	6570	9				> 5000		138	15.0	61
OREAS 139 (Peroxide Fusion) Cert	1.69		11.9	10.2					0.690	3.30	23.1	40.4	0.501	6570	11.1				22000		145	16.04	63.0
OREAS 139 (Peroxide Fusion) Meas	1.7			11.1					0.6		24.2	48		6320	9				> 5000		136		57
OREAS 139 (Peroxide Fusion) Cert	1.69			10.2					0.690		23.1	40.4		6570	11.1				22000		145		63.0
OREAS 624 (Peroxide Fusion) Meas			16.1	23.8					4.1	0.9	18.5	11	1.26	651	16	6.0	15.1		> 5000	4.3	31.2	12.1	72
OREAS 624 (Peroxide Fusion) Cert			16.3	22.1					4.14	0.991	17.3	10.3	1.31	660	17.8	5.78	16.8		6120	4.27	33.0	13.2	72.0
OREAS 624 (Peroxide Fusion) Meas				20.1					4.2		17.4	13		646	19	5.6	16.2		> 5000	3.7	34.0		72
OREAS 624 (Peroxide Fusion) Cert				22.1					4.14		17.3	10.3		660	17.8	5.78	16.8		6120	4.27	33.0		72.0
OREAS 124 (Peroxide Fusion) Meas	1.4	1.2		11.1	3.2		0.7	10			22.8			675			22.4			5.8	88.4		
OREAS 124 (Peroxide Fusion) Cert	1.60	1.15		10.5	3.47		0.580	6.22			21.6			700			20.8			5.39	86.0		
OREAS 124 (Peroxide Fusion) Meas	1.1	1.2		10.8	3.4		0.5	< 10			21.7			672			21.9			5.7	87.4		
OREAS 124 (Peroxide Fusion)	1.60	1.15		10.5	3.47		0.580	6.22			21.6			700			20.8			5.39	86.0		

Analyte Symbol	Er	Eu	Fe	Ga	Gd	Ge	Ho	Hf	In	K	La	Li	Mg	Mn	Mo	Nb	Nd	Ni	Pb	Pr	Rb	S	Sb
Unit Symbol	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Lower Limit	0.1	0.1	0.05	0.2	0.1	0.7	0.2	10	0.2	0.1	0.4	3	0.01	3	1	2.4	0.4	10	0.8	0.1	0.4	0.01	2
Method Code	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2
Cert																							
OREAS 352 Peroxide Fusion Meas			0.50							0.3			0.09									11.8	
OREAS 352 Peroxide Fusion Cert			0.530							0.340			0.101									12.1	
AMIS 0346 (Peroxide Fusion) Meas			> 30.0																				
AMIS 0346 (Peroxide Fusion) Cert			44.3																				
AMIS 0346 (Peroxide Fusion) Meas																							
AMIS 0346 (Peroxide Fusion) Cert																							
P134469 Orig	< 0.1	< 0.1	0.35	16.2	< 0.1	4.2	< 0.2	< 10	< 0.2	4.5	< 0.4	1480	< 0.01	127	4	11.6	< 0.4	20	14.1	< 0.1	1380	< 0.01	< 2
P134469 Dup	< 0.1	0.2	0.35	17.5	< 0.1	4.2	< 0.2	< 10	< 0.2	4.5	< 0.4	1460	< 0.01	126	5	8.5	< 0.4	10	14.0	< 0.1	1330	< 0.01	< 2
P134477 Orig	< 0.1	0.1	0.43	19.3	0.4	3.4	< 0.2	< 10	< 0.2	1.5	1.2	1550	0.04	240	6	12.4	1.5	30	27.8	0.3	383	0.02	< 2
P134477 Dup	0.2	< 0.1	0.42	16.5	0.1	3.7	< 0.2	< 10	< 0.2	1.5	1.3	1630	0.04	226	5	13.4	1.1	20	22.8	0.3	399	0.01	< 2
P134491 Orig	< 0.1	0.6	0.78	21.8	< 0.1	2.7	< 0.2	< 10	< 0.2	8.4	< 0.4	752	0.14	498	2	47.0	< 0.4	20	60.1	< 0.1	2450	< 0.01	< 2
P134491 Dup	< 0.1	0.5	0.79	20.6	< 0.1	3.0	< 0.2	< 10	< 0.2	8.4	0.4	732	0.14	420	1	39.2	< 0.4	20	23.5	0.1	2200	< 0.01	< 2
P134268 Orig	0.1	0.3	1.18	16.0	0.4	2.5	< 0.2	< 10	< 0.2	1.9	3.3	196	0.13	265	7	12.3	2.5	20	35.3	0.6	402	0.02	< 2
P134268 Dup	0.2	0.3	1.15	17.3	0.2	2.8	< 0.2	< 10	< 0.2	1.9	2.8	203	0.12	277	7	13.8	3.1	20	41.1	0.6	400	0.02	< 2
894533 Orig																							
894533 Split PREP DUP																							
Method Blank	< 0.1	< 0.1	< 0.05	< 0.2	< 0.1	< 0.7	< 0.2	< 10	< 0.2	< 0.1	< 0.4	< 3	< 0.01	6	< 1	< 2.4	< 0.4	10	1.2	< 0.1	1.7	< 0.01	< 2
Method Blank	< 0.1	< 0.1		< 0.2	< 0.1	< 0.7	< 0.2	< 10	< 0.2		< 0.4	4		< 3	< 1	< 2.4	< 0.4	20	< 0.8	< 0.1	1.6		< 2
Method Blank	< 0.1	< 0.1	< 0.05	< 0.2	< 0.1	< 0.7	< 0.2	< 10	< 0.2	< 0.1	< 0.4	< 3	< 0.01	7	1	< 2.4	< 0.4	10	< 0.8	< 0.1	2.0	< 0.01	< 2
Method Blank	< 0.1	< 0.1		< 0.2	< 0.1	< 0.7	< 0.2	< 10	< 0.2		< 0.4	4		11	< 1	< 2.4	< 0.4	20	1.6	< 0.1	2.3		< 2
Method Blank	< 0.1	< 0.1		< 0.2	< 0.1	< 0.7	< 0.2	< 10	< 0.2		< 0.4	< 3		5	< 1	< 2.4	< 0.4	10	< 0.8	< 0.1	1.8		< 2
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							
Method Blank																							

Analyte Symbol	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Au	Li
Unit Symbol	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	%
Lower Limit	8	0.01	0.1	0.5	3	0.2	0.1	6	0.1	0.01	0.1	0.1	0.1	5	0.7	0.1	0.1	30	5	0.01
Method Code	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FA-AA	FUS-Na2O2
NIST 694 Meas																				
NIST 694 Cert																				
DNC-1 Meas																				
DNC-1 Cert																				
GBW 07113 Meas																				
GBW 07113 Cert																				
PTM-1a Meas																				
PTM-1a Cert																				
W-2a Meas																				
W-2a Cert																				
NIST 696 Meas																				
NIST 696 Cert																				
DTS-2b Meas		18.9																		
DTS-2b Cert		18.4																		
GBW 07239 (NCS DC 70007) Meas				32.0											1000	38.9		120		
GBW 07239 (NCS DC 70007) Cert				33.2											1000.00	34.2		120		
GBW 07239 (NCS DC 70007) Meas				31.5											1030	36.0		140		
GBW 07239 (NCS DC 70007) Cert				33.2											1000.00	34.2		120		
SY-4 Meas																				
SY-4 Cert																				
Oreas 74a (Fusion) Meas		15.5																		
Oreas 74a (Fusion) Cert		15.14																		
Oreas 74a (Fusion) Meas																				
Oreas 74a (Fusion) Cert																				
BIR-1a Meas																				
BIR-1a Cert																				
ZW-C Meas																				
ZW-C Cert																				
OREAS 101a (Fusion) Meas			43.6				5.8		33.8	0.38		2.7	403	83		163	17.7			
OREAS 101a (Fusion) Cert			48.8				5.92		36.6	0.395		2.90	422	83		183	17.5			
OREAS 101b (Fusion) Meas																				
OREAS 101b (Fusion) Cert																				
NCS DC86318 Meas																				
NCS DC86318 Cert																				
AMIS 0129 Meas																				
AMIS 0129 Cert																				
NCS DC19003a Meas																				
NCS DC19003a Cert																				

Analyte Symbol	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Au	Li
Unit Symbol	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	%
Lower Limit	8	0.01	0.1	0.5	3	0.2	0.1	6	0.1	0.01	0.1	0.1	0.1	5	0.7	0.1	0.1	30	5	0.01
Method Code	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FA-AA	FUS-Na2O2
SARM 3 Meas																				
SARM 3 Cert																				
USZ 25-2006 Meas																				
USZ 25-2006 Cert																				
NCS DC86315 Meas						7530									29.5					
NCS DC86315 Cert						8350.000									21.4					
NCS DC86303 Meas															8.9					
NCS DC86303 Cert															8.9					
NCS DC86303 Meas															8.6					
NCS DC86303 Cert															8.9					
NCS DC86304 Meas																				1.08
NCS DC86304 Cert																				1.06
NCS DC86314 Meas				145											72.5					1.86
NCS DC86314 Cert				152											79.0					1.81
USZ 42-2006 Meas																				
USZ 42-2006 Cert																				
CPB-2 Meas																				
CPB-2 Cert																				
CZN-4 Meas	55	0.28																> 10000		
CZN-4 Cert	86.7	0.295																550700.00		
REE-1 Meas																				
REE-1 Cert																				
OREAS 922 (Peroxide Fusion) Meas		> 30.0	8.1	10.8	71	1.3	0.9		17.7	0.43	1.0	0.4	3.5	88		33.2	3.3	280		
OREAS 922 (Peroxide Fusion) Cert		30.51	7.31	10.0	58.0	1.3	1.02		17.7	0.439	0.9	0.510	3.6	92.0		31.1	3.17	280		
OREAS 621 (Peroxide Fusion) Meas		28.7			92				8.7	0.18	2.0		2.8	43	3.4	13.3	1.1	> 10000		
OREAS 621 (Peroxide Fusion) Cert		28.1			101				8.6	0.181	2.0		3.0	36.3	2.6	13.9	1.03	52200		
OREAS 621 (Peroxide Fusion) Meas					104				8.7		2.4		2.9	40	2.1	13.1	0.9	> 10000		
OREAS 621 (Peroxide Fusion) Cert					101				8.6		2.0		3.0	36.3	2.6	13.9	1.03	52200		
OREAS 251(FA-Ancaster) Meas																			493	

Analyte Symbol	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Au	Li
Unit Symbol	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	%
Lower Limit	8	0.01	0.1	0.5	3	0.2	0.1	6	0.1	0.01	0.1	0.1	0.1	5	0.7	0.1	0.1	30	5	0.01
Method Code	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FA-AA	FUS-Na2O2
OREAS 251(FA-Ancaster) Cert																			504	
CCU-1e Meas								53			2.8							> 10000		
CCU-1e Cert								61.8			2.69							30200		
CCU-1e Meas								43			2.5							> 10000		
CCU-1e Cert								61.8			2.69							30200		
Oreas 237 (fire Assay) Meas																			2210	
Oreas 237 (fire Assay) Cert																			2210	
OREAS 680 (Peroxide Fusion) Meas		20.9	4.4		410		0.6		6.7	0.53			2.4	222		17.6	1.3	2310		
OREAS 680 (Peroxide Fusion) Cert		20.6	4.26		420		0.550		6.73	0.523			1.55	224		16.2	1.52	2320		
OREAS 680 (Peroxide Fusion) Meas			5.2		395		0.5		6.2				1.6	218		17.2	1.2	2340		
OREAS 680 (Peroxide Fusion) Cert			4.26		420		0.550		6.73				1.55	224		16.2	1.52	2320		
OREAS 139 (Peroxide Fusion) Meas		15.9			462		0.5		8.9	0.15	34.4		12.5			16.7		> 10000		
OREAS 139 (Peroxide Fusion) Cert		16.34			479		0.500		7.54	0.157	35.4		12.2			17.1		133600.00		
OREAS 139 (Peroxide Fusion) Meas					424		0.5		8.1		34.8		12.6			16.0		> 10000		
OREAS 139 (Peroxide Fusion) Cert					479		0.500		7.54		35.4		12.2			17.1		133600.00		
OREAS 624 (Peroxide Fusion) Meas		20.1			41				4.3	0.15	1.0		1.3	39	6.1	17.2	2.6	> 10000		
OREAS 624 (Peroxide Fusion) Cert		20.5			47.6				4.12	0.146	0.940		1.34	43.3	4.58	17.3	1.94	24100		
OREAS 624 (Peroxide Fusion) Meas					44				4.1		1.0		1.5	36	4.9	16.5	2.2	> 10000		
OREAS 624 (Peroxide Fusion) Cert					47.6				4.12		0.940		1.34	43.3	4.58	17.3	1.94	24100		
OREAS 124 (Peroxide Fusion) Meas			4.5				0.5		5.8			0.3	1860	36		14.9	1.8			
OREAS 124 (Peroxide Fusion) Cert			4.21				0.480		5.74			0.220	1790	23.3		14.2	1.63			
OREAS 124 (Peroxide Fusion) Meas			4.3				0.4		5.7			0.3	1790	30		14.3	1.6			
OREAS 124 (Peroxide Fusion) Cert			4.21				0.480		5.74			0.220	1790	23.3		14.2	1.63			

Analyte Symbol	Se	Si	Sm	Sn	Sr	Ta	Tb	Te	Th	Ti	Tl	Tm	U	V	W	Y	Yb	Zn	Au	Li
Unit Symbol	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	%
Lower Limit	8	0.01	0.1	0.5	3	0.2	0.1	6	0.1	0.01	0.1	0.1	0.1	5	0.7	0.1	0.1	30	5	0.01
Method Code	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FUS-MS-Na2O2	FA-AA	FUS-Na2O2
OREAS 352 Peroxide Fusion Meas										0.04										
OREAS 352 Peroxide Fusion Cert										0.0400										
AMIS 0346 (Peroxide Fusion) Meas										15.1				2630						
AMIS 0346 (Peroxide Fusion) Cert										15.0				2700						
AMIS 0346 (Peroxide Fusion) Meas														2680						
AMIS 0346 (Peroxide Fusion) Cert														2700						
P134469 Orig	< 8	> 30.0	< 0.1	5.6	218	9.5	< 0.1	11	< 0.1	< 0.01	10.9	< 0.1	0.6	7	< 0.7	< 0.1	< 0.1	< 30		
P134469 Dup	14	> 30.0	0.2	5.2	209	8.4	< 0.1	13	< 0.1	< 0.01	10.5	< 0.1	0.6	9	< 0.7	< 0.1	< 0.1	< 30		
P134477 Orig	15	> 30.0	0.3	10.0	267	4.9	< 0.1	< 6	0.6	0.04	3.1	< 0.1	0.5	11	< 0.7	1.3	0.1	70		
P134477 Dup	10	> 30.0	0.2	10.0	248	4.8	< 0.1	< 6	0.7	0.04	3.1	< 0.1	0.5	13	1.0	1.4	0.1	< 30		
P134491 Orig	15	> 30.0	< 0.1	12.4	560	8.1	< 0.1	< 6	0.2	0.05	18.4	< 0.1	0.3	7	< 0.7	0.2	< 0.1	50		
P134491 Dup	10	> 30.0	< 0.1	13.6	527	7.5	< 0.1	< 6	0.2	0.05	16.9	< 0.1	0.3	9	1.8	0.2	0.1	70		
P134268 Orig	< 8	> 30.0	0.8	6.4	371	4.2	< 0.1	< 6	1.3	0.06	3.0	< 0.1	0.8	13	< 0.7	2.8	0.1	80		
P134268 Dup	< 8	> 30.0	0.5	5.5	381	5.1	< 0.1	< 6	1.4	0.06	3.3	< 0.1	0.9	14	< 0.7	1.5	0.3	40		
894533 Orig																			< 5	
894533 Split PREP DUP																			< 5	
Method Blank	< 8	< 0.01	< 0.1	2.3	5	0.2	< 0.1	17	< 0.1	< 0.01	< 0.1	< 0.1	< 0.1	10	1.0	< 0.1	< 0.1	40		
Method Blank	9		< 0.1	1.5	18	< 0.2	< 0.1	< 6	< 0.1		< 0.1	< 0.1	0.2	< 5	< 0.7	0.2	0.1	50		
Method Blank	< 8	< 0.01	< 0.1	4.2	< 3	0.3	< 0.1	< 6	< 0.1	< 0.01	< 0.1	< 0.1	< 0.1	< 5	1.8	< 0.1	< 0.1	< 30		
Method Blank	< 8		< 0.1	1.7	15	0.5	< 0.1	11	< 0.1		< 0.1	< 0.1	< 0.1	< 5	< 0.7	0.2	< 0.1	80		
Method Blank	< 8		< 0.1	< 0.5	< 3	0.4	< 0.1	7	< 0.1		< 0.1	< 0.1	< 0.1	7	1.6	< 0.1	< 0.1	< 30		
Method Blank																				
Method Blank																				
Method Blank																				
Method Blank																			< 5	
Method Blank																			< 5	

APPENDIX 1

Mozley Shaking Table Mass Balance (125 – 180 μm) for REE (La, Ce, Pr, Nd, Yb, Dy, Sm) :

Mozley Table 125-180 μm REE ICP analysis (Concentrate: Conc 125-180 μm, Tails: Tail 2 (125-180 μm) + Tails 1(125-180 μm))

Mozley Table 125 - 180 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
		La grade	La mass	La distr.	Ce grade	Ce mass	Ce distr.	Pr grade	Pr mass	Pr distr.	Nd grade	Nd mass	Nd distr.	Yb grade	Yb mass	Yb distr.	Dy grade	Dy mass	Dy distr.	Sm grade	Sm mass	Sm distr.
Sample Name	g	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%
125-180 μm analyzed	240,34	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (125-180 μm)	105,30	801	84,3	71,7	1610	170	71,9	169	17,8	71,2	576	60,7	71,0	101	10,6	81,5	71,9	7,57	76,1	86,6	9,12	70,4
Concentrate Mass Pull (%)	43,81																					
TAIL2 (125-180 μm)	60,95	378	23,0	19,6	743	45,3	19,2	81,1	4,94	19,8	281	17,1	20,1	17,0	1,04	7,94	21,3	1,30	13,1	42,7	2,60	20,1
TAIL1 (125-180 μm)	74,09	139	10,3	8,75	281	20,8	8,84	30,6	2,27	9,07	103	7,63	8,93	18,7	1,39	10,6	14,5	1,07	10,8	16,6	1,23	9,50
Overall Tails	135,04	247	33,3	28,3	490	66,1	28,1	53,4	7,21	28,8	183	24,8	29,0	17,9	2,42	18,5	17,6	2,37	23,9	28,4	3,83	29,6
Calculated Head Grade	240,34	490	117,7	100	980	236	100	104	25,0	100	355	85,4	100	54,3	13,1	100	41,4	9,94	100	53,9	13,0	100
Recovery (%)			71,7			71,9			71,2			71,0			81,5			76,1			70,4	

Concentrate Mass Pull : 43.8% (Ore = 100 tons, Concentrate = 43.8 tons)

Calculated Head Grades : La = 490 ppm, Ce = 980 ppm, Pr = 104 ppm, Nd = 355 ppm, Yb = 54.3 ppm, Dy = 41.4 ppm, Sm = 53.9 ppm

Concentrate Grades : La = 801 ppm, Ce = 1610 ppm, Pr = 169 ppm, Nd = 576 ppm, Yb = 101 ppm, Dy = 71.9 ppm, Sm = 86.6 ppm

Tails Grades : La = 247 ppm, Ce = 490 ppm, Pr = 53.4 ppm, Nd = 183 ppm, Yb = 17.9 ppm, Dy = 17.6 ppm, Sm = 28.4 ppm

Recovery : La = 71.7%, Ce = 71.9%, Pr = 71.2%, Nd = 71.0%, Yb = 81.5%, Dy = 76.1%, Sm = 70.4%

Mozley Table 125-180 μm REE ICP analysis (Concentrate: Conc 125-180mm + Tail 2 (125-180 mm), Tails: Tails 1(125-180 μm))

Mozley Table 125 - 180 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
		La grade	La mass	La distr.	Ce grade	Ce mass	Ce distr.	Pr grade	Pr mass	Pr distr.	Nd grade	Nd mass	Nd distr.	Yb grade	Yb mass	Yb distr.	Dy grade	Dy mass	Dy distr.	Sm grade	Sm mass	Sm distr.
Sample Name	g	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%	ppm	mg	%
125-180 μm analyzed	240,34	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,0	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (125-180 μm)	105,30	801	84,3	71,7	1610	170	71,9	169	17,8	71,2	576	60,7	71,0	101	10,6	81,5	71,9	7,57	76,1	86,6	9,12	70,4
TAIL2 (125-180 μm)	60,95	378	23,0	19,6	743	45,3	19,2	81,1	4,94	19,8	281	17,1	20,1	17,0	1,04	7,94	21,3	1,30	13,1	42,7	2,60	20,1
Overall Conc	166,25	646	107	91,2	1292	215	91,2	137	22,7	90,9	468	77,8	91,1	70,2	11,7	89,4	53,3	8,87	89,2	70,5	11,7	90,5
Concentrate Mass Pull (%)	69,17																					
TAIL1 (125-180 μm)	74,09	139	10,3	8,75	281	20,8	8,84	30,6	2,27	9,07	103	7,63	8,93	18,7	1,39	10,6	14,5	1,07	10,8	16,6	1,23	9,50
Calculated Head Grade	240,34	490	118	100	980	236	100	104	25,0	100	355	85,4	100	54,3	13,1	100	41,4	9,94	100	53,9	13,0	100
Recovery (%)			91,2			91,2			90,9			91,1			89,4			89,2			90,5	

Concentrate Mass Pull : 69.2% (Ore = 100 tons, Concentrate = 69.2 tons)

Calculated Head Grades : La = 490 ppm, Ce = 980 ppm, Pr = 104 ppm, Nd = 355 ppm, Yb = 54.3 ppm, Dy = 41.4 ppm, Sm = 53.9 ppm

Concentrate Grades : La = 646 ppm, Ce = 1292 ppm, Pr = 137 ppm, Nd = 468 ppm, Yb = 70.2 ppm, Dy = 53.3 ppm, Sm = 70.5 ppm

Tails Grades : La = 139 ppm, Ce = 281 ppm, Pr = 30.6 ppm, Nd = 103 ppm, Yb = 18.7 ppm, Dy = 14.5 ppm, Sm = 16.6 ppm

Recovery : La = 91.2%, Ce = 91.2%, Pr = 90.9%, Nd = 91.1%, Yb = 89.4%, Dy = 89.2%, Sm = 90.5%

Mozley Shaking Table Mass Balance (180 – 250 μm) for REE (La, Ce, Pr, Nd, Yb, Dy, Sm) :

Mozley Table 180-250 μm REE ICP analysis (Concentrate: Conc 180-250 μm, Tails: Tails 2 (180-250 μm) + Tails 1(180-250 μm))

Mozley Table 180 - 250 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	Au mass mg	Au distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
180-250 μm analyzed	242,14	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (180-250 μm)	130,93	637	83,4	75,2	1290	169	75,9	140	18,3	75,6	469	61,4	75,0	75,9	9,94	77,6	55,9	7,32	76,0	70,8	9,27	74,6
Concentrate Mass Pull (%)	54,1																					
TAIL2 (180-250 μm)	53,16	380	20,2	18,22	732	38,9	17,5	81,0	4,31	17,7	282	15,0	18,3	28,4	1,51	11,8	25,8	1,37	14,2	42,0	2,23	18,0
TAIL1 (180- 250 μm)	58,05	125	7,26	6,55	256	14,9	6,67	28,0	1,63	6,70	95,2	5,53	6,75	23,4	1,36	10,6	16,1	0,93	9,71	15,9	0,92	7,43
Overall Tails	111,21	247	27,5	24,8	484	53,8	24,1	53,3	5,93	24,4	184	20,5	25,0	25,8	2,87	22,4	20,7	2,31	24,0	28,4	3,16	25,4
Calculated Head Grade	242,14	458	110,9	100	920	223	100	100	24,3	100	338	81,9	100	52,9	12,8	100	39,8	9,63	100	51,3	12,4	100
Recovery (%)			75,2			75,9			75,6			75,0			77,6			76,0			74,6	

Concentrate Mass Pull : 54.1% (Ore = 100 tons, Concentrate = 54.1 tons)

Calculated Head Grades : La = 458 ppm, Ce = 920 ppm, Pr = 100 ppm, Nd = 338 ppm, Yb = 52.9 ppm, Dy = 39.8 ppm, Sm = 51.3 ppm

Concentrate Grades : La = 637 ppm, Ce = 1290 ppm, Pr = 140 ppm, Nd = 469 ppm, Yb = 75.9 ppm, Dy = 55.9 ppm, Sm = 70.8 ppm

Tails Grades : La = 247 ppm, Ce = 484 ppm, Pr = 53.3 ppm, Nd = 184 ppm, Yb = 25.8 ppm, Dy = 20.7 ppm, Sm = 28.4 ppm

Recovery : La = 75.2%, Ce = 75.9%, Pr = 75.6%, Nd = 75.0%, Yb = 77.6%, Dy = 76.0%, Sm = 74.6%

Mozley Table 180-250 μm REE ICP analysis (Concentrate: Conc 180-250 μm + Tails 2 (180-250 μm), Tails: Tails 1(180-250 μm))

Mozley Table 180 - 250 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	La mass mg	La distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
180-250 μm analyzed	242,14	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (180-250 μm)	130,93	637	83,4	75,2	1290	169	75,9	140	18,3	75,6	469	61,4	75,0	75,9	9,94	77,6	55,9	7,32	76,0	70,8	9,27	74,6
TAIL2 (180-250 μm)	53,16	380	20,2	18,2	732	38,9	17,5	81,0	4,31	17,7	282	15,0	18,3	28,4	1,51	11,8	25,8	1,37	14,2	42,0	2,23	18,0
Overall Conc	184,09	563	104	93,5	1129	208	93,3	123	22,6	93,3	415	76,4	93,3	62,2	11,4	89,4	47,2	8,69	90,3	62,5	11,5	92,6
Concentrate Mass Pull (%)	76,0																					
TAIL1 (180-250 μm)	58,05	125	7,26	6,55	256	14,9	6,67	28,0	1,63	6,70	95,2	5,53	6,75	23,4	1,36	10,6	16,1	0,93	9,71	15,9	0,92	7,43
Calculated Head Grade	242,14	458	111	100	920	223	100	100	24,3	100	338	81,9	100	52,9	12,8	100	39,8	9,63	100	51,3	12,4	100
Recovery (%)			93,5			93,3			93,3			93,3			89,4			90,3			92,6	

Concentrate Mass Pull : 76.0% (Ore = 100 tons, Concentrate = 76.0 tons)

Calculated Head Grades : La = 458 ppm, Ce = 920 ppm, Pr = 100 ppm, Nd = 338 ppm, Yb = 52.9 ppm, Dy = 39.8 ppm, Sm = 51.3 ppm

Concentrate Grades : La = 563 ppm, Ce = 1129 ppm, Pr = 123 ppm, Nd = 415 ppm, Yb = 62.2 ppm, Dy = 47.2 ppm, Sm = 62.5 ppm

Tails Grades : La = 125 ppm, Ce = 256 ppm, Pr = 28.0 ppm, Nd = 95.2 ppm, Yb = 23.4 ppm, Dy = 16.1 ppm, Sm = 15.9 ppm

Recovery : La = 93.5%, Ce = 93.3%, Pr = 93.3%, Nd = 93.3%, Yb = 89.4%, Dy = 90.3%, Sm = 92.6%

Mozley Shaking Table Mass Balance (250 – 350 μm) for REE (La, Ce, Pr, Nd, Yb, Dy, Sm) :

Mozley Table 250-350 μm REE ICP analysis (Concentrate: Conc (250-350 μm), Tails: Tails 2 (250-350 μm) + Tails 1(250-350 μm))

Mozley Table 250 - 350 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	Au mass mg	Au distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
250-350 μm analyzed	258,67	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (250-350 μm)	102,40	869	89,0	74,2	1720	176	73,9	184	18,8	73,8	643	65,8	74,2	105	10,8	84,3	73,3	7,51	78,8	93,9	9,62	73,4
Concentrate Mass Pull (%)	39,6																					
TAIL2 (250-350 μm)	29,90	541	16,2	13,5	1100	32,9	13,8	115	3,44	13,5	393	11,8	13,2	15,9	0,48	3,73	25,1	0,75	7,88	57,5	1,72	13,1
TAIL1 (250-350 μm)	126,37	117	14,8	12,3	233	29,4	12,3	25,8	3,26	12,8	87,8	11,1	12,5	12,1	1,53	12,0	10,0	1,26	13,27	13,9	1,76	13,4
Overall Tails	156,27	198	31,0	25,8	399	62,3	26,1	42,9	6,70	26,2	146	22,8	25,8	12,8	2,00	15,7	12,9	2,01	21,16	22,2	3,48	26,6
Calculated Head Grade	258,67	464	119,9	100	922	238	100	98,7	25,5	100	343	88,7	100	49,3	12,8	100	36,8	9,52	100	50,6	13,1	100
Recovery (%)			74,2			73,9			73,8			74,2			84,3			78,8			73,4	

Concentrate Mass Pull : 39.6% (Ore = 100 tons, Concentrate = 39.6 tons)

Calculated Head Grades : La = 464 ppm, Ce = 922 ppm, Pr = 98.7 ppm, Nd = 343 ppm, Yb = 49.3 ppm, Dy = 36.8 ppm, Sm = 50.6 ppm

Concentrate Grades : La = 869 ppm, Ce = 1790 ppm, Pr = 184 ppm, Nd = 643 ppm, Yb = 105 ppm, Dy = 73.3 ppm, Sm = 93.9 ppm

Tails Grades : La = 198 ppm, Ce = 399 ppm, Pr = 42.9 ppm, Nd = 146 ppm, Yb = 12.8 ppm, Dy = 12.9 ppm, Sm = 22.2 ppm

Recovery : La = 74.2%, Ce = 73.9%, Pr = 73.8%, Nd = 74.2%, Yb = 84.3%, Dy = 78.8%, Sm = 73.4%

Mozley Table 250-350 μm REE ICP analysis (Concentrate: Conc (250-350 μm) + Tails 2 (250-350 μm), Tails: Tails 1 (250-350 μm))

Mozley Table 250 - 350 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	La mass mg	La distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
250-350 μm analyzed	258,67	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (250-350 μm)	102,40	869	89,0	74,2	1720	176	73,9	184	18,8	73,8	643	65,8	74,2	105	10,8	84,3	73,3	7,51	78,8	93,9	9,62	73,4
TAIL2 (250-350 μm)	29,90	541	16,2	13,5	1100	32,9	13,8	115	3,44	13,5	393	11,8	13,2	15,9	0,48	3,73	25,1	0,75	7,88	57,5	1,72	13,1
Overall Conc	132,30	795	105	87,7	1580	209	87,7	168	22,3	87,2	586	77,6	87,5	84,9	11,2	88,0	62,4	8,26	86,7	85,7	11,3	86,6
Concentrate Mass Pull (%)	51,1																					
TAIL1 (250- 350 μm)	126,37	117	14,8	12,3	233	29,4	12,3	25,8	3,26	12,8	87,8	11,1	12,5	12,1	1,53	12,0	10,0	1,26	13,3	13,9	1,76	13,4
Calculated Head Grade	258,67	464	120	100	922	238	100	98,7	25,5	100	343	88,7	100	49,3	12,8	100	36,8	9,52	100	50,6	13,1	100
Recovery (%)			87,7			87,7			87,2			87,5			88,0			86,7			86,6	

Concentrate Mass Pull : 51.1% (Ore = 100 tons, Concentrate = 51.1 tons)

Calculated Head Grades : La = 464 ppm, Ce = 922 ppm, Pr = 98.7 ppm, Nd = 343 ppm, Yb = 49.3 ppm, Dy = 36.8 ppm, Sm = 50.6 ppm

Concentrate Grades : La = 795 ppm, Ce = 1580 ppm, Pr = 168 ppm, Nd = 586 ppm, Yb = 84.9 ppm, Dy = 62.4 ppm, Sm = 85.7 ppm

Tails Grades : La = 117 ppm, Ce = 233 ppm, Pr = 25.8 ppm, Nd = 87.8 ppm, Yb = 12.1 ppm, Dy = 10.0 ppm, Sm = 13.9 ppm

Recovery : La = 87.7%, Ce = 87.7%, Pr = 87.2%, Nd = 87.5%, Yb = 88.0%, Dy = 86.7%, Sm = 86.6%

Mozley Shaking Table Mass Balance (350 – 500 μm) for REE (La, Ce, Pr, Nd, Yb, Dy, Sm) :

Mozley Table 350-500 μm REE ICP analysis (Concentrate: Conc (350-500 μm), Tails: Tails 2 (350-500 μm) + Tails 1(350-500 μm))

Mozley Table 350 - 500 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	La mass mg	La distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
350-500 μm analyzed	468,00	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (350-500 μm)	76,65	1330	102	43,9	2560	196	43,8	271	20,8	42,9	914	70,1	42,4	204	15,6	64,8	133	10,2	56,0	136	10,4	42,3
Concentrate Mass Pull (%)	16,4																					
TAIL2 (350-500 μm)	20,25	689	14,0	6,00	1370	27,7	6,19	148	3,00	6,19	506	10,2	6,20	21,7	0,44	1,82	31,0	0,63	3,45	71,7	1,45	5,89
TAIL1(350-500 μm)	371,10	314	117	50,1	604	224	50,0	66,4	24,6	50,9	229	85,0	51,4	21,7	8,05	33,4	19,9	7,38	40,6	34,4	12,8	51,8
Overall Tails	391,35	333	130	56,1	644	252	56,2	70,6	27,6	57,1	243	95,2	57,6	21,7	8,49	35,2	20,5	8,01	44,0	36,3	14,2	57,7
Calculated Head Grade	468,00	497	232	100	958	448	100	103	48,4	100	353	165,3	100	51,6	24,1	100	38,9	18,2	100	52,7	24,6	100
Recovery (%)			43,9			43,8			42,9			42,4			64,8			56,0			42,3	

Concentrate Mass Pull : 16.4% (Ore = 100 tons, Concentrate = 16.4 tons)

Calculated Head Grades : La = 497 ppm, Ce = 958 ppm, Pr = 103 ppm, Nd = 353 ppm, Yb = 51.6 ppm, Dy = 36.9 ppm, Sm = 52.7 ppm

Concentrate Grades : La = 1330 ppm, Ce = 2560 ppm, Pr = 271 ppm, Nd = 914 ppm, Yb = 204 ppm, Dy = 133 ppm, Sm = 136 ppm

Tails Grades : La = 333 ppm, Ce = 644 ppm, Pr = 70.6 ppm, Nd = 243 ppm, Yb = 21.7 ppm, Dy = 20.5 ppm, Sm = 36.3 ppm

Recovery : La = 43.9%, Ce = 43.8%, Pr = 42.9%, Nd = 42.4%, Yb = 64.8%, Dy = 56.0%, Sm = 42.3%

Mozley Table 350-500 μm REE ICP analysis (Concentrate: Conc (350-500 μm) + Tails 2 (350-500 μm), Tails: Tails 1(350-500 μm))

Mozley Table 350 - 500 μm Test	Mass	La metall. balance			Ce metall. balance			Pr metall. balance			Nd metall. balance			Yb metall. balance			Dy metall. balance			Sm metall. balance		
Sample Name	g	La grade ppm	La mass mg	La distr. %	Ce grade ppm	Ce mass mg	Ce distr. %	Pr grade ppm	Pr mass mg	Pr distr. %	Nd grade ppm	Nd mass mg	Nd distr. %	Yb grade ppm	Yb mass mg	Yb distr. %	Dy grade ppm	Dy mass mg	Dy distr. %	Sm grade ppm	Sm mass mg	Sm distr. %
250-350 μm analyzed	468,00	0,00	0,00	100	0,0	0	100	0,0	0	100	0,0	0	100	0,0	0,00	100	0,00	0,00	100	0,00	0,00	100
CONC (350-500 μm)	76,65	1330	102	43,9	2560	196	43,8	271	20,8	42,9	914	70,1	42,4	204	15,6	64,8	133	10,2	56,0	136	10,4	42,3
TAIL2 (350-500 μm)	20,25	689	14,0	6,00	1370	27,7	6,2	148	3,00	6,19	506	10,2	6,20	21,7	0,44	1,82	31,0	0,63	3,45	71,7	1,45	5,89
Overall Conc	96,90	1196	116	49,9	2311	224	50,0	245	23,8	49,1	829	80,3	48,6	166	16,1	66,6	111,7	10,8	59,4	123	11,9	48,2
Concentrate Mass Pull (%)	20,7																					
TAIL1(350-500 μm)	371,10	314	117	50,1	604	224	50,0	66,4	24,6	50,9	229	85,0	51,4	21,7	8,05	33,4	19,9	7,38	40,6	34,4	12,8	51,8
Calculated Head Grade	468,00	497	232	100	958	448	100	103	48,4	100	353	165	100	51,6	24,1	100	38,9	18,21	100	52,7	24,6	100
Recovery (%)			49,9			50,0			49,1			48,6			66,6			59,4			48,2	

Concentrate Mass Pull : 20.7% (Ore = 100 tons, Concentrate = 20.7 tons)

Calculated Head Grades : La = 497 ppm, Ce = 958 ppm, Pr = 103 ppm, Nd = 353 ppm, Yb = 51.6 ppm, Dy = 36.9 ppm, Sm = 52.7 ppm

Concentrate Grades : La = 1196 ppm, Ce = 2311 ppm, Pr = 245 ppm, Nd = 829 ppm, Yb = 166 ppm, Dy = 112 ppm, Sm = 123 ppm

Tails Grades : La = 314 ppm, Ce = 604 ppm, Pr = 66.4 ppm, Nd = 229 ppm, Yb = 21.7 ppm, Dy = 19.9 ppm, Sm = 34.4 ppm

Recovery : La = 49.9%, Ce = 50.0%, Pr = 49.1%, Nd = 48.6%, Yb = 66.6%, Dy = 59.4%, Sm = 48.2%

ECMM

Thetford Mines

Extraction and precipitation of a rare earth concentrate from an allanite ore

Rapport: FNC-01-2019-09-15

By Romain Barbaroux, chemist, Ph.D

For Jean Bernard, geologist

The 2019-12-21

Introduction

Overview

Rare earths are a group of 15 elements within group III of the periodic table. Their chemical properties are close to those of yttrium, scandium or actinium. Rare earths have been grouped into the lanthanide subgroup (elements 57 to 71 of the periodic table) in addition to scandium and yttrium. Promethium, which corresponds to element 61, is an unstable radionuclide produced by nuclear fission.

All soils have similar chemical properties, especially in aqueous solution. The differences between rare earths being so small, it is therefore easy to concentrate all in the same aqueous solution through simple chemical reactions.

Under non-aqueous conditions, the differences between the rare earths become more obvious. This is particularly true for metallic forms and anhydrous crystalline forms. Note for example the different electromagnetic properties of rare earths.

In the mining sector, REE (rare earth elements) are classified into two groups:

- Light REE (LREE): from lanthanum to europium (La, Ce, Pd, Nd, Sm, Eu)
- Heavy REE (HREE): from gadolinium to lutetium (Gd, Tb, Dy, Ho, Er, Yb, Lu)

There are also two other elements that are neither LREE nor HREE: scandium (Sc) and yttrium (Y)

Rare earths are not so rare. These elements are scattered throughout the earth's crust, but are usually found in small quantities. They are found only in the form of oxides, silicates, carbonates of phosphates and halides. REEs are included in several types of ores at very low concentrations ranging from 10 to 300 ppm, making their exploitation and recovery difficult. Only three ores based on REEs, monazite, bastnaesite and xenotime escape this rule and allow industrial exploitation of REE. These three minerals alone account for approximately 95% of the known RTE stock. Other REEs ores exist of course like parisite, synchisite or allanite.

Chemical Principles of Extraction and Precipitation

Their exploitation remains a challenge because the REEs are usually accompanied in their minerals by other elements that can be dangerous or even radioactive. These radioactive elements, such as thorium or uranium, have in addition physical and chemical properties close to the REE which makes their separation more difficult.

Monazite and xenotime are generally phosphate ores. In the monazite, we find much more LREE than HREE.

Several extraction, separation and purification routes have been developed to value REEs from ores. Generally, after the excavation phase, REEs-rich minerals are concentrated by flotation, gravity or magnetism. These REEs

concentrates are then treated by hydrometallurgy to produce metals and chemical compounds of REEs.

After concentration of the REEs-containing minerals, the REEs must be extracted from the concentrate. Several rare earth mineral processing processes exist. These methods generally include heat treatment of the ore in the presence of acidic or basic reagents.

Air roasting at high temperature allows the oxidation of REEs such as cerium (III) to oxidized REEs at their highest valency such as cerium (IV) as shown in equation 1. Once oxidized, the REEs can be sulfated by washing with sulfuric acid as shown in equation 2 or chlorinated by washing with hydrochloric acid as shown in equation 3. In the case of cerium, cerium (IV) chlorides and cerium (IV) sulphates are soluble compounds, so they can be solubilized during an acid leaching phase.

$$2Ce_2O_3 + O_2 = 4CeO_2$$ *Équation 1.*

$$CeO_2 + 2H_2SO_4 = Ce(SO_4)_2 + 2H_2O$$ *Équation 2.*

$$CeO_2 + 4HCl = CeCl_4 + 2H_2O$$ *Équation 3.*

Grilling with sulfuric acid is a very common process. The powdered ore is mixed with concentrated sulfuric acid and baked at temperatures between 200 and 400 ° C for several hours. The calcine thus produced is washed with water to dissolve the REEs in the form of sulphates according to equation 4. The thorium is also dissolved in the sulphate roaster according to equations

5 and 6. The optimal reaction conditions and the use of the reagents must be specifically adapted to the ore tested. Different factors influence the reaction, for example: the presence of iron oxide resulting in increased acid consumption. At roasting temperatures above 300 ° C, the recovery of rare earths decreases in most cases, while the leaching of thorium is also reduced. Since thorium is generally an undesirable leachate, the roasting temperature will be a compromise between rare earth recovery and Thorium leaching.

$$2\,Ce(PO_4) + 3\,H_2SO_4 = Ce_2(SO_4)_3 + 2\,H_2PO_4$$ *Équation 4.*

$$ThSiO_4 + 2\,H_2SO_4 = Th(SO_4)_2 + SiO_2 + 2\,H_2O$$ *Équation 5.*

$$Th_3(PO_4) + 6\,H_2SO_4 = 3\,Th(SO_4)3 + 4\,H_2PO_4$$ *Équation 6.*

Hydrochloric acid leaching is commonly applied for carbonate minerals such as bastnaesite, parisite, synchisite or similar minerals, but can also be used to decompose allanite, cerite or gadolinite. The ore is leached in concentrated hydrochloric acid at temperatures close to 90 ° C. If the ore contains fluorine (eg bastnaesite), a portion of the REEs forms insoluble REE fluorides remaining in the solid residue. To recover these REEs, the solid residue must be alkaline washed with sodium hydroxide to convert the REEs to hydroxides and soluble sodium fluoride.

In the presence of calcite or similar carbonate phases in the ore, leaching with dilute hydrochloric acid at room temperature is suitable for purifying

the ore prior to decomposition, as these reaction conditions dissolve the undesirable carbonate phases without attacking bastnaesite.

The presence of zeolites tends to form silica gels upon dissolution in an acid. Depending on the zeolite content, different precautions must be taken during the decomposition to minimize the formation of gels.

Alternatively, the alkaline fusion can be applied to specific ores. The most common process is decomposition, sodium hydroxide being applicable to monazite and bastnaesite. The ore is mixed with 50-60% by weight of caustic soda (or carbonate of soda) and decomposes at a temperature between 700-900 ° C. The rare earths are converted into hydroxides, while the phosphates (of the monazite) or carbonates and fluorides (bastnaesite) are converted into soluble sodium salts which can be removed by washing. As shown in equation 7. The resulting solids are washed in dilute hydrochloric acid as shown in equation 8.

$$CePO_4 + 3\,NaOH = Ce(OH)_3 + Na_3PO_4$$ *Équation 7.*

$$Ce(OH)_3 + 3\,HCl = CeCl_3 + 3\,H_2O$$ *Équation 8.*

The choice of the decomposition method depends on various factors. Caustic decomposition often results in purer products, but if the ore contains several different minerals, a process capable of decomposing them all must be defined. Since, in most cases, mineral concentrates are present in significant amounts of secondary components that do not contain REEs,

the effectiveness of this process will generally be affected by them. Another point to consider is the regional availability of reagents.

The REE concentrate can finally be made by precipitation from the aqueous solution produced by the acidic leaching of the REE ore. The chlorides or sulphates of REE as well as the oxides of thorium and uranium are then dissolved in water. The REE ore leach acid solution will be neutralized with ammonium hydroxide to pH 1.08-1.84 to produce a precipitate of thorium and uranium hydroxides according to equation 9. This precipitate of thorium and uranium hydroxides is then treated for future burial by a kind of environmental company like Veolia.

$$ThCl_3 + 3\,NH_4OH = Th(OH)_3 + 3\,NH_4Cl$$ *Équation 9.*

The REEs are then precipitated as oxalate according to equation 10. Finally, this REE oxalate concentrate is calcined according to equation 11 to produce a 94% rare earth oxide. This concentrate of REE oxides is then economically recoverable.

$$4\,C_2H_2O_4 + CeCl_4 = Ce(HC_2O_4)_4 + 4\,HCl$$ *Équation 10.*

$$Ce(HC_2O_4)_4 + 3\,O_2 = CeO_4 + 8\,CO_2 + 2\,H_2O$$ *Équation 11.*

The rare earth ore FNC-01

The analyzed sample that was chosen for characterization is sample FNC-01 (63394). This sample has been provided by Fancamp. This sample is an ore of allanite, a silicate with a significant content of REEs. the general formula $A_2M_3Si_3O_{12}$ (OH), where the A sites can contain large cations such as elements Ca^{2+} ,$Sr^{2+,}$ and rare earths, and the M sites admit among others Al^{3+}, Fe^{3+}, Mn^{2+}, Fe^{2+} or Mg^{2+}. However, a large amount of additional elements, including thorium, uranium, zirconium, phosphate, barium, chromium and others may be present in the mineral. Sample FNC-01 was analyzed by digestion and ICP-AES and ICP-MS. The results are shown in Table 1.

Tableau 1. Chemical characteristics of FNC-01

elements	Concentration (%)
Fe	0.4
F	0.06
ThO2	0.28
U3O8	0.00
La2O3	2.47
CeO2	4.97
Pr6O11	0.51
Nd2O3	1.57
Sm2O3	0.21
Eu2O3	0.01
Gd2O3	0.11
Td4O7	0.01
Dy2O3	0.06
Ho2O3	0.01
Er2O3	0.02
Tm2O3	0.00
Yb2O3	0.01
HfO2	0.00
Y2O3	0.25
ZrO2	0.05

Sample FNC-01 shows significant levels of lanthanum oxides. cerium oxides and neodymium oxides. These REEs. present in FNC-01 are light rare earths (LREE). Note the presence of 0.28% thorium oxides and the absence of uranium. Table 2 shows the prices per kg of some REE contained in FNC-01. Table 2 also gives an economic value of the ton of FNC-01 ores.

Tableau 2. Economic value of the ore FNC-01

Oxides	Price/kg ($)	Mass REE/t ore (kg)	Economic value ($)
CeO2	5.99	49.7	297.7
La2O3	7.8	24.7	192.6
Nd2O3	94.4	15.7	1482.1
Pr6O11	121.6	5.1	620.16
Sm2O3	28.14	2.1	59.1
Y2O3	47	2.5	117.5
TOTAL ($)			**2769.2**

It can be concluding from Table 2 that the ore FNC-01, considering some REEs and Y_2O_3, has an economic value of $ 2.770 per ton of ore.

Hydrometallurgical treatment process for the FNC ore

The ideal chemical engineering is to have the most concentrated source of REE to improve the economic value of the process. This concentration could be made from the FNC ore in two ways:

- Flotation
- Gravimetric

This aspect will be discussed in another work. The ore on which our work will rely will be ore FNC-01. After the analysis of the different treatment processes of the existing REEs and after the analysis of the FNC-01 allanite ore, the hydrometallurgical process at the laboratory scale will be carried out by following the following steps:

- Sample analysis (ICP-MS. ICP-AES)
- Grinding of the sample (P80 = 50 µm)
- Oxidation of the sample (air atmosphere. 750 ^{o}C / 3 hours)
- Acid washing of calcine (20% HCl /20% solid / 95 ^{o}C)
- Precipitation of thorium hydroxide by ammonium hydroxide (Ph 1.08-1.84)
- Precipitation of oxides of REE by oxalic acid
- Air oxidation of REE oxalates (air atmosphere. 750 ^{o}C / 3 hours)

Diagram of the process for the treatment of FNC-01

The diagram of the process of the FNC-01 allanite ore treatment is shown in Figure 1.

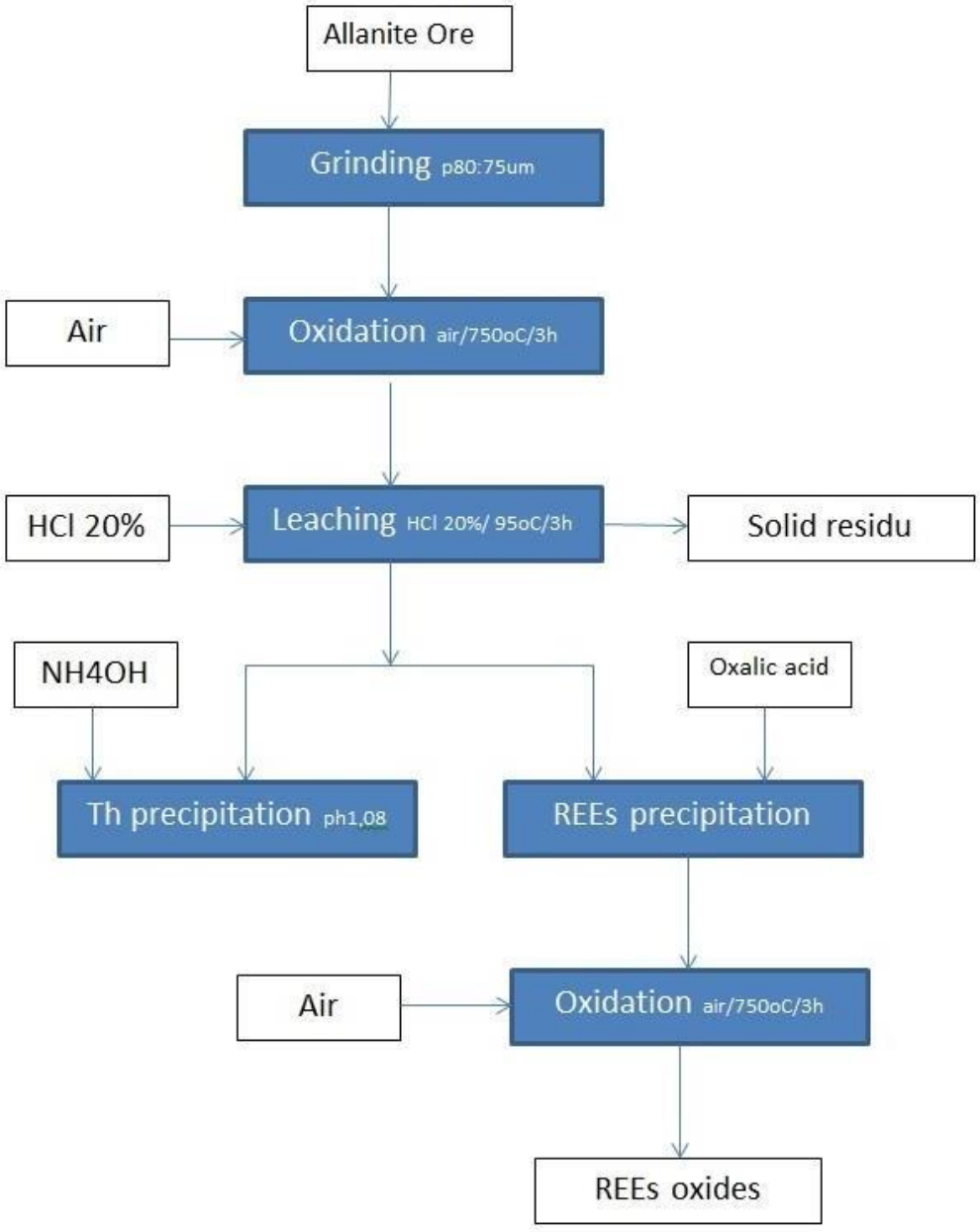


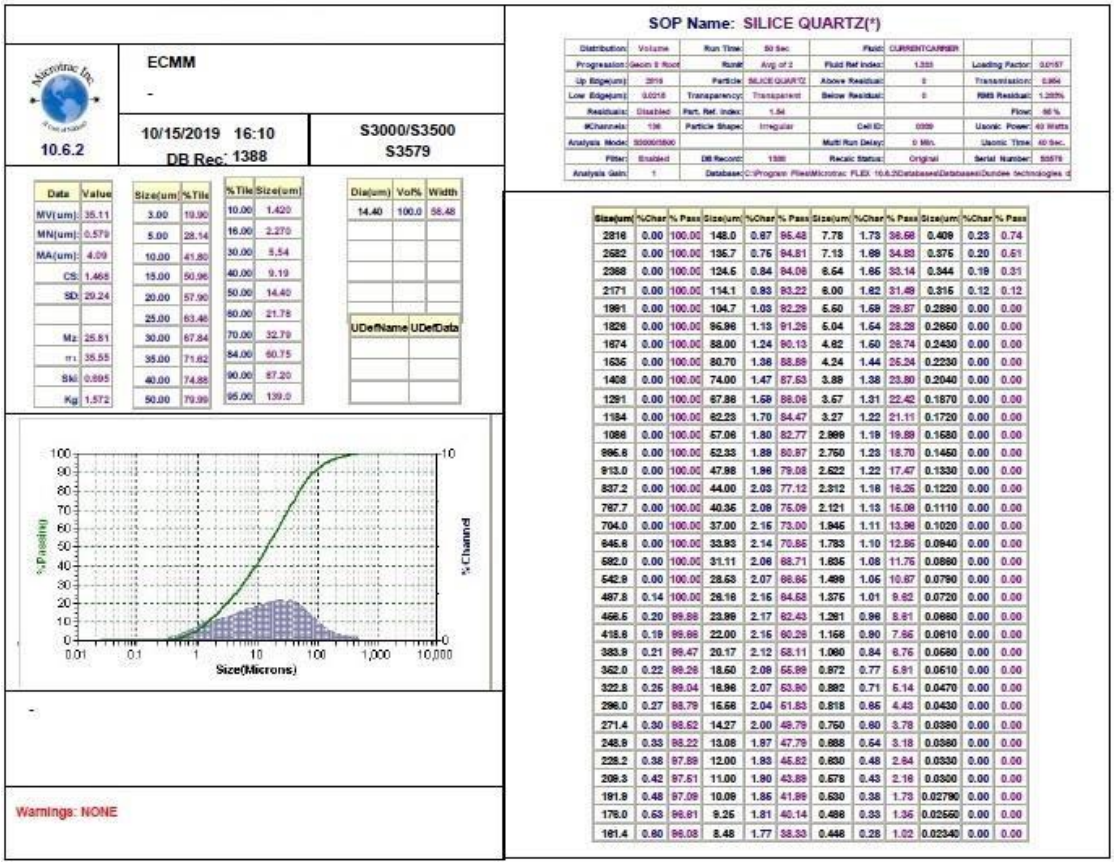
Figure 1. Process flow diagram of the hydrometallurgical treatment of ore FNC-01

Extraction

Crushing and milling of Allanite sample FNC-01 from Baude Lake

The rock sample from Baude Lake is an allanite ore named FNC-01. The mass of the sample used for this test is about 300 g. Sample FNC-01 was crushed in a jaw crusher and then milled in a ball mill. The particle size of the milled sample FNC-01 was determined by laser particle size. The results are shown in Table 3.

Tableau 3. Laser particule size analyse of milled FNC-01 sample



ECMM

10/15/2019 16:10
DB Rec: 1388

S3000/S3500
S3579

10.6.2

SOP Name: SILICE QUARTZ(*)

Data	Value
MV(um):	35.11
MN(um):	0.579
MA(um):	4.09
CS:	1.465
SD:	29.24
Mz	25.51
m1	35.55
Ske	0.895
Kg	1.572

Size(um)	%Tile
3.00	19.90
5.00	28.14
10.00	41.80
15.00	50.96
20.00	57.90
25.00	63.46
30.00	67.84
35.00	71.62
40.00	74.88
50.00	79.99

%Tile	Size(um)
10.00	1.420
16.00	2.270
30.00	5.54
40.00	9.19
50.00	14.40
60.00	21.78
70.00	32.79
84.00	60.75
90.00	87.20
95.00	139.0

Dia(um)	Vol%	Width
14.40	100.0	58.48

UDefName	UDefData

Warnings: NONE

Size(um)	%Char	% Pass	Size(um)	%Char	% Pass	Size(um)	%Char	% Pass	Size(um)	%Char	% Pass
2816	0.00	100.00	148.0	0.87	95.48	7.78	1.73	38.68	0.409	0.23	0.74
2582	0.00	100.00	135.7	0.75	94.61	7.13	1.89	34.83	0.375	0.20	0.51
2368	0.00	100.00	124.5	0.84	94.06	6.64	1.85	33.14	0.344	0.18	0.31
2171	0.00	100.00	114.1	0.93	93.22	6.00	1.82	31.49	0.315	0.12	0.12
1991	0.00	100.00	104.7	1.03	92.29	5.60	1.69	29.87	0.2890	0.00	0.00
1828	0.00	100.00	96.96	1.13	91.26	5.04	1.64	28.28	0.2650	0.00	0.00
1674	0.00	100.00	88.00	1.24	90.13	4.82	1.60	26.74	0.2430	0.00	0.00
1535	0.00	100.00	80.70	1.38	88.89	4.24	1.44	25.24	0.2230	0.00	0.00
1408	0.00	100.00	74.00	1.47	87.53	3.88	1.38	23.80	0.2040	0.00	0.00
1291	0.00	100.00	67.86	1.58	86.06	3.67	1.31	22.42	0.1870	0.00	0.00
1184	0.00	100.00	62.23	1.70	84.47	3.27	1.22	21.11	0.1720	0.00	0.00
1086	0.00	100.00	57.06	1.80	82.77	2.999	1.19	19.89	0.1580	0.00	0.00
996.6	0.00	100.00	52.33	1.88	80.97	2.750	1.23	18.70	0.1450	0.00	0.00
913.0	0.00	100.00	47.98	1.96	79.08	2.522	1.22	17.47	0.1330	0.00	0.00
837.2	0.00	100.00	44.00	2.03	77.12	2.312	1.18	16.25	0.1220	0.00	0.00
767.7	0.00	100.00	40.36	2.09	75.09	2.121	1.13	15.08	0.1110	0.00	0.00
704.0	0.00	100.00	37.00	2.15	73.00	1.945	1.11	13.96	0.1020	0.00	0.00
645.8	0.00	100.00	33.93	2.14	70.86	1.783	1.10	12.86	0.0940	0.00	0.00
592.0	0.00	100.00	31.11	2.08	68.71	1.635	1.08	11.76	0.0860	0.00	0.00
542.9	0.00	100.00	28.53	2.07	66.65	1.499	1.06	10.67	0.0790	0.00	0.00
497.8	0.14	100.00	26.16	2.16	64.58	1.375	1.01	9.62	0.0720	0.00	0.00
456.5	0.20	99.86	23.99	2.17	62.43	1.291	0.96	8.61	0.0660	0.00	0.00
418.8	0.19	99.66	22.00	2.15	60.26	1.166	0.90	7.66	0.0610	0.00	0.00
383.9	0.21	99.47	20.17	2.12	58.11	1.080	0.84	6.76	0.0560	0.00	0.00
352.0	0.22	99.26	18.50	2.09	55.99	0.972	0.77	5.91	0.0510	0.00	0.00
322.8	0.26	99.04	16.96	2.07	53.90	0.892	0.71	5.14	0.0470	0.00	0.00
296.0	0.27	98.79	15.56	2.04	51.83	0.818	0.65	4.43	0.0430	0.00	0.00
271.4	0.30	98.52	14.27	2.00	49.79	0.750	0.60	3.78	0.0390	0.00	0.00
248.9	0.33	98.22	13.08	1.97	47.79	0.688	0.54	3.18	0.0360	0.00	0.00
228.2	0.38	97.89	12.00	1.93	45.82	0.630	0.48	2.64	0.0330	0.00	0.00
209.3	0.42	97.51	11.00	1.90	43.89	0.578	0.43	2.16	0.0300	0.00	0.00
191.9	0.48	97.09	10.09	1.85	41.99	0.530	0.38	1.73	0.02790	0.00	0.00
176.0	0.53	96.61	9.25	1.81	40.14	0.486	0.33	1.36	0.02560	0.00	0.00
161.4	0.60	96.08	8.48	1.77	38.33	0.448	0.28	1.02	0.02340	0.00	0.00

The results in Table 3 show that the particle size of the ground sample FNC-01 is very fine. The P80 was measured close to 52 microns. The fine granulometry of the FNC-01 sample particles will improve the extraction of REEs during the acid wash phase.

Extraction of REEs from FNC-01 sample by acid leaching

Extraction of REEs from ore FNC-01 was carried out by washing with 10% hydrochloric acid with a solid percentage of 10% for a period of 2 hours. A mass of 50 g of milled ore FNC-01 was leached.

Three leaching temperatures were tested: 20°C, 60°C and 90°C. After leaching, the slurry was filtered. The residual solid, FNC-01-S was then washed twice with 50 ml of water. Filtration of leaching residues at 60°C and 90°C was particularly long. This was caused by the formation of a silica gel. The residual solution FNC-01-L was recovered. It will be treated in a later work. The solid FNC-01-S was then dried and analyzed by XRF. The results are shown in Table 4.

Table 4.

Client: ECMM
projet: M-9215

XRF Semi-quantitatif

ECMM temp pièce	
Formula	Conc
SiO2	77,30%
Fe2O3	6,87%
Al2O3	6,26%
K2O	1,81%
Na2O	1,72%
CeO2	1,61%
CaO	1,50%
TiO2	1,03%
La2O3	0,64%
Nd2O3	0,51%
Cl	0,15%
MnO	0,13%
ThO2	0,10%
Pr6O11	0,09%
ZrO2	0,09%
MgO	0,06%
Y2O3	0,06%
Sm2O3	0,04%
SrO	0,04%
ZnO	0,01%
Nb2O5	85 PPM
Rb2O	69 PPM
PbO	57 PPM
TOTAL :	100,02%

ECMM Temp 60 degré celsius	
Formula	Conc
SiO2	80,70%
Fe2O3	6,18%
Al2O3	5,98%
K2O	1,86%
Na2O	1,83%
TiO2	1,02%
CaO	0,83%
CeO2	0,64%
La2O3	0,25%
Cl	0,20%
Nd2O3	0,18%
ZrO2	0,10%
MnO	0,07%
ThO2	0,04%
P2O5	0,03%
Y2O3	0,02%
SrO	0,02%
ZnO	82 PPM
Rb2O	65 PPM
Nb2O5	63 PPM
PbO	30 PPM
TOTAL :	99,95%

ECMM Temp 90 degré celsius	
Formula	Conc
SiO2	82,20%
Al2O3	5,59%
Fe2O3	5,23%
K2O	2,01%
Na2O	1,74%
TiO2	1,12%
CaO	0,67%
CeO2	0,41%
Cl	0,34%
La2O3	0,16%
Nd2O3	0,11%
ThO2	0,09%
ZrO2	0,08%
P2O5	0,07%
MnO	0,05%
BaO	0,03%
Y2O3	0,01%
SrO	0,01%
Rb2O	74 PPM
ZnO	68 PPM
Nb2O5	59 PPM
PbO	49 PPM
TOTAL :	99,92%

Appareil: XRF S8 Tiger de Bruker
Condition Semi-Quantitatif: Analyse sur l'échantillon en poudre SQ/Oxydes/prolene 4µm 7g/HeAtm/28 mm/Full
Résultat normalisé à 100% en fonction d'une matrice de SiO2. Interférence importante entre le Nb et le Y.

The solids from the dry leach residues were weighed. The results are shown in Table 5.

Table 5

Temperature (T°C)	Mass of residues (g)	Loss of mass (%)
20	30.71	38.6
60	26.96	46.1
90	23.55	52.9

The results show that high masses of material were dissolved during leaching. Indeed, the results in Table 5 show a mass loss of 53% for the acid wash at 90 °C.

The extraction percentages for the REEs mainly present in ore FNC-01, La, Ce, Nd, Pr, Sm, Y and Th were calculated. The results are shown in Table 6.

Table 6.

	Pourcentage extraction à 20 °C (%)	**Pourcentage extraction à 60 °C (%)**	**Pourcentage extraction à 90 °C (%)**
CeO2	79.6	93.1	91.8
La2O3	79.4	93.2	91.9
Nd2O3	78.7	93.6	92.8
Pr6O11	83.7	100	100
Sm2O3	80.5	100	100
Y2O3	78.9	100	94.4
ThO2	75.6	91.7	65.4

- The acid wash at 20 ° C from ore FNC-01 allows the extraction of significant percentages of REEs. For example, 79% of the neodymium oxides were extracted at room temperature.

- The acid wash at 60 ° C from the ore FNC-01 allows the extraction of large percentages of REEs, greater than 92%. For example, a percentage of 94% of the neodymium oxides were extracted at room temperature.

- It is noted that the extraction percentages of the REEs at 90 ° C were lower than the extraction percentages of the REEs at 60 ° C. This can be explained by the formation and the presence of a silica gel during the filtration which made the separation between the solid and the

liquid difficult and not optimal.

- Finally, we notice that for the three acid washes at 20, 60 and 90 ° C, significant quantities of thorium could be put in solution. Thorium oxides in solution should therefore be treated separately from REEs in order to isolate them and treat them by landfill.

Selective precipitation of thorium and REEs Concentrate

REEs will be extracted in the form of REE oxalate from the acid solution by selective precipitation. REE oxalate is indeed an economically recoverable form for REEs. But before, the thorium from the acid solution will be eliminated by precipitation in the form of a hydride. The acid solution will be neutralized up to pH 1.8 with ammonium hydroxide according to equation 9. Once the thorium hydroxide has precipitated and then recovered by filtration, the residual acid solution may be treated with oxalic acid to precipitate the oxalates of REEs according equation 10.

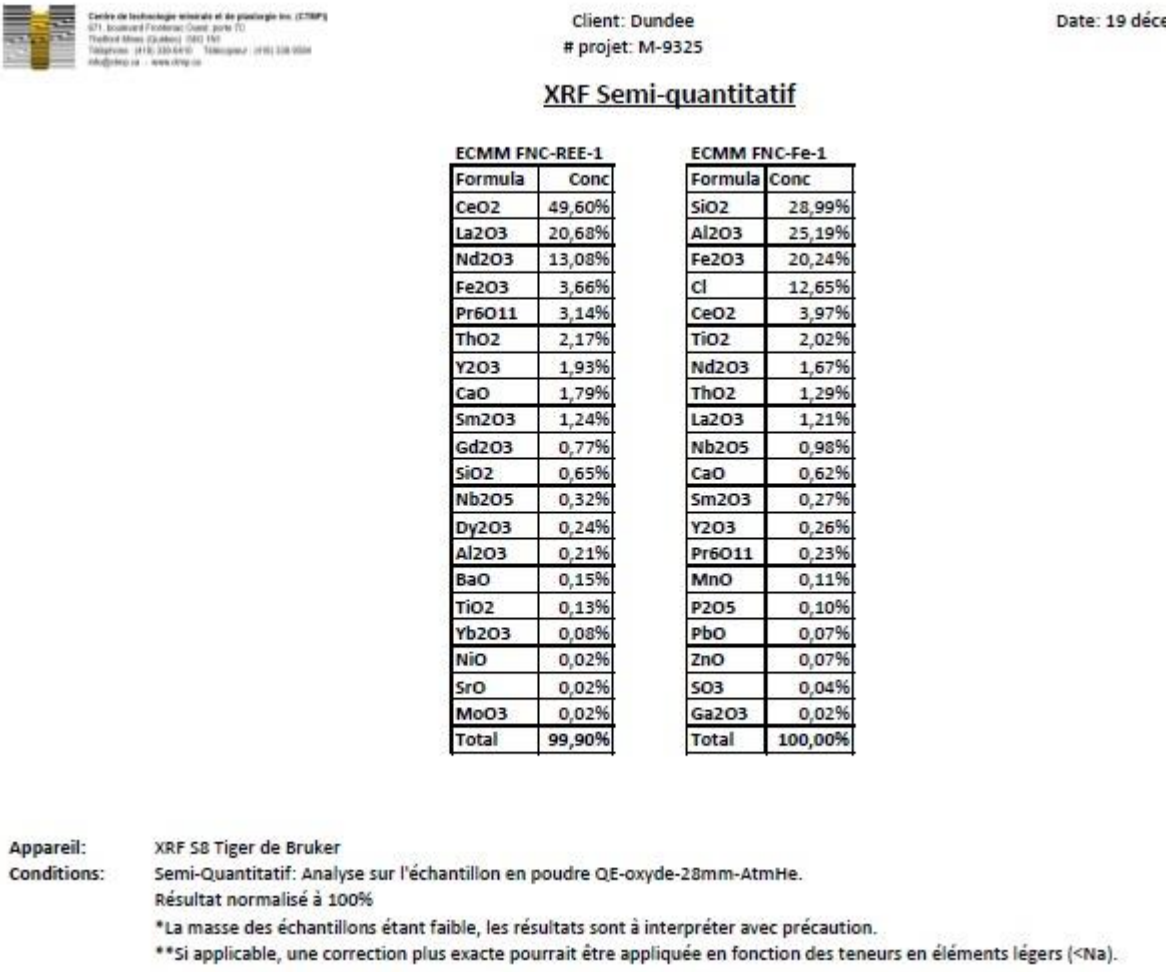
The acid solution produced during the acid washing of the FNC-01 ore at a temperature of 60 ^{o}C was chosen to test the elimination of thorium and the recovery of the REE concentrate.

Selective precipitation of thorium from acid leaching solution

The 840 ml acid wash solution produced at 60oC was neutralized to pH 1.8 by the addition of 8.4 ml of 30% ammonium hydroxide. A red solid then precipitated from the solution. This solid (1.55 g) was then filtered, dried and then analyzed by XRF. The results are shown in Figure X.

Precipitation of REEs from acid leaching solution

After precipitation of the solid FNC-Fe-1, the residual acid solution was treated in order to recover the REEs. A mass of 16.8 g of oxalic acid was added to the acid solution. A white solid (6.1 g) then precipitated in the acid solution. The solid, FNC-REE-1 was filtered, dried and then analyzed by XRF. The results are shown in Figure X.



Client: Dundee
projet: M-9325

Date: 19 déce

XRF Semi-quantitatif

ECMM FNC-REE-1	
Formula	Conc
CeO2	49,60%
La2O3	20,68%
Nd2O3	13,08%
Fe2O3	3,66%
Pr6O11	3,14%
ThO2	2,17%
Y2O3	1,93%
CaO	1,79%
Sm2O3	1,24%
Gd2O3	0,77%
SiO2	0,65%
Nb2O5	0,32%
Dy2O3	0,24%
Al2O3	0,21%
BaO	0,15%
TiO2	0,13%
Yb2O3	0,08%
NiO	0,02%
SrO	0,02%
MoO3	0,02%
Total	99,90%

ECMM FNC-Fe-1	
Formula	Conc
SiO2	28,99%
Al2O3	25,19%
Fe2O3	20,24%
Cl	12,65%
CeO2	3,97%
TiO2	2,02%
Nd2O3	1,67%
ThO2	1,29%
La2O3	1,21%
Nb2O5	0,98%
CaO	0,62%
Sm2O3	0,27%
Y2O3	0,26%
Pr6O11	0,23%
MnO	0,11%
P2O5	0,10%
PbO	0,07%
ZnO	0,07%
SO3	0,04%
Ga2O3	0,02%
Total	100,00%

Appareil: XRF S8 Tiger de Bruker
Conditions: Semi-Quantitatif: Analyse sur l'échantillon en poudre QE-oxyde-28mm-AtmHe.
Résultat normalisé à 100%
*La masse des échantillons étant faible, les résultats sont à interpréter avec précaution.
**Si applicable, une correction plus exacte pourrait être appliquée en fonction des teneurs en éléments légers (<Na).

Figure x

Mass balance for the precipitation of thorium and REEs

The mass balance for the extraction at 60 ^{o}C of the REEs and the thorium was showed in the table 7.

Table x: Mass balance for the extraction of REEs from FNC-01 at 60 oC

	FNC-01 (% of recovery)	**Acid leaching (% of recovery)**	**FNC-Fe-1 (% of recovery)**	**FNC-REE-1 (% of recovery)**
Ce	100	93.1	0.74	92.4
La	100	93.2	0.45	92.7
Nd	100	93.6	0.55	93.1
Pr	100	100	0.38	99.6
Sm	100	100	1.13	98.8
Y	100	94.4	0.98	93.4
Th	100	91.7	3.46	88.24

The results from table 7 showed:

- A large percentage, close to 100%, of the LREEs were extracted during the acid wash at 60 ^{o}C.
- Only 3.5% of the total thorium mass was extracted during the precipitation of the solid FNC-Fe-1.
- 92.4% of the cerium, 92.7% of the lanthanum and 93.1 of the neodymium were recovered in the recoverable form of the solid FNC-REE-1, an oxalate of REEs.
- The thorium content of the recoverable solid FNC-REE-1 is only 2% Th.

Conclusions

A lixiviation with hydrochloric acid at 60 ^{o}C makes it possible to extract more than 90% of the LREEs from the allanite ore FNC-01.

The LREEs extracted from the FNC-01 ore can be economically valued by the precipitation of a concentrate of LREEs oxalate.

The method proposed by FIG. 1 seems to be promising. The recoverable solid of LREEs oxalate could be roasted in order to produce a concentrate of LREEs oxides.

The process proposed in Figure 1 must be optimized so that the economic recovery of LREEs from the FNC-01 ore can give better economic results.

An allanite concentrate could be produced by flotation or gravimetric concentration from the FNC-01 ore in order to optimize the economic results.

Finally, it will be necessary to ask the question of the relevance of selectively removing thorium.

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