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CERTIFICATE OF ANALYSIS FOR

Pegmatitic Li-Nb-Sn ORE
CERTIFIED REFERENCE MATERIAL
OREAS 148

Summary Statistics for Key Analytes.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Peroxide Fusion ICP						
Li, Lithium (wt.%)	0.476	0.011	0.472	0.481	0.462	0.491
Li_2O, Lithium oxide (wt.%)	1.03	0.023	1.02	1.04	0.996	1.06
Nb, Niobium (wt.%)	0.168	0.011	0.161	0.174	0.162	0.174
Sn, Tin (ppm)	1157	80	1108	1206	1100	1215

Note: intervals may appear asymmetric due to rounding.

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 148.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion						
Al, Aluminium (wt.%)	5.27	0.170	5.18	5.35	5.15	5.38
As, Arsenic (ppm)	58	3.2	56	59	55	60
Ba, Barium (ppm)	1000	36	980	1019	975	1024
Be, Beryllium (ppm)	36.2	2.53	35.1	37.3	34.8	37.7
Bi, Bismuth (ppm)	18.9	1.17	18.3	19.5	18.4	19.5
Ca, Calcium (wt.%)	0.872	0.037	0.855	0.888	0.851	0.892
Ce, Cerium (ppm)	725	64	684	766	704	747
Co, Cobalt (ppm)	6.31	0.403	6.12	6.49	6.07	6.54
Cr, Chromium (ppm)	60	9	55	64	57	62
Cs, Cesium (ppm)	314	16	306	322	307	321
Cu, Copper (ppm)	338	16	331	345	328	347
Dy, Dysprosium (ppm)	6.66	0.93	5.65	7.68	6.36	6.97
Er, Erbium (ppm)	2.20	0.26	1.92	2.48	2.05	2.34
Eu, Europium (ppm)	7.54	0.458	6.95	8.13	7.20	7.87
Fe, Iron (wt.%)	3.02	0.132	2.96	3.08	2.95	3.09
Ga, Gallium (ppm)	29.2	2.32	27.7	30.7	28.5	29.9
Gd, Gadolinium (ppm)	17.1	2.2	14.6	19.6	16.4	17.8
Ge, Germanium (ppm)	0.55	0.10	0.44	0.67	0.50	0.60
Hf, Hafnium (ppm)	2.16	0.22	2.07	2.25	1.98	2.33
Ho, Holmium (ppm)	0.84	0.09	0.72	0.97	0.76	0.93
In, Indium (ppm)	3.98	0.202	3.86	4.10	3.84	4.12
K, Potassium (wt.%)	1.47	0.041	1.45	1.49	1.43	1.51
La, Lanthanum (ppm)	446	28	432	461	429	464
Li, Lithium (wt.%)	0.465	0.009	0.461	0.470	0.454	0.477
Li_2O, Lithium oxide (wt.%)	1.00	0.020	0.993	1.01	0.978	1.03
Lu, Lutetium (ppm)	0.17	0.02	0.15	0.19	0.16	0.18
Mg, Magnesium (wt.%)	0.454	0.020	0.445	0.463	0.440	0.468
Mn, Manganese (wt.%)	0.037	0.002	0.036	0.038	0.036	0.038
Mo, Molybdenum (ppm)	8.86	0.344	8.72	9.00	8.51	9.21
Na, Sodium (wt.%)	0.860	0.039	0.839	0.881	0.841	0.879
Nb, Niobium (wt.%)	0.169	0.010	0.162	0.176	0.165	0.173
Nd, Neodymium (ppm)	267	11	253	281	254	279
Ni, Nickel (ppm)	22.2	0.98	21.8	22.6	21.4	22.9
P, Phosphorus (wt.%)	0.131	0.005	0.128	0.134	0.127	0.134
Pb, Lead (ppm)	24.9	2.20	23.9	26.0	23.7	26.2
Pr, Praseodymium (ppm)	82	2.0	80	84	79	84
Rb, Rubidium (ppm)	1324	41	1306	1341	1290	1358
Sb, Antimony (ppm)	16.2	0.78	15.9	16.5	15.6	16.8
Sc, Scandium (ppm)	8.23	0.554	7.91	8.56	7.92	8.54
Sm, Samarium (ppm)	34.2	0.94	33.4	35.0	33.0	35.4
Sr, Strontium (ppm)	204	16	197	212	199	210

Note: intervals may appear asymmetric due to rounding

Table 1 continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion continued						
Ta, Tantalum (ppm)	23.1	2.9	21.2	24.9	22.1	24.0
Tb, Terbium (ppm)	1.71	0.145	1.59	1.83	1.63	1.79
Th, Thorium (ppm)	48.2	3.62	46.3	50.1	46.7	49.8
Ti, Titanium (wt.%)	0.345	0.015	0.338	0.352	0.336	0.353
Tl, Thallium (ppm)	12.2	0.59	11.9	12.5	11.9	12.4
Tm, Thulium (ppm)	0.20	0.03	0.16	0.24	IND	IND
U, Uranium (ppm)	8.10	0.332	7.95	8.25	7.82	8.39
V, Vanadium (ppm)	54	3.1	53	56	52	56
W, Tungsten (ppm)	6.45	0.373	6.31	6.59	5.92	6.98
Y, Yttrium (ppm)	18.5	2.0	17.6	19.4	17.9	19.1
Yb, Ytterbium (ppm)	1.15	0.12	1.06	1.23	1.01	1.28
Zn, Zinc (ppm)	162	5	160	164	156	169
Zr, Zirconium (ppm)	79	4.8	76	81	76	81
Peroxide Fusion ICP						
Al, Aluminium (wt.%)	5.37	0.148	5.30	5.44	5.22	5.52
As, Arsenic (ppm)	59	4.0	56	62	54	64
Ba, Barium (ppm)	1009	26	991	1027	976	1042
Be, Beryllium (ppm)	38.8	2.00	37.5	40.0	37.0	40.6
Bi, Bismuth (ppm)	19.3	1.31	18.3	20.2	18.3	20.2
Ca, Calcium (wt.%)	0.903	0.048	0.881	0.925	0.866	0.940
Ce, Cerium (ppm)	795	53	754	836	758	832
Cr, Chromium (ppm)	69	5.8	64	74	64	73
Cs, Cesium (ppm)	311	13	303	320	299	324
Cu, Copper (ppm)	351	35	328	373	334	367
Dy, Dysprosium (ppm)	6.06	0.492	5.70	6.41	5.74	6.37
Er, Erbium (ppm)	2.00	0.121	1.96	2.04	1.82	2.18
Eu, Europium (ppm)	7.22	0.425	6.93	7.52	6.82	7.62
Fe, Iron (wt.%)	3.06	0.083	3.02	3.09	2.98	3.13
Ga, Gallium (ppm)	29.2	1.50	27.9	30.6	26.7	31.8
Gd, Gadolinium (ppm)	15.8	1.34	14.9	16.6	15.0	16.6
Hf, Hafnium (ppm)	4.15	0.53	3.74	4.55	IND	IND
Ho, Holmium (ppm)	0.94	0.12	0.84	1.04	0.86	1.03
In, Indium (ppm)	4.22	0.299	3.96	4.47	3.81	4.62
K, Potassium (wt.%)	1.50	0.050	1.48	1.53	1.47	1.54
La, Lanthanum (ppm)	478	15	466	489	459	496
Li, Lithium (wt.%)	0.476	0.011	0.472	0.481	0.462	0.491
Li_2O, Lithium oxide (wt.%)	1.03	0.023	1.02	1.04	0.996	1.06
Mg, Magnesium (wt.%)	0.469	0.016	0.462	0.475	0.453	0.484
Mn, Manganese (wt.%)	0.038	0.002	0.037	0.039	0.036	0.040
Mo, Molybdenum (ppm)	10.1	0.59	9.7	10.5	IND	IND
Nb, Niobium (wt.%)	0.168	0.011	0.161	0.174	0.162	0.174
Nd, Neodymium (ppm)	260	12	251	268	248	271

Note: intervals may appear asymmetric due to rounding

Table 1 continued.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Peroxide Fusion ICP continued						
P, Phosphorus (wt.%)	0.129	0.008	0.125	0.133	0.122	0.137
Pr, Praseodymium (ppm)	82	1.9	81	83	80	84
Rb, Rubidium (ppm)	1362	79	1303	1421	1321	1403
Sb, Antimony (ppm)	16.3	0.96	15.3	17.3	15.1	17.5
Sc, Scandium (ppm)	8.64	1.43	6.86	10.42	IND	IND
Si, Silicon (wt.%)	36.00	1.065	35.36	36.63	35.11	36.88
Sm, Samarium (ppm)	34.3	3.16	32.2	36.4	33.0	35.6
Sn, Tin (ppm)	1157	80	1108	1206	1100	1215
Sr, Strontium (ppm)	209	11	204	214	198	220
Tb, Terbium (ppm)	1.58	0.141	1.47	1.69	1.45	1.71
Th, Thorium (ppm)	51	2.0	49	52	49	52
Ti, Titanium (wt.%)	0.352	0.011	0.347	0.357	0.342	0.362
Tl, Thallium (ppm)	12.3	0.73	11.6	12.9	11.6	12.9
Tm, Thulium (ppm)	0.24	0.04	0.22	0.27	0.21	0.28
U, Uranium (ppm)	8.55	0.448	8.34	8.76	7.90	9.21
V, Vanadium (ppm)	56	3.1	55	58	52	60
W, Tungsten (ppm)	6.42	1.32	5.27	7.56	IND	IND
Y, Yttrium (ppm)	19.4	1.47	18.3	20.6	18.9	20.0
Yb, Ytterbium (ppm)	1.37	0.18	1.32	1.43	IND	IND
Zn, Zinc (ppm)	159	11	153	164	149	169
Zr, Zirconium (ppm)	153	25	130	177	135	172
Borate Fusion XRF						
Al_2O_3, Aluminium(III) oxide (wt.%)	10.20	0.096	10.14	10.25	10.14	10.25
BaO, Barium oxide (ppm)	1152	55	1122	1181	IND	IND
CaO, Calcium oxide (wt.%)	1.24	0.014	1.23	1.24	1.23	1.25
Fe_2O_3, Iron(III) oxide (wt.%)	4.35	0.055	4.32	4.38	4.32	4.38
K_2O, Potassium oxide (wt.%)	1.81	0.022	1.79	1.82	1.79	1.82
MgO, Magnesium oxide (wt.%)	0.797	0.015	0.790	0.804	0.785	0.809
MnO, Manganese oxide (wt.%)	0.050	0.001	0.049	0.050	0.047	0.053
Na_2O, Sodium oxide (wt.%)	1.19	0.018	1.18	1.20	1.17	1.21
Nb_2O_5, Niobium(V) oxide (wt.%)	0.245	0.009	0.240	0.250	0.239	0.251
P_2O_5, Phosphorus(V) oxide (wt.%)	0.302	0.008	0.298	0.305	0.296	0.307
SiO_2, Silicon dioxide (wt.%)	76.59	0.399	76.40	76.78	76.34	76.84
Sn, Tin (ppm)	1181	72	1140	1223	1150	1213
SO_3, Sulphur trioxide (wt.%)	0.057	0.005	0.054	0.060	0.052	0.063
SrO, Strontium oxide (ppm)	223	29	204	243	IND	IND
TiO_2, Titanium dioxide (wt.%)	0.584	0.008	0.581	0.587	0.574	0.594
Thermogravimetry						
LOI^{1000}, Loss on ignition @1000°C (wt.%)	0.887	0.060	0.852	0.922	0.861	0.914

Note: intervals may appear asymmetric due to rounding

INTRODUCTION

OREAS reference materials are intended to provide a low cost method of evaluating and improving the quality of analysis of geological samples. To the geologist they provide a means of implementing quality control in analytical data sets generated in exploration from the grass roots level through to prospect evaluation, and in grade control at mining operations. To the analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

SOURCE MATERIALS

Certified Reference Material OREAS 148 has been prepared from spodumene $LiAl(Si_2O_5)$-rich pegmatite ore blended with granodiorite and with minor additions of Sn oxide ore and Nb concentrate. The pegmatite was sourced from stockpile grab samples from the Greenbushes Mine owned by Talison Lithium Ltd located just south of the town of Greenbushes in the south-western corner of Western Australia. The barren I-type hornblende-bearing granodiorite was sourced from the Late Devonian Lysterfield granodiorite complex located in eastern Melbourne, Australia. The Sn lateritic ore material was sourced from the Doradilla Project located in north central NSW and the Nb concentrate was sourced from Anglo American Brasil Catalão's niobium mine in Goiás, Brazil. The Nb concentrate was produced from niobium-rich ore developed in the saprolite zone over alkaline-carbonatite complexes.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 148 was prepared in the following manner:

- Drying to constant mass at 105°C;
- Milling of Li and Nb ores to 100% minus 30 microns;
- Milling of Sn ore and granodiorite to 98% minus 75 microns;
- Preliminary homogenisation and check assaying of source materials;
- Final homogenisation by blending the source materials in specific ratios to achieve target grades;
- Packaging in 10g units in laminated foil pouches.

ANALYTICAL PROGRAM

Twenty two commercial analytical laboratories participated in the program to certify the analytes reported in Table 1. The following methods were employed:

- Four acid digestion for full ICP-OES and ICP-MS elemental suites (up to 22 laboratories depending on the element) except for one laboratory who used an AAS finish for Li only;
- Peroxide fusion for full ICP-OES and ICP-MS elemental suites (up to 21 laboratories depending on the element);
- Lithium borate fusion with XRF finish for whole rock package including Nb and Ta (up to 22 laboratories depending on the element);

- Thermogravimetry for LOI at 1000° C; (9 laboratories used a conventional muffle furnace and 6 laboratories used a thermogravimetric analyser).

For the round robin program ten test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 20g scoop splits from each of three separate 300g test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e. to ascertain whether between-unit variance is greater than within-unit variance. Table 1 presents the 117 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 56 indicative values. Table 3 provides performance gate intervals for the certified values based on their associated pooled standard deviations. Tabulated results of all elements together with analytical method codes, uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 148 DataPack-1.1.190226_154450.xlsx**).

Table 2. Indicative Values for OREAS 148.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Ag	ppm	*0.649*	Ir	ppm	*0.007*	Si	wt.%	*34.98*
Au	ppm	*0.098*	Pt	ppm	*0.018*	Sn	ppm	*837*
B	ppm	*3.23*	Re	ppm	*< 0.002*	Te	ppm	*0.21*
Cd	ppm	*0.48*	S	wt.%	*0.024*			
Hg	ppm	*0.030*	Se	ppm	*2.20*			
Peroxide Fusion ICP								
Ag	ppm	*5.08*	Lu	ppm	*0.17*	Se	ppm	*< 20*
B	ppm	*27.5*	Ni	ppm	*26.9*	Ta	ppm	*22.2*
Cd	ppm	*< 10*	Pb	ppm	*28.4*	Te	ppm	*< 1*
Co	ppm	*< 20*	Re	ppm	*< 0.1*			
Ge	ppm	*4.27*	S	wt.%	*0.020*			
Borate Fusion XRF								
As	ppm	*81*	Gd_2O_3	ppm	*< 100*	Sm_2O_3	ppm	*< 100*
Bi	ppm	*< 100*	HfO_2	ppm	*< 100*	Ta_2O_5	ppm	*< 100*
CeO_2	ppm	*975*	La_2O_3	ppm	*613*	ThO_2	ppm	*< 100*
Cl	ppm	*107*	Mo	ppm	*< 10*	U_3O_8	ppm	*< 100*
Co	ppm	*29.2*	Nd_2O_3	ppm	*450*	V_2O_5	ppm	*121*
Cr_2O_3	ppm	*100*	Ni	ppm	*35.2*	W	ppm	*21.7*
Cu	ppm	*326*	Pb	ppm	*43.7*	Y_2O_3	ppm	*117*
Dy_2O_3	ppm	*< 100*	Pr_6O_{11}	ppm	*400*	Yb_2O_3	ppm	*< 100*
Er_2O_3	ppm	*< 100*	Rb	ppm	*1365*	Zn	ppm	*160*
Ga_2O_3	ppm	*46.7*	Sb	ppm	*18.3*	Zr	ppm	*167*

Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

STATISTICAL ANALYSIS

Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits (Table 1) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. In certain instances statistician's prerogative has been employed in discriminating outliers. Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status. The Certified Values are the means of accepted laboratory means after outlier filtering.

The 95% Confidence Limits are inversely proportional to the number of participating laboratories and inter-laboratory agreement. It is a measure of the reliability of the certified value. A 95% confidence interval indicates a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits. *95% Confidence Limits should not be used as control limits for laboratory performance.*

Standard Deviation values (1SDs) are reported in Table 1 and provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. The SD's take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The SD values thus include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. OREAS prepared reference materials have a level of homogeneity such that the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e. after removal of any individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e. the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. **The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.**

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical process and this SD is not directly related to the round robin program.

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include inter-lab bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

Table 3 shows **Performance Gates** calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned. A second method utilises a 5% window calculated directly from the certified value. Standard deviation is also shown in relative percent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised when concentration levels approach lower limits of detection of the analytical methods employed as performance gates calculated from standard deviations tend to be excessively wide whereas those determined by the 5% method are too narrow.

Tolerance Limits (ISO Guide 3207) were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for tin (Sn) by fusion XRF, where 99% of the time ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 1150 and 1213 ppm. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35). *Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.*

The homogeneity of OREAS 148 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty four round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation is to test that no statistically significant difference exists in the variance between-units to that of the variance within-units. This allows an assessment of homogeneity across the entire prepared batch of OREAS 148. The test was performed using the following parameters:

- Null Hypothesis, H_0: Between-unit variance is no greater than within-unit variance (reject H_0 if p-value < 0.05);
- Alternative Hypothesis, H_1: Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of *p*-values. This process derived no significant *p*-values across the entire 113 certified values except for neodymium (Nd) by 4-acid digest. This isolated case is most likely due to random statistical probability as there is no other supporting evidence to suspect greater between-unit variance compared with within-unit variance. The null hypothesis is therefore retained.

It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not the analytes are distributed in a similar manner throughout the packaging run of OREAS 148 and whether the variance between two subsamples from the same unit is statistically distinguishable to the variance from two subsamples taken from any two separate units. A reference material therefore, can possess poor absolute homogeneity yet still pass a relative homogeneity test if the within-unit heterogeneity is large and similar across all units.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 148 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Table 3. Pooled-Lab Performance Gates for OREAS 148.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion											
Al, wt.%	5.27	0.170	4.93	5.61	4.76	5.78	3.23%	6.47%	9.70%	5.00	5.53
As, ppm	58	3.2	51	64	48	67	5.60%	11.20%	16.80%	55	60
Ba, ppm	1000	36	927	1072	891	1109	3.64%	7.27%	10.91%	950	1050
Be, ppm	36.2	2.53	31.2	41.3	28.6	43.8	6.98%	13.97%	20.95%	34.4	38.0
Bi, ppm	18.9	1.17	16.6	21.3	15.4	22.4	6.21%	12.41%	18.62%	18.0	19.9
Ca, wt.%	0.872	0.037	0.798	0.945	0.761	0.982	4.23%	8.47%	12.70%	0.828	0.915
Ce, ppm	725	64	597	853	534	917	8.81%	17.63%	26.44%	689	762
Co, ppm	6.31	0.403	5.50	7.11	5.10	7.51	6.39%	12.79%	19.18%	5.99	6.62
Cr, ppm	60	9	42	77	34	85	14.41%	28.82%	43.23%	57	63
Cs, ppm	314	16	283	345	267	361	5.01%	10.01%	15.02%	298	330
Cu, ppm	338	16	305	370	289	386	4.78%	9.55%	14.33%	321	355
Dy, ppm	6.66	0.93	4.81	8.52	3.88	9.44	13.91%	27.82%	41.73%	6.33	7.00
Er, ppm	2.20	0.26	1.68	2.72	1.42	2.98	11.78%	23.57%	35.35%	2.09	2.31
Eu, ppm	7.54	0.458	6.62	8.46	6.17	8.91	6.07%	12.15%	18.22%	7.16	7.92
Fe, wt.%	3.02	0.132	2.76	3.29	2.63	3.42	4.37%	8.74%	13.10%	2.87	3.17
Ga, ppm	29.2	2.32	24.6	33.8	22.2	36.2	7.95%	15.90%	23.85%	27.7	30.7
Gd, ppm	17.1	2.2	12.6	21.5	10.4	23.8	13.08%	26.16%	39.24%	16.2	17.9
Ge, ppm	0.55	0.10	0.35	0.76	0.25	0.86	18.51%	37.02%	55.53%	0.53	0.58
Hf, ppm	2.16	0.22	1.72	2.59	1.51	2.81	10.08%	20.16%	30.24%	2.05	2.27
Ho, ppm	0.84	0.09	0.65	1.03	0.56	1.13	11.25%	22.50%	33.75%	0.80	0.89
In, ppm	3.98	0.202	3.57	4.38	3.37	4.58	5.08%	10.15%	15.23%	3.78	4.18
K, wt.%	1.47	0.041	1.39	1.55	1.35	1.60	2.82%	5.64%	8.46%	1.40	1.54
La, ppm	446	28	390	503	362	531	6.31%	12.62%	18.94%	424	469
Li, wt.%	0.465	0.009	0.447	0.484	0.438	0.493	1.96%	3.93%	5.89%	0.442	0.489
Li_2O, wt.%	1.00	0.020	0.963	1.04	0.943	1.06	1.96%	3.93%	5.89%	0.952	1.05
Lu, ppm	0.17	0.02	0.12	0.22	0.10	0.24	14.47%	28.93%	43.40%	0.16	0.18
Mg, wt.%	0.454	0.020	0.414	0.493	0.395	0.513	4.35%	8.70%	13.05%	0.431	0.477
Mn, wt.%	0.037	0.002	0.034	0.041	0.032	0.042	4.77%	9.54%	14.30%	0.035	0.039
Mo, ppm	8.86	0.344	8.17	9.55	7.83	9.89	3.88%	7.77%	11.65%	8.42	9.30
Na, wt.%	0.860	0.039	0.783	0.937	0.744	0.976	4.49%	8.98%	13.47%	0.817	0.903
Nb, wt.%	0.169	0.010	0.150	0.188	0.140	0.198	5.72%	11.45%	17.17%	0.160	0.177
Nd, ppm	267	11	244	289	233	300	4.19%	8.37%	12.56%	253	280
Ni, ppm	22.2	0.98	20.2	24.1	19.2	25.1	4.42%	8.85%	13.27%	21.1	23.3
P, wt.%	0.131	0.005	0.120	0.141	0.115	0.146	4.00%	7.99%	11.99%	0.124	0.137
Pb, ppm	24.9	2.20	20.5	29.3	18.3	31.5	8.85%	17.70%	26.54%	23.7	26.2
Pr, ppm	82	2.0	78	86	76	88	2.39%	4.79%	7.18%	78	86
Rb, ppm	1324	41	1242	1405	1202	1446	3.08%	6.16%	9.24%	1258	1390
Sb, ppm	16.2	0.78	14.6	17.8	13.9	18.5	4.81%	9.61%	14.42%	15.4	17.0
Sc, ppm	8.23	0.554	7.13	9.34	6.57	9.90	6.73%	13.46%	20.19%	7.82	8.65

Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
Sm, ppm	34.2	0.94	32.3	36.1	31.4	37.0	2.75%	5.51%	8.26%	32.5	35.9
Sr, ppm	204	16	173	236	158	251	7.62%	15.25%	22.87%	194	215
Ta, ppm	23.1	2.9	17.3	28.9	14.4	31.8	12.52%	25.04%	37.57%	21.9	24.2
Tb, ppm	1.71	0.145	1.42	2.00	1.28	2.14	8.47%	16.93%	25.40%	1.62	1.80
Th, ppm	48.2	3.62	41.0	55.5	37.4	59.1	7.51%	15.03%	22.54%	45.8	50.6
Ti, wt.%	0.345	0.015	0.314	0.376	0.299	0.391	4.47%	8.94%	13.41%	0.328	0.362
Tl, ppm	12.2	0.59	11.0	13.4	10.4	13.9	4.84%	9.67%	14.51%	11.6	12.8
Tm, ppm	0.20	0.03	0.14	0.26	0.11	0.29	14.91%	29.83%	44.74%	0.19	0.21
U, ppm	8.10	0.332	7.44	8.77	7.10	9.10	4.10%	8.20%	12.30%	7.70	8.51
V, ppm	54	3.1	48	61	45	64	5.72%	11.45%	17.17%	52	57
W, ppm	6.45	0.373	5.70	7.20	5.33	7.57	5.79%	11.58%	17.36%	6.13	6.77
Y, ppm	18.5	2.0	14.5	22.5	12.6	24.4	10.71%	21.41%	32.12%	17.6	19.4
Yb, ppm	1.15	0.12	0.91	1.38	0.79	1.50	10.30%	20.60%	30.90%	1.09	1.20
Zn, ppm	162	5	151	173	146	178	3.34%	6.68%	10.03%	154	170
Zr, ppm	79	4.8	69	88	64	93	6.07%	12.14%	18.21%	75	82
Peroxide Fusion ICP											
Al, wt.%	5.37	0.148	5.07	5.66	4.92	5.81	2.77%	5.53%	8.30%	5.10	5.64
As, ppm	59	4.0	51	67	47	71	6.75%	13.51%	20.26%	56	62
Ba, ppm	1009	26	956	1062	930	1088	2.62%	5.24%	7.86%	959	1060
Be, ppm	38.8	2.00	34.8	42.8	32.8	44.8	5.15%	10.30%	15.45%	36.8	40.7
Bi, ppm	19.3	1.31	16.6	21.9	15.3	23.2	6.81%	13.63%	20.44%	18.3	20.2
Ca, wt.%	0.903	0.048	0.807	0.999	0.758	1.048	5.34%	10.68%	16.01%	0.858	0.948
Ce, ppm	795	53	689	901	636	955	6.68%	13.36%	20.03%	755	835
Cr, ppm	69	5.8	57	80	51	86	8.38%	16.76%	25.13%	65	72
Cs, ppm	311	13	286	337	273	350	4.11%	8.22%	12.32%	296	327
Cu, ppm	351	35	280	421	245	456	10.05%	20.10%	30.15%	333	368
Dy, ppm	6.06	0.492	5.07	7.04	4.58	7.53	8.12%	16.25%	24.37%	5.75	6.36
Er, ppm	2.00	0.121	1.76	2.24	1.63	2.36	6.07%	12.13%	18.20%	1.90	2.10
Eu, ppm	7.22	0.425	6.37	8.07	5.95	8.50	5.88%	11.77%	17.65%	6.86	7.58
Fe, wt.%	3.06	0.083	2.89	3.22	2.81	3.30	2.71%	5.42%	8.13%	2.90	3.21
Ga, ppm	29.2	1.50	26.2	32.3	24.7	33.8	5.14%	10.29%	15.43%	27.8	30.7
Gd, ppm	15.8	1.34	13.1	18.5	11.8	19.8	8.48%	16.96%	25.43%	15.0	16.6
Hf, ppm	4.15	0.53	3.09	5.20	2.56	5.73	12.77%	25.54%	38.31%	3.94	4.35
Ho, ppm	0.94	0.12	0.69	1.19	0.57	1.31	13.11%	26.22%	39.33%	0.89	0.99
In, ppm	4.22	0.299	3.62	4.81	3.32	5.11	7.08%	14.17%	21.25%	4.00	4.43
K, wt.%	1.50	0.050	1.40	1.60	1.35	1.65	3.30%	6.61%	9.91%	1.43	1.58
La, ppm	478	15	448	507	434	521	3.05%	6.10%	9.15%	454	501
Li, wt.%	0.476	0.011	0.455	0.498	0.444	0.509	2.26%	4.52%	6.78%	0.453	0.500
Li_2O, wt.%	1.03	0.023	0.980	1.07	0.956	1.10	2.26%	4.52%	6.78%	0.975	1.08
Mg, wt.%	0.469	0.016	0.436	0.501	0.420	0.518	3.48%	6.96%	10.44%	0.445	0.492
Mn, wt.%	0.038	0.002	0.034	0.041	0.032	0.043	4.80%	9.60%	14.41%	0.036	0.040
Mo, ppm	10.1	0.59	8.9	11.2	8.3	11.8	5.82%	11.63%	17.45%	9.6	10.6
Nb, wt.%	0.168	0.011	0.145	0.191	0.134	0.202	6.76%	13.52%	20.28%	0.160	0.176

Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Peroxide Fusion ICP continued											
Nd, ppm	260	12	236	284	224	296	4.64%	9.28%	13.93%	247	273
P, wt.%	0.129	0.008	0.114	0.145	0.106	0.153	6.08%	12.15%	18.23%	0.123	0.136
Pr, ppm	82	1.9	78	86	76	88	2.36%	4.72%	7.08%	78	86
Rb, ppm	1362	79	1204	1520	1125	1599	5.80%	11.61%	17.41%	1294	1430
Sb, ppm	16.3	0.96	14.4	18.2	13.5	19.2	5.86%	11.72%	17.57%	15.5	17.1
Sc, ppm	8.64	1.43	5.79	11.49	4.36	12.92	16.51%	33.03%	49.54%	8.21	9.07
Si, wt.%	36.00	1.065	33.87	38.13	32.80	39.19	2.96%	5.91%	8.87%	34.20	37.80
Sm, ppm	34.3	3.16	28.0	40.6	24.8	43.8	9.20%	18.40%	27.60%	32.6	36.0
Sn, ppm	1157	80	997	1317	917	1397	6.92%	13.84%	20.76%	1099	1215
Sr, ppm	209	11	186	232	174	243	5.49%	10.99%	16.48%	198	219
Tb, ppm	1.58	0.141	1.30	1.86	1.16	2.01	8.92%	17.85%	26.77%	1.50	1.66
Th, ppm	51	2.0	47	55	44	57	4.01%	8.02%	12.03%	48	53
Ti, wt.%	0.352	0.011	0.329	0.375	0.318	0.386	3.24%	6.47%	9.71%	0.335	0.370
Tl, ppm	12.3	0.73	10.8	13.7	10.1	14.4	5.96%	11.92%	17.88%	11.6	12.9
Tm, ppm	0.24	0.04	0.17	0.31	0.13	0.35	14.89%	29.78%	44.66%	0.23	0.25
U, ppm	8.55	0.448	7.66	9.45	7.21	9.90	5.24%	10.48%	15.72%	8.13	8.98
V, ppm	56	3.1	50	62	47	66	5.42%	10.84%	16.25%	54	59
W, ppm	6.42	1.32	3.78	9.05	2.47	10.37	20.53%	41.06%	61.59%	6.10	6.74
Y, ppm	19.4	1.47	16.5	22.4	15.0	23.8	7.55%	15.10%	22.64%	18.5	20.4
Yb, ppm	1.37	0.18	1.00	1.74	0.82	1.93	13.45%	26.91%	40.36%	1.30	1.44
Zn, ppm	159	11	137	181	126	192	6.94%	13.88%	20.83%	151	167
Zr, ppm	153	25	104	203	79	227	16.12%	32.24%	48.36%	146	161
Borate Fusion XRF											
Al_2O_3, wt.%	10.20	0.096	10.00	10.39	9.91	10.48	0.94%	1.88%	2.82%	9.69	10.71
BaO, ppm	1152	55	1041	1262	986	1317	4.79%	9.57%	14.36%	1094	1209
CaO, wt.%	1.24	0.014	1.21	1.26	1.19	1.28	1.11%	2.23%	3.34%	1.17	1.30
Fe_2O_3, wt.%	4.35	0.055	4.24	4.46	4.19	4.51	1.26%	2.52%	3.77%	4.13	4.57
K_2O, wt.%	1.81	0.022	1.76	1.85	1.74	1.87	1.21%	2.42%	3.64%	1.72	1.90
MgO, wt.%	0.797	0.015	0.768	0.826	0.754	0.841	1.83%	3.66%	5.49%	0.757	0.837
MnO, wt.%	0.050	0.001	0.048	0.052	0.047	0.053	1.94%	3.88%	5.82%	0.047	0.052
Na_2O, wt.%	1.19	0.018	1.15	1.22	1.14	1.24	1.49%	2.98%	4.47%	1.13	1.25
Nb_2O_5, wt.%	0.245	0.009	0.228	0.262	0.219	0.271	3.53%	7.06%	10.59%	0.233	0.257
P_2O_5, wt.%	0.302	0.008	0.286	0.317	0.278	0.325	2.58%	5.16%	7.74%	0.286	0.317
SiO_2, wt.%	76.59	0.399	75.79	77.38	75.39	77.78	0.52%	1.04%	1.56%	72.76	80.42
Sn, ppm	1181	72	1038	1325	966	1396	6.06%	12.12%	18.19%	1122	1240
SO_3, wt.%	0.057	0.005	0.048	0.067	0.043	0.072	8.43%	16.86%	25.29%	0.054	0.060
SrO, ppm	223	29	166	280	137	309	12.81%	25.63%	38.44%	212	234
TiO_2, wt.%	0.584	0.008	0.569	0.599	0.561	0.607	1.31%	2.61%	3.92%	0.555	0.613
Thermogravimetry											
LOI^{1000}, wt.%	0.887	0.060	0.767	1.007	0.707	1.067	6.77%	13.53%	20.30%	0.843	0.932

Note: intervals may appear asymmetric due to rounding.

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. ALS, Brisbane, QLD, Australia
3. ALS, Lima, Peru
4. ALS, Loughrea, Galway, Ireland
5. ALS, Perth, WA, Australia
6. ALS, Vancouver, BC, Canada
7. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
8. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
9. Bureau Veritas Geoanalytical, Perth, WA, Australia
10. Intertek Genalysis, Perth, WA, Australia
11. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
12. MinAnalytical Services, Perth, WA, Australia
13. Nagrom, Perth, WA, Australia
14. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
15. SGS Australia Mineral Services, Perth, WA, Australia
16. SGS Canada Inc., Vancouver, BC, Canada
17. SGS del Peru, Lima, Peru
18. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
19. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
20. UIS Analytical Services, Centurion , South Africa
21. Zarazma Mahan Company, Mahan, Kerrman, Iran
22. Zarazma Mineral Studies Company, Tehran, Iran

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It is packaged in 10g units in robust single-use laminated foil pouches.

INTENDED USE

OREAS 148 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- for the verification of analytical methods for analytes reported in Table 1;
- for the calibration of instruments used in the determination of the concentration of analytes reported in Table 1.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 149 has been prepared from spodumene $LiAl(Si_2O_5)$-rich pegmatite ore with minor additions of Sn oxide ore and Nb concentrate. It contains very little reactive sulphide and in its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

INSTRUCTIONS FOR CORRECT USE

The certified values determined by 4-acid digestion and peroxide fusion ICP refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis.

In contrast the certified values determined by borate fusion XRF and for LOI at 1000° C are on a dry basis. This requires the removal of hygroscopic moisture by drying in air to constant mass at 105° C. If the reference material is not dried prior to analysis, the certified values should be corrected to the moisture-bearing basis.

HANDLING INSTRUCTIONS

Fine powders pose a risk to eyes and lungs and therefore standard precautions such as the use of safety glasses and dust masks are advised.

TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This 'representivity' was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis. The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

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CERTIFYING OFFICER

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REFERENCES

ISO Guide 30 (1992), Terms and definitions used in connection with reference materials.

ISO Guide 31 (2000), Reference materials – Contents of certificates and labels.

ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.

ISO Guide 35 (2006), Certification of reference materials - General and statistical principals.