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CERTIFICATE OF ANALYSIS FOR

Pegmatitic Li-Nb-Sn ORE
CERTIFIED REFERENCE MATERIAL
OREAS 149

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.%)	1.03	0.030	1.01	1.04	1.00	1.05
Li_2O, Lithium oxide (wt.%)	2.21	0.064	2.18	2.25	2.16	2.27
Nb, Niobium (wt.%)	0.626	0.022	0.611	0.640	0.609	0.642
Sn, Tin (wt.%)	0.329	0.031	0.310	0.348	0.317	0.340

Note: intervals may appear asymmetric due to rounding.

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 149.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion						
Ag, Silver (ppm)	1.04	0.16	0.89	1.18	0.87	1.20
Al, Aluminium (wt.%)	7.47	0.430	7.25	7.69	7.25	7.68
As, Arsenic (ppm)	149	7	146	152	143	154
Ba, Barium (ppm)	2816	115	2757	2874	2743	2888
Be, Beryllium (ppm)	26.1	1.85	25.3	26.9	25.2	27.0
Bi, Bismuth (ppm)	46.5	3.89	44.5	48.4	44.4	48.5
Ca, Calcium (wt.%)	1.04	0.040	1.02	1.06	1.01	1.06
Ce, Cerium (ppm)	400	35	383	417	387	414
Co, Cobalt (ppm)	8.02	0.453	7.80	8.23	7.66	8.38
Cr, Chromium (ppm)	85	6.1	82	89	82	88
Cs, Cesium (ppm)	341	12	336	346	332	351
Cu, Copper (ppm)	338	27	325	350	328	347
Dy, Dysprosium (ppm)	4.95	0.83	4.04	5.87	4.50	5.41
Er, Erbium (ppm)	1.83	0.22	1.56	2.11	1.67	2.00
Eu, Europium (ppm)	4.51	0.59	3.83	5.18	4.28	4.73
Fe, Iron (wt.%)	4.17	0.146	4.11	4.23	4.08	4.25
Ga, Gallium (ppm)	48.4	1.56	47.5	49.3	46.7	50.1
Hf, Hafnium (ppm)	2.90	0.213	2.82	2.99	2.73	3.08
Ho, Holmium (ppm)	0.67	0.09	0.56	0.79	0.62	0.72
In, Indium (ppm)	11.3	0.88	10.7	11.9	10.9	11.7
K, Potassium (wt.%)	1.38	0.043	1.36	1.39	1.35	1.40
La, Lanthanum (ppm)	235	25	223	248	225	246
Li, Lithium (wt.%)	0.993	0.027	0.981	1.004	0.970	1.015
Li_2O, Lithium oxide (wt.%)	2.14	0.059	2.11	2.16	2.09	2.19
Lu, Lutetium (ppm)	0.19	0.02	0.17	0.21	IND	IND
Mg, Magnesium (wt.%)	0.533	0.022	0.523	0.542	0.518	0.548
Mn, Manganese (wt.%)	0.045	0.002	0.044	0.046	0.044	0.046
Mo, Molybdenum (ppm)	10.8	0.52	10.6	11.1	10.4	11.3
Na, Sodium (wt.%)	0.932	0.126	0.873	0.991	0.915	0.949
Nb, Niobium (wt.%)	0.631	0.022	0.614	0.648	0.609	0.653
Nd, Neodymium (ppm)	153	7	145	161	144	163
Ni, Nickel (ppm)	31.6	1.50	30.9	32.3	30.3	33.0
P, Phosphorus (wt.%)	0.096	0.013	0.089	0.102	0.090	0.101
Pb, Lead (ppm)	36.1	2.72	34.5	37.6	34.7	37.5
Pr, Praseodymium (ppm)	48.7	2.25	45.9	51.5	46.2	51.2
Rb, Rubidium (ppm)	775	59	748	802	746	803
Sb, Antimony (ppm)	28.3	1.95	27.3	29.3	26.9	29.7
Sc, Scandium (ppm)	7.51	0.407	7.33	7.68	7.08	7.94
Sm, Samarium (ppm)	19.8	0.71	19.1	20.6	18.8	20.8
Sr, Strontium (ppm)	221	10	217	226	215	228
Ta, Tantalum (ppm)	26.5	2.8	24.7	28.2	25.0	28.0

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						
Tb, Terbium (ppm)	1.12	0.088	1.06	1.19	1.07	1.18
Th, Thorium (ppm)	108	6	105	110	102	113
Ti, Titanium (wt.%)	0.356	0.023	0.346	0.366	0.346	0.365
Tl, Thallium (ppm)	6.98	0.467	6.73	7.22	6.71	7.24
Tm, Thulium (ppm)	0.20	0.03	0.16	0.24	IND	IND
U, Uranium (ppm)	22.1	2.4	21.0	23.2	21.1	23.1
V, Vanadium (ppm)	73	5.1	70	76	71	75
Y, Yttrium (ppm)	16.3	1.47	15.5	17.0	15.8	16.7
Yb, Ytterbium (ppm)	1.26	0.072	1.22	1.30	1.11	1.40
Zn, Zinc (ppm)	350	10	346	354	340	360
Zr, Zirconium (ppm)	77	6.2	75	80	74	80
Peroxide Fusion ICP						
Al, Aluminium (wt.%)	7.89	0.203	7.78	8.00	7.74	8.05
As, Arsenic (ppm)	152	12	143	160	145	159
Ba, Barium (ppm)	2862	128	2781	2942	2776	2947
Be, Beryllium (ppm)	30.5	3.9	27.9	33.2	28.5	32.5
Bi, Bismuth (ppm)	47.8	3.88	44.6	51.0	45.9	49.6
Ca, Calcium (wt.%)	1.06	0.051	1.04	1.08	1.03	1.09
Ce, Cerium (ppm)	432	18	420	445	418	447
Cr, Chromium (ppm)	103	16	88	118	96	109
Cs, Cesium (ppm)	350	12	343	357	337	362
Cu, Copper (ppm)	370	45	340	401	355	385
Dy, Dysprosium (ppm)	4.39	0.225	4.30	4.47	4.08	4.69
Er, Erbium (ppm)	1.82	0.168	1.74	1.91	1.62	2.02
Eu, Europium (ppm)	4.29	0.259	4.15	4.43	4.06	4.52
Fe, Iron (wt.%)	4.30	0.066	4.27	4.33	4.23	4.37
Ga, Gallium (ppm)	47.1	2.49	44.8	49.3	44.0	50.1
Gd, Gadolinium (ppm)	9.67	0.668	9.21	10.12	8.70	10.63
Hf, Hafnium (ppm)	5.23	0.96	4.45	6.01	IND	IND
Ho, Holmium (ppm)	0.75	0.063	0.72	0.78	0.70	0.81
K, Potassium (wt.%)	1.42	0.056	1.39	1.44	1.37	1.46
La, Lanthanum (ppm)	267	7	263	270	259	274
Li, Lithium (wt.%)	1.03	0.030	1.01	1.04	1.00	1.05
Li_2O, Lithium oxide (wt.%)	2.21	0.064	2.18	2.25	2.16	2.27
Mn, Manganese (wt.%)	0.046	0.001	0.045	0.046	0.044	0.047
Mo, Molybdenum (ppm)	11.5	1.6	10.3	12.6	IND	IND
Nb, Niobium (wt.%)	0.626	0.022	0.611	0.640	0.609	0.642
Nd, Neodymium (ppm)	151	10	145	157	145	157
P, Phosphorus (wt.%)	0.107	0.008	0.103	0.111	0.101	0.112
Pb, Lead (ppm)	41.1	7.9	34.5	47.7	38.8	43.4
Pr, Praseodymium (ppm)	47.8	1.89	46.8	48.9	46.0	49.7
Rb, Rubidium (ppm)	824	31	800	847	802	846

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						
Sb, Antimony (ppm)	29.0	3.0	26.9	31.1	26.8	31.2
Si, Silicon (wt.%)	31.39	0.939	30.85	31.92	30.82	31.95
Sm, Samarium (ppm)	19.5	1.41	18.7	20.3	18.6	20.4
Sn, Tin (wt.%)	0.329	0.031	0.310	0.348	0.317	0.340
Sr, Strontium (ppm)	229	8	224	235	221	238
Ta, Tantalum (ppm)	30.6	2.94	27.5	33.7	29.5	31.6
Tb, Terbium (ppm)	1.10	0.17	0.99	1.22	1.04	1.17
Th, Thorium (ppm)	116	8	111	122	111	122
Ti, Titanium (wt.%)	0.374	0.007	0.372	0.377	0.362	0.387
Tl, Thallium (ppm)	7.11	0.410	6.76	7.45	6.74	7.47
Tm, Thulium (ppm)	0.24	0.04	0.22	0.26	IND	IND
U, Uranium (ppm)	24.9	1.22	24.0	25.7	23.9	25.9
Y, Yttrium (ppm)	17.3	1.7	16.1	18.5	16.8	17.8
Yb, Ytterbium (ppm)	1.47	0.133	1.43	1.50	IND	IND
Zn, Zinc (ppm)	345	18	333	357	332	358
Zr, Zirconium (ppm)	156	24	132	180	143	169
Borate Fusion XRF						
Al_2O_3, Aluminium(III) oxide (wt.%)	14.98	0.184	14.88	15.08	14.90	15.06
BaO, Barium oxide (ppm)	3202	75	3158	3245	3127	3277
CaO, Calcium oxide (wt.%)	1.47	0.016	1.46	1.48	1.46	1.48
Fe_2O_3, Iron(III) oxide (wt.%)	6.13	0.109	6.08	6.19	6.10	6.17
K_2O, Potassium oxide (wt.%)	1.70	0.019	1.69	1.71	1.69	1.72
MgO, Magnesium oxide (wt.%)	0.953	0.020	0.944	0.963	0.940	0.967
Na_2O, Sodium oxide (wt.%)	1.31	0.016	1.31	1.32	1.30	1.33
Nb_2O_5, Niobium(V) oxide (wt.%)	0.915	0.024	0.897	0.933	0.902	0.927
P_2O_5, Phosphorus(V) oxide (wt.%)	0.243	0.008	0.239	0.248	0.239	0.248
SiO_2, Silicon dioxide (wt.%)	66.80	0.610	66.47	67.12	66.57	67.02
Sn, Tin (wt.%)	0.337	0.013	0.330	0.344	0.330	0.344
SO_3, Sulphur trioxide (wt.%)	0.084	0.005	0.080	0.087	0.074	0.093
SrO, Strontium oxide (ppm)	234	40	207	261	IND	IND
TiO_2, Titanium dioxide (wt.%)	0.627	0.011	0.621	0.632	0.620	0.633
V_2O_5, Vanadium(V) oxide (ppm)	154	27	124	185	IND	IND
Zn, Zinc (ppm)	335	30	295	375	318	352
Thermogravimetry						
LOI^{1000}, Loss on ignition @1000°C (wt.%)	1.31	0.074	1.26	1.36	1.28	1.35

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 149 has been prepared from spodumene $LiAl(Si_2O_5)$-rich pegmatite ore 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 149 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 prepared batch. The six samples received by each laboratory were obtained by taking two 20g scoop splits from each of three separate 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 113 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 60 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 149 DataPack-1.1.190226_151550.xlsx**).

Table 2. Indicative Values for OREAS 149.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Au	ppm	*0.179*	Hg	ppm	*0.039*	Se	ppm	*3.20*
B	ppm	*5.87*	Ir	ppm	*0.014*	Si	wt.%	*31.68*
Cd	ppm	*0.96*	Pt	ppm	*0.030*	Sn	wt.%	*0.235*
Gd	ppm	*8.97*	Re	ppm	*< 0.002*	Te	ppm	*0.38*
Ge	ppm	*0.36*	S	wt.%	*0.033*	W	ppm	*11.1*
Peroxide Fusion ICP								
Ag	ppm	*13.0*	Lu	ppm	*0.21*	Se	ppm	*< 20*
B	ppm	*24.2*	Mg	wt.%	*0.554*	Te	ppm	*< 1*
Cd	ppm	*< 10*	Ni	ppm	*41.8*	V	ppm	*79*
Co	ppm	*< 20*	Re	ppm	*< 0.1*	W	ppm	*14.7*
Ge	ppm	*7.34*	S	wt.%	*0.033*			
In	ppm	*11.5*	Sc	ppm	*7.32*			
Borate Fusion XRF								
As	ppm	*214*	Gd_2O_3	ppm	*< 100*	Sb	ppm	*19.2*
Bi	ppm	*< 100*	HfO_2	ppm	*< 100*	Sm_2O_3	ppm	*< 100*
CeO_2	ppm	*550*	La_2O_3	ppm	*225*	Ta_2O_5	ppm	*31.0*
Cl	ppm	*195*	MnO	wt.%	*0.060*	ThO_2	ppm	*139*
Co	ppm	*43.9*	Mo	ppm	*< 10*	U_3O_8	ppm	*43.3*
Cr_2O_3	ppm	*124*	Nd_2O_3	ppm	*350*	W	ppm	*28.7*
Cu	ppm	*323*	Ni	ppm	*43.5*	Y_2O_3	ppm	*150*
Dy_2O_3	ppm	*< 100*	Pb	ppm	*47.3*	Yb_2O_3	ppm	*< 100*
Er_2O_3	ppm	*< 100*	Pr_6O_{11}	ppm	*417*	Zr	ppm	*161*
Ga_2O_3	ppm	*83*	Rb	ppm	*854*			

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-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 0.330 and 0.344 wt.%. 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 149 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 149. 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 uranium (U) by peroxide fusion. 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 149 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 149 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

Table 3. Pooled-Lab Performance Gates for OREAS 149.

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											
Ag, ppm	1.04	0.16	0.72	1.36	0.56	1.51	15.39%	30.79%	46.18%	0.98	1.09
Al, wt.%	7.47	0.430	6.61	8.33	6.18	8.76	5.76%	11.53%	17.29%	7.09	7.84
As, ppm	149	7	135	163	128	170	4.69%	9.37%	14.06%	141	156
Ba, ppm	2816	115	2585	3046	2470	3161	4.09%	8.19%	12.28%	2675	2956
Be, ppm	26.1	1.85	22.4	29.8	20.5	31.6	7.09%	14.18%	21.27%	24.8	27.4
Bi, ppm	46.5	3.89	38.7	54.2	34.8	58.1	8.36%	16.73%	25.09%	44.1	48.8
Ca, wt.%	1.04	0.040	0.96	1.12	0.92	1.16	3.89%	7.78%	11.67%	0.99	1.09
Ce, ppm	400	35	330	470	295	505	8.75%	17.49%	26.24%	380	420
Co, ppm	8.02	0.453	7.11	8.92	6.66	9.38	5.65%	11.29%	16.94%	7.62	8.42
Cr, ppm	85	6.1	73	97	67	104	7.19%	14.39%	21.58%	81	89
Cs, ppm	341	12	318	364	306	376	3.39%	6.79%	10.18%	324	358
Cu, ppm	338	27	283	392	255	420	8.13%	16.26%	24.39%	321	354
Dy, ppm	4.95	0.83	3.29	6.62	2.45	7.46	16.84%	33.68%	50.52%	4.71	5.20
Er, ppm	1.83	0.22	1.39	2.27	1.17	2.49	11.98%	23.96%	35.94%	1.74	1.92
Eu, ppm	4.51	0.59	3.32	5.69	2.73	6.28	13.12%	26.24%	39.37%	4.28	4.73
Fe, wt.%	4.17	0.146	3.87	4.46	3.73	4.61	3.51%	7.02%	10.53%	3.96	4.38
Ga, ppm	48.4	1.56	45.3	51.5	43.7	53.1	3.21%	6.43%	9.64%	46.0	50.8
Hf, ppm	2.90	0.213	2.48	3.33	2.26	3.54	7.33%	14.66%	21.99%	2.76	3.05
Ho, ppm	0.67	0.09	0.49	0.85	0.40	0.94	13.34%	26.68%	40.02%	0.64	0.70
In, ppm	11.3	0.88	9.5	13.1	8.7	13.9	7.79%	15.59%	23.38%	10.7	11.9
K, wt.%	1.38	0.043	1.29	1.46	1.25	1.51	3.12%	6.24%	9.36%	1.31	1.45
La, ppm	235	25	185	286	160	311	10.71%	21.42%	32.13%	224	247
Li, wt.%	0.993	0.027	0.938	1.047	0.911	1.074	2.74%	5.49%	8.23%	0.943	1.042
Li_2O, wt.%	2.14	0.059	2.02	2.25	1.96	2.31	2.74%	5.49%	8.23%	2.03	2.24
Lu, ppm	0.19	0.02	0.14	0.24	0.12	0.26	12.29%	24.58%	36.87%	0.18	0.20
Mg, wt.%	0.533	0.022	0.489	0.576	0.468	0.598	4.08%	8.15%	12.23%	0.506	0.559
Mn, wt.%	0.045	0.002	0.040	0.050	0.038	0.052	5.30%	10.61%	15.91%	0.043	0.047
Mo, ppm	10.8	0.52	9.8	11.9	9.3	12.4	4.76%	9.52%	14.27%	10.3	11.4
Na, wt.%	0.932	0.126	0.680	1.184	0.554	1.310	13.53%	27.06%	40.59%	0.885	0.978
Nb, wt.%	0.631	0.022	0.588	0.674	0.566	0.696	3.44%	6.88%	10.32%	0.599	0.663
Nd, ppm	153	7	139	167	132	174	4.56%	9.12%	13.67%	146	161
Ni, ppm	31.6	1.50	28.6	34.6	27.1	36.1	4.75%	9.51%	14.26%	30.0	33.2
P, wt.%	0.096	0.013	0.069	0.122	0.055	0.136	14.01%	28.01%	42.02%	0.091	0.100
Pb, ppm	36.1	2.72	30.6	41.5	27.9	44.3	7.55%	15.10%	22.65%	34.3	37.9
Pr, ppm	48.7	2.25	44.2	53.2	41.9	55.4	4.62%	9.25%	13.87%	46.2	51.1
Rb, ppm	775	59	658	892	599	950	7.56%	15.11%	22.67%	736	813
Sb, ppm	28.3	1.95	24.4	32.2	22.5	34.2	6.88%	13.76%	20.63%	26.9	29.7
Sc, ppm	7.51	0.407	6.69	8.32	6.29	8.73	5.42%	10.85%	16.27%	7.13	7.88
Sm, ppm	19.8	0.71	18.4	21.3	17.7	22.0	3.57%	7.14%	10.72%	18.8	20.8
Sr, ppm	221	10	201	241	191	251	4.49%	8.98%	13.46%	210	232
Ta, ppm	26.5	2.8	20.9	32.0	18.1	34.8	10.55%	21.09%	31.64%	25.1	27.8
Tb, ppm	1.12	0.088	0.95	1.30	0.86	1.39	7.80%	15.59%	23.39%	1.07	1.18
Th, ppm	108	6	96	120	90	126	5.62%	11.24%	16.86%	102	113

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											
Ti, wt.%	0.356	0.023	0.310	0.401	0.287	0.424	6.43%	12.86%	19.29%	0.338	0.373
Tl, ppm	6.98	0.467	6.04	7.91	5.58	8.38	6.69%	13.37%	20.06%	6.63	7.33
Tm, ppm	0.20	0.03	0.14	0.26	0.11	0.29	15.25%	30.50%	45.76%	0.19	0.21
U, ppm	22.1	2.4	17.2	27.0	14.8	29.4	11.08%	22.16%	33.25%	21.0	23.2
V, ppm	73	5.1	63	83	58	88	7.04%	14.08%	21.12%	69	77
Y, ppm	16.3	1.47	13.3	19.2	11.8	20.7	9.04%	18.08%	27.13%	15.4	17.1
Yb, ppm	1.26	0.072	1.11	1.40	1.04	1.48	5.75%	11.50%	17.25%	1.20	1.32
Zn, ppm	350	10	330	371	319	381	2.93%	5.85%	8.78%	333	368
Zr, ppm	77	6.2	65	90	59	96	7.97%	15.94%	23.91%	73	81
Peroxide Fusion ICP											
Al, wt.%	7.89	0.203	7.49	8.30	7.28	8.50	2.58%	5.15%	7.73%	7.50	8.29
As, ppm	152	12	129	175	117	187	7.67%	15.35%	23.02%	144	159
Ba, ppm	2862	128	2605	3118	2477	3247	4.48%	8.96%	13.45%	2719	3005
Be, ppm	30.5	3.9	22.8	38.3	18.9	42.1	12.68%	25.36%	38.04%	29.0	32.0
Bi, ppm	47.8	3.88	40.0	55.6	36.1	59.4	8.13%	16.26%	24.39%	45.4	50.2
Ca, wt.%	1.06	0.051	0.96	1.16	0.91	1.21	4.78%	9.55%	14.33%	1.00	1.11
Ce, ppm	432	18	396	469	377	487	4.22%	8.45%	12.67%	411	454
Cr, ppm	103	16	71	135	54	151	15.71%	31.43%	47.14%	98	108
Cs, ppm	350	12	326	374	314	385	3.39%	6.78%	10.17%	332	367
Cu, ppm	370	45	281	460	237	504	12.05%	24.09%	36.14%	352	389
Dy, ppm	4.39	0.225	3.94	4.84	3.71	5.06	5.13%	10.26%	15.39%	4.17	4.60
Er, ppm	1.82	0.168	1.49	2.16	1.32	2.33	9.24%	18.48%	27.73%	1.73	1.91
Eu, ppm	4.29	0.259	3.77	4.81	3.51	5.07	6.04%	12.09%	18.13%	4.07	4.50
Fe, wt.%	4.30	0.066	4.17	4.43	4.10	4.50	1.53%	3.07%	4.60%	4.09	4.52
Ga, ppm	47.1	2.49	42.1	52.0	39.6	54.5	5.28%	10.56%	15.85%	44.7	49.4
Gd, ppm	9.67	0.668	8.33	11.00	7.66	11.67	6.91%	13.81%	20.72%	9.18	10.15
Hf, ppm	5.23	0.96	3.31	7.14	2.35	8.10	18.33%	36.65%	54.98%	4.97	5.49
Ho, ppm	0.75	0.063	0.63	0.88	0.57	0.94	8.32%	16.65%	24.97%	0.72	0.79
K, wt.%	1.42	0.056	1.30	1.53	1.25	1.59	3.98%	7.97%	11.95%	1.35	1.49
La, ppm	267	7	253	280	247	287	2.50%	5.00%	7.50%	253	280
Li, wt.%	1.03	0.030	0.97	1.09	0.94	1.12	2.89%	5.79%	8.68%	0.98	1.08
Li_2O, wt.%	2.21	0.064	2.09	2.34	2.02	2.41	2.89%	5.79%	8.68%	2.10	2.32
Mn, wt.%	0.046	0.001	0.043	0.048	0.042	0.049	2.69%	5.38%	8.08%	0.043	0.048
Mo, ppm	11.5	1.6	8.3	14.6	6.7	16.2	13.86%	27.72%	41.59%	10.9	12.0
Nb, wt.%	0.626	0.022	0.582	0.670	0.560	0.692	3.52%	7.04%	10.56%	0.594	0.657
Nd, ppm	151	10	132	171	122	181	6.49%	12.97%	19.46%	144	159
P, wt.%	0.107	0.008	0.091	0.123	0.083	0.131	7.54%	15.09%	22.63%	0.101	0.112
Pb, ppm	41.1	7.9	25.4	56.8	17.5	64.6	19.13%	38.26%	57.39%	39.0	43.1
Pr, ppm	47.8	1.89	44.1	51.6	42.2	53.5	3.94%	7.89%	11.83%	45.4	50.2
Rb, ppm	824	31	761	886	730	917	3.78%	7.56%	11.34%	782	865
Sb, ppm	29.0	3.0	23.1	34.9	20.2	37.9	10.17%	20.34%	30.51%	27.6	30.5
Si, wt.%	31.39	0.939	29.51	33.26	28.57	34.20	2.99%	5.98%	8.97%	29.82	32.96
Sm, ppm	19.5	1.41	16.7	22.3	15.3	23.7	7.20%	14.41%	21.61%	18.5	20.5

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											
Sn, wt.%	0.329	0.031	0.266	0.391	0.235	0.422	9.52%	19.04%	28.56%	0.312	0.345
Sr, ppm	229	8	214	244	206	252	3.33%	6.66%	9.99%	218	241
Ta, ppm	30.6	2.94	24.7	36.5	21.7	39.4	9.63%	19.26%	28.89%	29.0	32.1
Tb, ppm	1.10	0.17	0.76	1.44	0.59	1.61	15.40%	30.79%	46.19%	1.05	1.16
Th, ppm	116	8	100	132	92	140	6.96%	13.91%	20.87%	110	122
Ti, wt.%	0.374	0.007	0.360	0.389	0.353	0.396	1.93%	3.85%	5.78%	0.356	0.393
Tl, ppm	7.11	0.410	6.28	7.93	5.87	8.34	5.77%	11.55%	17.32%	6.75	7.46
Tm, ppm	0.24	0.04	0.17	0.32	0.13	0.36	15.66%	31.32%	46.99%	0.23	0.25
U, ppm	24.9	1.22	22.4	27.3	21.2	28.5	4.91%	9.82%	14.73%	23.6	26.1
Y, ppm	17.3	1.7	13.9	20.8	12.1	22.5	10.00%	20.00%	30.00%	16.5	18.2
Yb, ppm	1.47	0.133	1.20	1.73	1.07	1.86	9.08%	18.16%	27.25%	1.39	1.54
Zn, ppm	345	18	308	382	290	400	5.31%	10.62%	15.93%	328	362
Zr, ppm	156	24	107	205	83	229	15.68%	31.35%	47.03%	148	164
Borate Fusion XRF											
Al_2O_3, wt.%	14.98	0.184	14.61	15.35	14.43	15.53	1.23%	2.46%	3.68%	14.23	15.73
BaO, ppm	3202	75	3051	3352	2976	3428	2.35%	4.70%	7.05%	3042	3362
CaO, wt.%	1.47	0.016	1.44	1.50	1.42	1.52	1.07%	2.14%	3.21%	1.40	1.54
Fe_2O_3, wt.%	6.13	0.109	5.92	6.35	5.81	6.46	1.78%	3.55%	5.33%	5.83	6.44
K_2O, wt.%	1.70	0.019	1.67	1.74	1.65	1.76	1.14%	2.28%	3.42%	1.62	1.79
MgO, wt.%	0.953	0.020	0.912	0.994	0.892	1.015	2.15%	4.29%	6.44%	0.906	1.001
Na_2O, wt.%	1.31	0.016	1.28	1.35	1.27	1.36	1.23%	2.47%	3.70%	1.25	1.38
Nb_2O_5, wt.%	0.915	0.024	0.867	0.962	0.844	0.986	2.59%	5.18%	7.77%	0.869	0.961
P_2O_5, wt.%	0.243	0.008	0.227	0.260	0.218	0.269	3.45%	6.91%	10.36%	0.231	0.256
SiO_2, wt.%	66.80	0.610	65.57	68.02	64.96	68.63	0.91%	1.83%	2.74%	63.46	70.14
Sn, wt.%	0.337	0.013	0.311	0.363	0.298	0.375	3.80%	7.60%	11.40%	0.320	0.354
SO_3, wt.%	0.084	0.005	0.074	0.094	0.069	0.099	5.82%	11.65%	17.47%	0.080	0.088
SrO, ppm	234	40	155	313	115	352	16.90%	33.80%	50.70%	222	245
TiO_2, wt.%	0.627	0.011	0.604	0.649	0.593	0.660	1.77%	3.54%	5.31%	0.595	0.658
V_2O_5, ppm	154	27	100	209	72	236	17.69%	35.38%	53.07%	147	162
Zn, ppm	335	30	275	395	245	424	8.92%	17.83%	26.75%	318	352
Thermogravimetry											
LOI^{1000}, wt.%	1.31	0.074	1.17	1.46	1.09	1.53	5.59%	11.19%	16.78%	1.25	1.38

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
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22. Zarazma Mineral Studies Company, Tehran, Iran

PREPARER AND SUPPLIER

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

INTENDED USE

OREAS 149 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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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.