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CERTIFICATE OF ANALYSIS FOR

PLATINUM GROUP ELEMENT (PGE) ORE
CERTIFIED REFERENCE MATERIAL
OREAS 683

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 683.

Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Pb Collection Fire Assay						
Au, Gold (ppb)	207	6	205	209	204	210
Pd, Palladium (ppb)	853	41	836	870	830	876
Pt, Platinum (ppb)	1760	113	1713	1808	1711	1810
NiS Collection Fire Assay						
Au, Gold (ppb)	195	11	183	208	184	207
Ir, Iridium (ppb)	50	1.6	48.2	51.0	47.4	51.8
Pd, Palladium (ppb)	858	40	829	887	821	895
Pt, Platinum (ppb)	1723	143	1618	1829	1659	1787
Rh, Rhodium (ppb)	146	13	138	154	141	152
Ru, Ruthenium (ppb)	252	23	235	268	241	262
Peroxide Fusion ICP						
Al, Aluminium (wt.%)	7.24	0.223	7.12	7.36	7.14	7.34
Ba, Barium (ppm)	184	11	177	190	178	189
Ca, Calcium (wt.%)	5.32	0.244	5.19	5.44	5.19	5.45
Ce, Cerium (ppm)	17.5	0.55	17.0	18.0	17.0	18.0
Co, Cobalt (ppm)	86	8.3	82	90	84	89
Cr, Chromium (wt.%)	0.994	0.045	0.970	1.018	0.973	1.014
Cs, Cesium (ppm)	1.34	0.18	1.16	1.51	IND	IND
Cu, Copper (ppm)	405	29	391	419	392	418
Dy, Dysprosium (ppm)	1.52	0.20	1.36	1.68	1.42	1.61

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						
Er, Erbium (ppm)	0.89	0.09	0.82	0.96	0.80	0.98
Eu, Europium (ppm)	0.60	0.07	0.56	0.65	0.54	0.67
Fe, Iron (wt.%)	7.46	0.204	7.36	7.56	7.33	7.59
Ga, Gallium (ppm)	14.3	0.81	13.8	14.9	IND	IND
Gd, Gadolinium (ppm)	1.70	0.121	1.61	1.79	1.56	1.84
Ho, Holmium (ppm)	0.30	0.022	0.28	0.32	0.27	0.32
K, Potassium (wt.%)	0.506	0.030	0.490	0.522	0.487	0.525
La, Lanthanum (ppm)	8.35	0.681	7.86	8.85	7.99	8.72
Li, Lithium (ppm)	7.48	1.48	6.76	8.20	IND	IND
Lu, Lutetium (ppm)	0.13	0.02	0.10	0.15	IND	IND
Mg, Magnesium (wt.%)	8.65	0.303	8.49	8.81	8.48	8.82
Mn, Manganese (wt.%)	0.124	0.003	0.122	0.125	0.122	0.126
Nd, Neodymium (ppm)	9.13	0.433	8.78	9.48	8.84	9.42
Ni, Nickel (ppm)	1215	64	1184	1245	1189	1241
Pr, Praseodymium (ppm)	2.13	0.072	2.09	2.17	2.01	2.24
Rb, Rubidium (ppm)	27.9	1.18	27.2	28.5	26.9	28.8
S, Sulphur (wt.%)	0.194	0.018	0.183	0.205	0.174	0.215
Sc, Scandium (ppm)	19.2	2.1	17.2	21.1	IND	IND
Si, Silicon (wt.%)	22.87	0.599	22.59	23.16	22.44	23.30
Sm, Samarium (ppm)	1.87	0.115	1.78	1.96	IND	IND
Sr, Strontium (ppm)	267	14	258	276	261	274
Tb, Terbium (ppm)	0.25	0.017	0.24	0.27	0.23	0.28
Th, Thorium (ppm)	2.30	0.181	2.22	2.38	2.03	2.56
Ti, Titanium (wt.%)	0.270	0.005	0.269	0.272	0.263	0.278
Tm, Thulium (ppm)	0.13	0.011	0.13	0.14	IND	IND
U, Uranium (ppm)	0.59	0.10	0.53	0.66	IND	IND
V, Vanadium (ppm)	196	14	185	208	189	203
Y, Yttrium (ppm)	8.12	0.261	7.98	8.25	7.78	8.45
Yb, Ytterbium (ppm)	0.88	0.11	0.79	0.96	IND	IND
Zn, Zinc (ppm)	84	12	74	94	71	98
4-Acid Digestion						
Ag, Silver (ppm)	0.172	0.021	0.156	0.189	IND	IND
Al, Aluminium (wt.%)	7.15	0.227	7.05	7.26	7.03	7.27
Ba, Barium (ppm)	188	6	185	190	181	194
Be, Beryllium (ppm)	0.56	0.09	0.52	0.60	0.49	0.63
Bi, Bismuth (ppm)	0.16	0.013	0.15	0.17	IND	IND
Ca, Calcium (wt.%)	5.23	0.187	5.14	5.31	5.12	5.34
Cd, Cadmium (ppm)	0.072	0.011	0.068	0.076	IND	IND
Ce, Cerium (ppm)	17.1	0.86	16.7	17.6	16.6	17.7
Co, Cobalt (ppm)	85	4.5	83	87	82	87
Cr, Chromium (wt.%)	0.771	0.096	0.720	0.822	0.738	0.803
Cs, Cesium (ppm)	1.32	0.056	1.29	1.35	1.22	1.42

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						
Cu, Copper (ppm)	404	10	401	407	393	415
Dy, Dysprosium (ppm)	1.54	0.051	1.51	1.56	1.45	1.63
Er, Erbium (ppm)	0.93	0.048	0.90	0.96	0.87	0.99
Eu, Europium (ppm)	0.58	0.07	0.52	0.63	0.55	0.61
Fe, Iron (wt.%)	7.32	0.275	7.20	7.44	7.21	7.43
Ga, Gallium (ppm)	13.8	0.52	13.5	14.0	13.4	14.1
Gd, Gadolinium (ppm)	1.64	0.164	1.51	1.78	1.55	1.74
Hf, Hafnium (ppm)	0.75	0.056	0.73	0.78	0.71	0.80
Ho, Holmium (ppm)	0.32	0.015	0.31	0.33	0.30	0.33
In, Indium (ppm)	0.028	0.005	0.026	0.030	0.025	0.031
K, Potassium (wt.%)	0.507	0.028	0.494	0.521	0.489	0.526
La, Lanthanum (ppm)	8.17	0.474	7.93	8.40	7.91	8.42
Li, Lithium (ppm)	6.51	0.395	6.29	6.72	5.85	7.16
Lu, Lutetium (ppm)	0.13	0.006	0.13	0.14	IND	IND
Mg, Magnesium (wt.%)	8.63	0.244	8.52	8.74	8.47	8.79
Mn, Manganese (wt.%)	0.120	0.006	0.118	0.123	0.118	0.123
Mo, Molybdenum (ppm)	1.00	0.12	0.93	1.07	0.92	1.08
Na, Sodium (wt.%)	1.03	0.036	1.01	1.04	1.00	1.05
Nb, Niobium (ppm)	2.61	0.165	2.53	2.68	2.47	2.74
Nd, Neodymium (ppm)	8.75	0.390	8.45	9.04	8.26	9.23
Ni, Nickel (ppm)	1181	63	1150	1212	1146	1215
P, Phosphorus (wt.%)	0.050	0.003	0.048	0.051	0.048	0.052
Pb, Lead (ppm)	10.2	0.73	10.0	10.5	9.8	10.6
Pr, Praseodymium (ppm)	2.17	0.096	2.10	2.24	2.10	2.24
Rb, Rubidium (ppm)	26.8	1.40	26.2	27.5	25.9	27.8
S, Sulphur (wt.%)	0.205	0.013	0.197	0.213	0.198	0.212
Sc, Scandium (ppm)	19.7	1.47	19.0	20.3	18.9	20.4
Sm, Samarium (ppm)	1.86	0.146	1.76	1.96	1.74	1.99
Sn, Tin (ppm)	0.85	0.10	0.79	0.91	IND	IND
Sr, Strontium (ppm)	276	13	269	282	268	284
Tb, Terbium (ppm)	0.25	0.014	0.24	0.26	0.24	0.27
Th, Thorium (ppm)	2.42	0.226	2.32	2.52	2.26	2.58
Ti, Titanium (wt.%)	0.263	0.013	0.256	0.270	0.255	0.270
Tm, Thulium (ppm)	0.13	0.007	0.13	0.14	IND	IND
U, Uranium (ppm)	0.58	0.044	0.56	0.59	0.54	0.62
V, Vanadium (ppm)	187	10	182	192	182	192
W, Tungsten (ppm)	1.23	0.068	1.20	1.26	IND	IND
Y, Yttrium (ppm)	8.02	0.472	7.78	8.25	7.75	8.29
Yb, Ytterbium (ppm)	0.88	0.059	0.84	0.91	IND	IND
Zn, Zinc (ppm)	92	7.0	88	95	88	95
Zr, Zirconium (ppm)	26.3	3.1	24.6	28.1	24.6	28.1

Note: intervals may appear asymmetric due to rounding

Table 2. Indicative Values for OREAS 683.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
NiS Collection Fire Assay								
Os	ppb	*37.8*	Re	ppb	*0.667*			
Peroxide Fusion ICP								
Ag	ppm	*< 1*	In	ppm	*< 0.2*	Sn	ppm	*< 10*
As	ppm	*< 100*	Mo	ppm	*1.23*	Ta	ppm	*< 0.5*
B	ppm	*17.9*	Nb	ppm	*2.35*	Te	ppm	*< 2*
Be	ppm	*< 5*	P	wt.%	*0.039*	Tl	ppm	*< 0.5*
Bi	ppm	*0.18*	Pb	ppm	*10.9*	W	ppm	*1.26*
Cd	ppm	*< 10*	Re	ppm	*< 0.1*	Zr	ppm	*40.0*
Ge	ppm	*1.32*	Sb	ppm	*0.23*			
Hf	ppm	*0.89*	Se	ppm	*< 20*			
4-Acid Digestion								
As	ppm	*2.13*	Re	ppm	*0.002*	Ta	ppm	*0.20*
Ge	ppm	*0.12*	Sb	ppm	*0.16*	Te	ppm	*0.28*
Hg	ppm	*< 0.01*	Se	ppm	*1.33*	Tl	ppm	*0.094*
Infrared Combustion								
C	wt.%	*0.101*	S	wt.%	*0.181*			

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.

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

OREAS 683 is a platinum group element (PGE) ore certified reference material (CRM) prepared and certified by Ore Research & Exploration Pty Ltd. OREAS 683 has been prepared from PGE ores blended with barren gabbro-norite. The PGE ores were sourced from the Dishaba mine, owned and operated by Anglo American Platinum Ltd. The Dishaba mine is located in the west of Limpopo province, South Africa, approximately 250 kilometres north of Johannesburg. The common minerals of economic importance within a pegmatitic pyroxenite host are sulphides of iron, nickel, copper and alloys of the PGE's. The barren gabbro-norite was sourced from the Late Cambrian Black Hill Norite Complex located 85km east of Adelaide, Australia.

OREAS 683 is one of a suite of five PGE ore CRMs ranging in 4E concentrations (4E = 4 elements; platinum (Pt), palladium (Pd), rhodium (Rh) and gold (Au)) from 0.82 to 6.1ppm.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 683 was prepared in the following manner:

- Drying all materials to constant mass at 105°C;
- Crushing and milling of the barren gabbro-norite to >98% minus 75 microns;
- Crushing and milling of ore materials to 100% minus 30 microns;
- Blending in appropriate proportions to achieve the desired grades;
- Packaging in 60g units sealed in laminated foil pouches and 500g units in plastic jars.

ANALYTICAL PROGRAM

Twenty three geochemical 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 18 laboratories depending on the element);
- Peroxide fusion for full ICP-OES and ICP-MS elemental suites (up to 18 laboratories depending on the element);
- Au, Pt, Pd, Ir, Rh and Ru by nickel sulphide (NiS) collection fire assay with ICP-MS (8 laboratories) or ICP-OES (1 laboratory) finish (9 laboratories reported Ir, Pd, Pt, Rh and Ru, 7 laboratories reported Au, 2 laboratories reported Os and 1 laboratory reported Re);
- Au, Pt and Pd by lead collection fire assay with ICP-OES (18 laboratories) and ICP-MS (3 laboratories) finish;
- Instrumental neutron activation analysis for Au on 20 x 85mg subsamples to confirm homogeneity (1 laboratory – analyses currently underway with results expected 5 March, 2018).

For the round robin program twenty 1kg 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 100g 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 100 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 35 indicative values. Table 3 provides performance gate intervals for the certified values based on their pooled 1SD's and Table 4 shows the gold instrumental neutron activation analysis (INAA) results for twenty 85 milligram subsamples determined by ANSTO in Lucas Heights, NSW, Australia.

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 683 DataPack.xlsx**).

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.

Table 3. Performance Gates for OREAS 683.

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
Pb Collection Fire Assay											
Au, ppb	207	6	195	218	189	224	2.82%	5.63%	8.45%	196	217
Pd, ppb	853	41	771	935	730	976	4.81%	9.62%	14.43%	810	896
Pt, ppb	1760	113	1535	1986	1423	2098	6.39%	12.78%	19.17%	1672	1849
NiS Collection Fire Assay											
Au, ppb	195	11	173	218	162	229	5.78%	11.57%	17.35%	186	205
Ir, ppb	49.6	1.6	46.4	52.8	44.8	54.4	3.25%	6.50%	9.76%	47.1	52.1
Pd, ppb	858	40	777	939	737	979	4.72%	9.43%	14.15%	815	901
Pt, ppb	1723	143	1438	2009	1295	2152	8.28%	16.57%	24.85%	1637	1809
Rh, ppb	146	13	120	173	107	186	9.01%	18.02%	27.02%	139	153
Ru, ppb	252	23	207	297	184	319	8.95%	17.90%	26.85%	239	264
Peroxide Fusion											
Al, wt.%	7.24	0.223	6.79	7.69	6.57	7.91	3.08%	6.16%	9.24%	6.88	7.60
Ba, ppm	184	11	162	206	151	217	5.98%	11.97%	17.95%	174	193
Ca, wt.%	5.32	0.244	4.83	5.81	4.59	6.05	4.58%	9.16%	13.74%	5.05	5.59
Ce, ppm	17.5	0.55	16.4	18.6	15.8	19.1	3.13%	6.27%	9.40%	16.6	18.3
Co, ppm	86	8.3	70	103	62	111	9.56%	19.12%	28.68%	82	91
Cr, wt.%	0.994	0.045	0.904	1.084	0.859	1.129	4.52%	9.03%	13.55%	0.944	1.044
Cs, ppm	1.34	0.18	0.98	1.69	0.81	1.86	13.17%	26.33%	39.50%	1.27	1.40
Cu, ppm	405	29	347	463	318	492	7.14%	14.27%	21.41%	385	425
Dy, ppm	1.52	0.20	1.12	1.92	0.91	2.12	13.26%	26.52%	39.78%	1.44	1.60
Er, ppm	0.89	0.09	0.70	1.08	0.61	1.17	10.51%	21.02%	31.53%	0.85	0.93
Eu, ppm	0.60	0.07	0.47	0.74	0.40	0.80	11.09%	22.18%	33.27%	0.57	0.63
Fe, wt.%	7.46	0.204	7.05	7.87	6.85	8.07	2.73%	5.46%	8.19%	7.09	7.83
Ga, ppm	14.3	0.81	12.7	16.0	11.9	16.8	5.66%	11.32%	16.97%	13.6	15.1
Gd, ppm	1.70	0.121	1.46	1.94	1.33	2.06	7.15%	14.29%	21.44%	1.61	1.78
Ho, ppm	0.30	0.022	0.25	0.34	0.23	0.36	7.45%	14.91%	22.36%	0.28	0.31
K, wt.%	0.506	0.030	0.445	0.566	0.415	0.597	5.99%	11.99%	17.98%	0.481	0.531
La, ppm	8.35	0.681	6.99	9.72	6.31	10.40	8.16%	16.31%	24.47%	7.94	8.77
Li, ppm	7.48	1.48	4.52	10.44	3.05	11.91	19.76%	39.52%	59.28%	7.11	7.85
Lu, ppm	0.13	0.02	0.08	0.17	0.06	0.20	18.36%	36.72%	55.08%	0.12	0.13
Mg, wt.%	8.65	0.303	8.05	9.26	7.74	9.56	3.50%	7.01%	10.51%	8.22	9.09
Mn, wt.%	0.124	0.003	0.118	0.130	0.115	0.133	2.42%	4.84%	7.26%	0.118	0.130

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 continued											
Nd, ppm	9.13	0.433	8.26	9.99	7.83	10.43	4.74%	9.49%	14.23%	8.67	9.59
Ni, ppm	1215	64	1087	1342	1023	1406	5.26%	10.51%	15.77%	1154	1275
Pr, ppm	2.13	0.072	1.98	2.27	1.91	2.34	3.39%	6.78%	10.16%	2.02	2.23
Rb, ppm	27.9	1.18	25.5	30.2	24.3	31.4	4.25%	8.50%	12.74%	26.5	29.2
S, wt.%	0.194	0.018	0.158	0.230	0.140	0.248	9.30%	18.61%	27.91%	0.184	0.204
Sc, ppm	19.2	2.1	15.0	23.4	12.8	25.5	11.00%	21.99%	32.99%	18.2	20.1
Si, wt.%	22.87	0.599	21.67	24.07	21.08	24.67	2.62%	5.24%	7.85%	21.73	24.02
Sm, ppm	1.87	0.115	1.64	2.10	1.52	2.22	6.17%	12.33%	18.50%	1.78	1.96
Sr, ppm	267	14	240	295	226	308	5.10%	10.20%	15.30%	254	281
Tb, ppm	0.25	0.017	0.22	0.29	0.20	0.31	6.69%	13.37%	20.06%	0.24	0.27
Th, ppm	2.30	0.181	1.93	2.66	1.75	2.84	7.90%	15.79%	23.69%	2.18	2.41
Ti, wt.%	0.270	0.005	0.260	0.281	0.255	0.286	1.96%	3.92%	5.87%	0.257	0.284
Tm, ppm	0.13	0.011	0.11	0.15	0.10	0.16	8.06%	16.11%	24.17%	0.13	0.14
U, ppm	0.59	0.10	0.40	0.79	0.30	0.88	16.28%	32.55%	48.83%	0.56	0.62
V, ppm	196	14	169	224	155	238	7.07%	14.13%	21.20%	186	206
Y, ppm	8.12	0.261	7.59	8.64	7.33	8.90	3.22%	6.44%	9.66%	7.71	8.52
Yb, ppm	0.88	0.11	0.66	1.09	0.56	1.20	12.18%	24.36%	36.55%	0.83	0.92
Zn, ppm	84	12	60	108	48	121	14.48%	28.96%	43.44%	80	88
4-Acid Digestion											
Ag, ppm	0.172	0.021	0.129	0.215	0.108	0.236	12.43%	24.85%	37.28%	0.164	0.181
Al, wt.%	7.15	0.227	6.70	7.61	6.47	7.84	3.18%	6.35%	9.53%	6.80	7.51
Ba, ppm	188	6	176	199	170	205	3.13%	6.26%	9.39%	178	197
Be, ppm	0.56	0.09	0.38	0.74	0.29	0.83	16.03%	32.07%	48.10%	0.53	0.59
Bi, ppm	0.16	0.013	0.13	0.18	0.12	0.20	8.01%	16.03%	24.04%	0.15	0.17
Ca, wt.%	5.23	0.187	4.86	5.60	4.67	5.79	3.57%	7.15%	10.72%	4.97	5.49
Cd, ppm	0.072	0.011	0.050	0.094	0.038	0.105	15.51%	31.02%	46.53%	0.068	0.075
Ce, ppm	17.1	0.86	15.4	18.9	14.5	19.7	5.03%	10.05%	15.08%	16.3	18.0
Co, ppm	85	4.5	76	94	71	98	5.36%	10.72%	16.09%	80	89
Cr, wt.%	0.771	0.096	0.579	0.962	0.484	1.058	12.41%	24.83%	37.24%	0.732	0.809
Cs, ppm	1.32	0.056	1.21	1.43	1.15	1.49	4.25%	8.50%	12.75%	1.25	1.39
Cu, ppm	404	10	385	423	375	432	2.35%	4.71%	7.06%	384	424
Dy, ppm	1.54	0.051	1.44	1.64	1.38	1.69	3.35%	6.69%	10.04%	1.46	1.62
Er, ppm	0.93	0.048	0.83	1.03	0.79	1.07	5.18%	10.35%	15.53%	0.88	0.98
Eu, ppm	0.58	0.07	0.44	0.71	0.37	0.78	11.84%	23.67%	35.51%	0.55	0.60
Fe, wt.%	7.32	0.275	6.77	7.87	6.50	8.15	3.75%	7.50%	11.25%	6.96	7.69
Ga, ppm	13.8	0.52	12.7	14.8	12.2	15.3	3.81%	7.61%	11.42%	13.1	14.5
Gd, ppm	1.64	0.164	1.32	1.97	1.15	2.14	9.98%	19.95%	29.93%	1.56	1.73
Hf, ppm	0.75	0.056	0.64	0.87	0.59	0.92	7.45%	14.91%	22.36%	0.72	0.79
Ho, ppm	0.32	0.015	0.29	0.35	0.27	0.36	4.71%	9.42%	14.13%	0.30	0.33
In, ppm	0.028	0.005	0.019	0.037	0.014	0.042	16.28%	32.57%	48.85%	0.027	0.029
K, wt.%	0.507	0.028	0.451	0.563	0.423	0.591	5.52%	11.04%	16.56%	0.482	0.533
La, ppm	8.17	0.474	7.22	9.12	6.74	9.59	5.81%	11.61%	17.42%	7.76	8.58
Li, ppm	6.51	0.395	5.72	7.30	5.32	7.69	6.07%	12.14%	18.21%	6.18	6.83

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											
Lu, ppm	0.13	0.006	0.12	0.15	0.12	0.15	4.46%	8.93%	13.39%	0.13	0.14
Mg, wt.%	8.63	0.244	8.14	9.12	7.89	9.36	2.83%	5.67%	8.50%	8.20	9.06
Mn, wt.%	0.120	0.006	0.109	0.132	0.104	0.137	4.67%	9.35%	14.02%	0.114	0.126
Mo, ppm	1.00	0.12	0.76	1.24	0.64	1.36	12.08%	24.17%	36.25%	0.95	1.05
Na, wt.%	1.03	0.036	0.96	1.10	0.92	1.13	3.47%	6.93%	10.40%	0.98	1.08
Nb, ppm	2.61	0.165	2.28	2.94	2.11	3.10	6.34%	12.69%	19.03%	2.48	2.74
Nd, ppm	8.75	0.390	7.97	9.52	7.58	9.91	4.46%	8.91%	13.37%	8.31	9.18
Ni, ppm	1181	63	1054	1307	990	1371	5.37%	10.75%	16.12%	1122	1240
P, wt.%	0.050	0.003	0.044	0.055	0.041	0.058	5.58%	11.17%	16.75%	0.047	0.052
Pb, ppm	10.2	0.73	8.8	11.7	8.0	12.4	7.17%	14.34%	21.51%	9.7	10.7
Pr, ppm	2.17	0.096	1.98	2.36	1.88	2.46	4.43%	8.86%	13.29%	2.06	2.28
Rb, ppm	26.8	1.40	24.0	29.6	22.6	31.0	5.22%	10.44%	15.67%	25.5	28.2
S, wt.%	0.205	0.013	0.179	0.231	0.165	0.245	6.43%	12.87%	19.30%	0.195	0.215
Sc, ppm	19.7	1.47	16.7	22.6	15.3	24.1	7.48%	14.96%	22.44%	18.7	20.6
Sc, ppm	19.7	1.47	16.7	22.6	15.3	24.1	7.48%	14.96%	22.44%	18.7	20.6
Sc, ppm	19.7	1.47	16.7	22.6	15.3	24.1	7.48%	14.96%	22.44%	18.7	20.6
Sc, ppm	19.7	1.47	16.7	22.6	15.3	24.1	7.48%	14.96%	22.44%	18.7	20.6
Sm, ppm	1.86	0.146	1.57	2.16	1.43	2.30	7.81%	15.61%	23.42%	1.77	1.96
Sn, ppm	0.85	0.10	0.65	1.05	0.55	1.15	11.68%	23.36%	35.04%	0.81	0.89
Sr, ppm	276	13	250	302	237	315	4.69%	9.39%	14.08%	262	290
Tb, ppm	0.25	0.014	0.23	0.28	0.21	0.29	5.34%	10.69%	16.03%	0.24	0.27
Th, ppm	2.42	0.226	1.97	2.87	1.74	3.10	9.33%	18.66%	28.00%	2.30	2.54
Ti, wt.%	0.263	0.013	0.236	0.290	0.223	0.303	5.07%	10.14%	15.21%	0.250	0.276
Tm, ppm	0.13	0.007	0.12	0.15	0.11	0.15	5.35%	10.69%	16.04%	0.13	0.14
U, ppm	0.58	0.044	0.49	0.66	0.44	0.71	7.64%	15.27%	22.91%	0.55	0.61
V, ppm	187	10	167	206	158	216	5.20%	10.41%	15.61%	178	196
W, ppm	1.23	0.068	1.09	1.37	1.03	1.44	5.55%	11.11%	16.66%	1.17	1.29
Y, ppm	8.02	0.472	7.07	8.96	6.60	9.43	5.89%	11.78%	17.66%	7.62	8.42
Yb, ppm	0.88	0.059	0.76	1.00	0.70	1.05	6.76%	13.52%	20.29%	0.83	0.92
Zn, ppm	92	7.0	78	106	70	113	7.68%	15.36%	23.04%	87	96
Zr, ppm	26.3	3.1	20.1	32.6	16.9	35.7	11.89%	23.77%	35.66%	25.0	27.7

Note: intervals may appear asymmetric due to rounding.

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 platinum (Pt) by lead collection fire assay, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 1711 and 1810 ppb. 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.*

For gold, tolerance can be determined by INAA using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the latter parameter is substantially reduced to a point where most of the variability in replicate assays is due to inhomogeneity of the reference material and measurement error becomes negligible. In this instance a subsample weight of 85 milligrams was employed and the 1RSD of 0.416% calculated for a 30g lead collection fire assay sample (7.81% at 85mg weights) confirms the high level of gold homogeneity in OREAS 683. The homogeneity is of a level such that ***sampling error is almost negligible*** for a conventional lead collection fire assay determination.

Table 4. Instrumental Neutron Activation Analysis of Au (ppb) on 20 x 85mg subsamples of OREAS 683.

Replicate No	INAA 85mg
1	192
2	217
3	247
4	206
5	209
6	244
7	207
8	179
9	209
10	232
11	204
12	198
13	237
14	217
15	205
16	214
17	211
18	206
19	220
20	216
Mean	214
Median	210
Std Dev.	17
Rel.Std.Dev.	7.81%
PDM[3]	3.26%

The homogeneity of OREAS 683 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty three round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals selected from the pool of twenty 1kg test units. 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 683. 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 100 certified values except for Barium (Ba), Cobalt (Co), Gallium (Ga) and Strontium (Sr) by peroxide fusion. These cases are all for elements low in concentration and close to their lower levels of detection (LLD) where reading resolution errors can lead to 'false negatives' ('significant' *p*-values that are in fact irrelevant Usually data becomes more reliable and meaningful when the concentration levels are at least twenty times the LLD. 'False negatives' can also be due to random statistical probability (100 certified values x 5% significance level) 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 683 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 683 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. AGAT Laboratories, Mississauga, Ontario, Canada
3. ALS, Johannesburg, South Africa
4. ALS, Loughrea, Galway, Ireland
5. ALS, Perth, WA, Australia
6. ALS, Vancouver, BC, Canada
7. Anglo Research Iron Ore Laboratory, Johannesburg, South Africa
8. ANSTO, Lucas Heights, NSW, Australia
9. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
10. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
11. Bureau Veritas Geoanalytical, Perth, WA, Australia
12. Bureau Veritas Kalassay, Perth, WA, Australia
13. Intertek Genalysis, Perth, WA, Australia
14. Labtium Oy, Saarenkylä, Rovaniemi, Finland
15. MINTEK Analytical Services, Randburg, South Africa
16. Ontario Geological Survey, Sudbury, Ontario, Canada
17. Set Point Laboratory, Mokopane, Limpopo, South Africa
18. SGS, Randfontein, Gauteng, South Africa

19. SGS Australia Mineral Services, Perth, WA, Australia
20. SGS Canada Inc., Vancouver, BC, Canada
21. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
22. SGS Mineral Services, Townsville, QLD, Australia
23. SGS South Africa Pty Ltd, Rustenburg, South Africa
24. Trojan Ni Mine Lab, Bindura, Zimbabwe

PREPARER AND SUPPLIER

Certified reference material OREAS 683 is prepared, certified and supplied by:

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It is packaged in unit sizes of 60g (single-use laminated foil pouches) and 500g (plastic jars).

INTENDED USE

OREAS 683 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 683 has been prepared from primary PGE ores blended with barren gabbro-norite. It is low in reactive sulphide (0.2% S) and in its unopened state and under normal conditions of storage 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 for OREAS 683 refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

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.

LEGAL NOTICE

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

DOCUMENT HISTORY

Revision No.	Date	Changes applied
1	23rd February, 2024	Minor revision to Au by Pb Fire Assay certification.
0	16th March, 2018	First publication.

QMS ACCREDITED

ORE Pty Ltd is accredited to ISO 9001:2015 by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.

CERTIFYING OFFICER

16th March, 2018

Craig Hamlyn (B.Sc. Hons - Geology), Technical Manager - ORE P/L

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