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CERTIFICATE OF ANALYSIS FOR

Granodiorite lithogeochem / blank

(Devonian Lysterfield granodiorite complex, Melbourne Province of Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 20a

Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 20a.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Pb Fire Assay						
Au, Gold (ppb)	< 3	IND	IND	IND	IND	IND
Borate Fusion XRF						
Al_2O_3, Aluminium(III) oxide (wt.%)	15.28	0.105	15.23	15.34	15.21	15.35
BaO, Barium oxide (ppm)	1239	78	1191	1286	IND	IND
CaO, Calcium oxide (wt.%)	3.61	0.020	3.60	3.62	3.59	3.63
Fe_2O_3, Iron(III) oxide (wt.%)	5.33	0.029	5.31	5.34	5.30	5.36
K_2O, Potassium oxide (wt.%)	4.00	0.027	3.98	4.01	3.98	4.02
MgO, Magnesium oxide (wt.%)	2.40	0.030	2.38	2.41	2.38	2.41
MnO, Manganese oxide (wt.%)	0.070	0.001	0.070	0.071	0.068	0.073
Na_2O, Sodium oxide (wt.%)	2.73	0.054	2.70	2.75	2.69	2.77
P_2O_5, Phosphorus(V) oxide (wt.%)	0.231	0.004	0.229	0.232	0.226	0.235
S, Sulphur (wt.%)	0.063	0.001	0.063	0.064	0.061	0.065
SiO_2, Silicon dioxide (wt.%)	64.49	0.339	64.33	64.64	64.26	64.71
Sr, Strontium (ppm)	292	36	267	316	273	310
TiO_2, Titanium dioxide (wt.%)	0.828	0.011	0.822	0.834	0.819	0.837
V_2O_5, Vanadium(V) oxide (ppm)	205	17	196	214	IND	IND
Thermogravimetry						
LOI^{1000}, Loss on ignition @1000°C (wt.%)	0.611	0.042	0.580	0.641	0.582	0.640
Borate / Peroxide Fusion ICP						
Al, Aluminium (wt.%)	7.99	0.157	7.79	8.19	7.86	8.12
Ba, Barium (ppm)	1082	31	1065	1099	1051	1113
Be, Beryllium (ppm)	3.60	0.66	3.10	4.09	IND	IND
Ca, Calcium (wt.%)	2.61	0.047	2.57	2.64	2.55	2.67
Ce, Cerium (ppm)	82	2.6	81	83	79	85
Co, Cobalt (ppm)	13.7	0.68	13.0	14.4	13.2	14.2
Cr, Chromium (ppm)	87	10	81	93	IND	IND
Cs, Cesium (ppm)	15.3	0.69	14.9	15.7	14.7	15.9
Cu, Copper (ppm)	46.5	4.15	43.6	49.3	IND	IND
Dy, Dysprosium (ppm)	5.24	0.280	5.12	5.36	5.06	5.42
Er, Erbium (ppm)	3.08	0.140	3.01	3.16	2.91	3.26
Eu, Europium (ppm)	1.44	0.078	1.40	1.49	1.36	1.53
Fe, Iron (wt.%)	3.78	0.085	3.71	3.85	3.73	3.84
Ga, Gallium (ppm)	19.4	1.14	18.7	20.0	18.7	20.0
Gd, Gadolinium (ppm)	5.79	0.296	5.63	5.95	5.55	6.03
Hf, Hafnium (ppm)	7.91	0.411	7.68	8.15	7.58	8.24
Ho, Holmium (ppm)	1.07	0.049	1.04	1.10	1.02	1.11
K, Potassium (wt.%)	3.34	0.070	3.28	3.39	3.28	3.40
La, Lanthanum (ppm)	41.9	1.99	40.9	43.0	40.2	43.6
Li, Lithium (ppm)	37.5	2.66	34.4	40.6	IND	IND
Lu, Lutetium (ppm)	0.45	0.028	0.43	0.47	0.42	0.48

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Borate / Peroxide Fusion ICP continued						
Mg, Magnesium (wt.%)	1.45	0.025	1.43	1.47	1.42	1.48
Mn, Manganese (wt.%)	0.054	0.001	0.053	0.055	0.051	0.057
Nd, Neodymium (ppm)	35.2	1.10	34.7	35.7	34.1	36.3
Ni, Nickel (ppm)	40.6	4.2	38.6	42.6	IND	IND
P, Phosphorus (wt.%)	0.099	0.005	0.097	0.101	0.094	0.103
Pb, Lead (ppm)	21.4	1.73	19.2	23.6	IND	IND
Pr, Praseodymium (ppm)	9.36	0.359	9.14	9.58	9.02	9.70
Rb, Rubidium (ppm)	233	10	228	239	226	241
Si, Silicon (wt.%)	30.20	0.414	29.78	30.63	29.82	30.59
Sm, Samarium (ppm)	6.66	0.199	6.59	6.73	6.30	7.03
Sn, Tin (ppm)	4.07	0.57	3.99	4.16	IND	IND
Sr, Strontium (ppm)	299	12	292	307	290	309
Ta, Tantalum (ppm)	1.60	0.106	1.54	1.66	IND	IND
Tb, Terbium (ppm)	0.88	0.051	0.84	0.92	0.84	0.92
Th, Thorium (ppm)	22.0	0.82	21.6	22.3	21.0	22.9
Ti, Titanium (wt.%)	0.503	0.011	0.493	0.513	0.492	0.514
Tl, Thallium (ppm)	1.14	0.11	1.05	1.23	IND	IND
Tm, Thulium (ppm)	0.45	0.015	0.45	0.46	0.42	0.49
U, Uranium (ppm)	6.69	0.358	6.57	6.81	6.33	7.05
V, Vanadium (ppm)	114	10	107	120	111	117
W, Tungsten (ppm)	3.85	0.75	3.56	4.14	IND	IND
Y, Yttrium (ppm)	29.2	0.99	28.6	29.8	28.4	30.0
Yb, Ytterbium (ppm)	2.96	0.195	2.90	3.02	2.74	3.18
Zr, Zirconium (ppm)	303	23	287	319	289	317
4-Acid Digestion						
Ag, Silver (ppm)	0.061	0.007	0.054	0.068	0.045	0.078
Al, Aluminium (wt.%)	7.72	0.316	7.54	7.90	7.53	7.91
As, Arsenic (ppm)	17.0	2.1	15.9	18.1	15.2	18.8
Ba, Barium (ppm)	1070	43	1047	1092	1044	1095
Be, Beryllium (ppm)	3.65	0.218	3.53	3.78	3.46	3.85
Bi, Bismuth (ppm)	0.14	0.02	0.13	0.15	0.10	0.18
Ca, Calcium (wt.%)	2.52	0.090	2.48	2.57	2.47	2.57
Cd, Cadmium (ppm)	0.086	0.015	0.078	0.093	0.064	0.107
Ce, Cerium (ppm)	77	3.4	75	79	74	80
Co, Cobalt (ppm)	13.4	0.53	13.1	13.7	13.0	13.7
Cr, Chromium (ppm)	65	4.9	62	68	62	69
Cs, Cesium (ppm)	15.2	0.69	14.8	15.6	14.8	15.6
Cu, Copper (ppm)	45.4	2.50	44.1	46.8	43.6	47.3
Dy, Dysprosium (ppm)	5.15	0.214	5.01	5.29	4.94	5.36
Er, Erbium (ppm)	2.94	0.179	2.77	3.12	2.79	3.10
Eu, Europium (ppm)	1.42	0.124	1.30	1.55	1.34	1.51

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
4-Acid Digestion continued						
Fe, Iron (wt.%)	3.60	0.113	3.54	3.65	3.52	3.68
Ga, Gallium (ppm)	19.6	0.41	19.4	19.8	19.1	20.1
Gd, Gadolinium (ppm)	5.56	0.363	5.28	5.84	5.23	5.89
Ge, Germanium (ppm)	0.17	0.03	0.13	0.20	IND	IND
Hf, Hafnium (ppm)	2.89	0.172	2.81	2.98	2.75	3.04
Ho, Holmium (ppm)	1.00	0.048	0.95	1.04	0.94	1.05
In, Indium (ppm)	0.050	0.006	0.047	0.053	0.042	0.058
K, Potassium (wt.%)	3.27	0.085	3.24	3.31	3.21	3.34
La, Lanthanum (ppm)	36.5	3.02	34.9	38.2	35.3	37.8
Li, Lithium (ppm)	38.5	2.18	37.4	39.6	37.2	39.8
Lu, Lutetium (ppm)	0.40	0.021	0.37	0.42	0.38	0.41
Mg, Magnesium (wt.%)	1.36	0.059	1.33	1.39	1.34	1.39
Mn, Manganese (wt.%)	0.052	0.001	0.051	0.052	0.051	0.053
Mo, Molybdenum (ppm)	3.25	0.277	3.13	3.36	2.89	3.60
Na, Sodium (wt.%)	1.98	0.052	1.96	2.00	1.94	2.02
Nb, Niobium (ppm)	20.4	1.13	19.7	21.0	19.7	21.1
Nd, Neodymium (ppm)	33.0	0.79	32.7	33.3	31.7	34.3
Ni, Nickel (ppm)	39.0	1.63	38.2	39.7	37.4	40.6
P, Phosphorus (wt.%)	0.101	0.004	0.099	0.102	0.097	0.105
Pb, Lead (ppm)	21.9	0.94	21.4	22.3	21.1	22.7
Pr, Praseodymium (ppm)	9.14	0.513	8.65	9.63	8.69	9.58
Rb, Rubidium (ppm)	218	17	208	227	211	225
S, Sulphur (wt.%)	0.064	0.004	0.061	0.066	0.061	0.067
Sb, Antimony (ppm)	0.57	0.042	0.55	0.58	0.54	0.59
Sc, Scandium (ppm)	12.3	0.84	11.9	12.7	11.9	12.6
Sm, Samarium (ppm)	6.60	0.414	6.20	6.99	6.32	6.87
Sn, Tin (ppm)	4.03	0.195	3.91	4.14	3.77	4.28
Sr, Strontium (ppm)	296	8	292	299	289	303
Ta, Tantalum (ppm)	1.56	0.083	1.51	1.60	1.48	1.63
Tb, Terbium (ppm)	0.86	0.044	0.82	0.90	0.83	0.89
Th, Thorium (ppm)	21.9	1.17	21.3	22.5	20.9	22.9
Ti, Titanium (wt.%)	0.489	0.015	0.480	0.497	0.479	0.498
Tl, Thallium (ppm)	1.13	0.065	1.10	1.16	1.09	1.18
Tm, Thulium (ppm)	0.43	0.036	0.39	0.47	IND	IND
U, Uranium (ppm)	6.37	0.432	6.14	6.60	6.07	6.67
V, Vanadium (ppm)	110	3	109	111	107	113
W, Tungsten (ppm)	3.38	0.43	3.16	3.59	2.97	3.78
Y, Yttrium (ppm)	26.8	1.89	25.8	27.8	26.1	27.5
Yb, Ytterbium (ppm)	2.66	0.152	2.54	2.78	2.50	2.81
Zn, Zinc (ppm)	69	2.3	68	71	67	72
Zr, Zirconium (ppm)	89	5.9	86	92	86	93

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion (sample weights 0.15-50g)						
Ag, Silver (ppm)	0.061	0.005	0.056	0.066	0.043	0.079
Al, Aluminium (wt.%)	2.37	0.133	2.30	2.44	2.30	2.43
As, Arsenic (ppm)	17.2	1.29	16.5	17.8	15.9	18.4
Ba, Barium (ppm)	487	17	477	498	477	497
Be, Beryllium (ppm)	0.65	0.07	0.59	0.70	0.60	0.69
Bi, Bismuth (ppm)	0.14	0.02	0.14	0.15	0.11	0.18
Ca, Calcium (wt.%)	0.834	0.050	0.806	0.862	0.815	0.853
Cd, Cadmium (ppm)	0.036	0.005	0.032	0.040	0.030	0.043
Ce, Cerium (ppm)	72	2.8	70	73	70	74
Co, Cobalt (ppm)	12.5	0.64	12.1	12.8	12.1	12.9
Cr, Chromium (ppm)	67	3.9	64	69	64	69
Cs, Cesium (ppm)	13.5	0.85	12.9	14.0	13.1	13.8
Cu, Copper (ppm)	45.9	2.39	44.6	47.1	44.7	47.1
Dy, Dysprosium (ppm)	3.60	0.226	3.31	3.89	3.37	3.83
Er, Erbium (ppm)	1.91	0.153	1.72	2.11	1.76	2.07
Eu, Europium (ppm)	0.38	0.06	0.31	0.45	0.33	0.43
Fe, Iron (wt.%)	3.27	0.172	3.17	3.37	3.20	3.34
Ga, Gallium (ppm)	8.77	0.456	8.46	9.08	8.58	8.96
Gd, Gadolinium (ppm)	4.42	0.419	3.86	4.99	4.30	4.55
Ge, Germanium (ppm)	0.18	0.017	0.16	0.20	0.16	0.20
Hf, Hafnium (ppm)	0.46	0.019	0.45	0.47	0.44	0.48
Ho, Holmium (ppm)	0.69	0.049	0.63	0.75	0.65	0.72
In, Indium (ppm)	0.030	0.003	0.028	0.032	0.027	0.033
K, Potassium (wt.%)	1.35	0.069	1.31	1.39	1.31	1.38
La, Lanthanum (ppm)	34.8	1.84	33.8	35.8	33.9	35.7
Li, Lithium (ppm)	37.7	1.71	37.0	38.4	36.6	38.9
Lu, Lutetium (ppm)	0.24	0.03	0.21	0.28	0.23	0.26
Mg, Magnesium (wt.%)	1.17	0.092	1.12	1.23	1.15	1.20
Mn, Manganese (wt.%)	0.036	0.002	0.035	0.037	0.035	0.037
Mo, Molybdenum (ppm)	3.01	0.32	2.83	3.19	2.79	3.23
Na, Sodium (wt.%)	0.257	0.013	0.248	0.265	0.247	0.266
Nb, Niobium (ppm)	1.15	0.13	1.05	1.24	1.01	1.28
Nd, Neodymium (ppm)	30.1	2.21	27.1	33.1	29.1	31.1
Ni, Nickel (ppm)	36.3	2.13	35.2	37.4	35.1	37.5
P, Phosphorus (wt.%)	0.097	0.004	0.094	0.099	0.094	0.099
Pb, Lead (ppm)	5.82	0.463	5.55	6.09	5.61	6.04
Rb, Rubidium (ppm)	164	9	158	170	160	168
S, Sulphur (wt.%)	0.070	0.011	0.063	0.077	0.068	0.072
Sb, Antimony (ppm)	0.28	0.03	0.25	0.30	0.26	0.29
Sc, Scandium (ppm)	7.65	0.77	7.17	8.14	7.38	7.93
Sm, Samarium (ppm)	5.21	0.54	4.50	5.91	4.65	5.77

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
Aqua Regia Digestion (sample weights 0.15-50g) continued						
Sn, Tin (ppm)	3.37	0.217	3.22	3.51	3.22	3.52
Sr, Strontium (ppm)	60	5.3	57	63	57	62
Ta, Tantalum (ppm)	0.009	0.001	0.008	0.010	IND	IND
Tb, Terbium (ppm)	0.64	0.036	0.61	0.68	IND	IND
Th, Thorium (ppm)	21.1	1.63	20.2	22.0	20.3	21.9
Ti, Titanium (wt.%)	0.366	0.034	0.347	0.386	0.356	0.377
Tl, Thallium (ppm)	0.86	0.051	0.82	0.89	0.82	0.89
U, Uranium (ppm)	5.91	0.347	5.75	6.07	5.59	6.23
V, Vanadium (ppm)	105	5	102	108	102	108
W, Tungsten (ppm)	2.27	0.24	2.10	2.44	1.96	2.58
Y, Yttrium (ppm)	19.3	0.72	18.9	19.7	18.7	19.9
Yb, Ytterbium (ppm)	1.66	0.20	1.43	1.88	1.58	1.73
Zn, Zinc (ppm)	63	4.1	61	65	61	65
Zr, Zirconium (ppm)	10.6	0.49	10.2	11.0	10.2	10.9
Infrared Combustion						
C, Carbon (wt.%)	0.054	0.010	0.049	0.059	0.045	0.063
S, Sulphur (wt.%)	0.059	0.005	0.056	0.061	0.056	0.061

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 2. Indicative Values for OREAS 20a.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppb	*1.19*	Pt	ppb	*< 5*	Rh	ppm	*0.000*
Borate Fusion XRF								
As	ppm	*13.8*	Hf	ppm	*< 80*	Sm	ppm	*< 90*
Bi	ppm	*< 90*	La	ppm	*85*	Ta	ppm	*< 8*
Ce	ppm	*68*	Mo	ppm	*8.33*	Th	ppm	*< 44*
Cl	ppm	*141*	Nb	ppm	*29.4*	U	ppm	*< 42*
Co	ppm	*23.5*	Nd	ppm	*< 90*	W	ppm	*7.14*
Cr_2O_3	ppm	*100*	Ni	ppm	*46.7*	Y	ppm	*< 80*
Cu	ppm	*53*	Pb	ppm	*41.5*	Zn	ppm	*76*
Dy	ppm	*< 90*	Pr	ppm	*< 90*	Zr	ppm	*299*
Eu	ppm	*< 90*	Rb	ppm	*183*			
Gd	ppm	*< 90*	Sb	ppm	*< 8*			
Thermogravity								
H_2O-	wt.%	*0.006*						
Borate / Peroxide Fusion ICP								
Ag	ppm	*< 5*	In	ppm	*< 0.2*	Sb	ppm	*0.65*
As	ppm	*18.1*	Mo	ppm	*3.59*	Sc	ppm	*12.2*
B	ppm	*22.5*	Na	wt.%	*1.91*	Se	ppm	*< 20*

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
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.

Table 2 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate / Peroxide Fusion ICP continued								
Bi	ppm	*0.13*	Nb	ppm	*20.0*	Te	ppm	*< 1*
Cd	ppm	*< 10*	Re	ppm	*< 0.1*	Zn	ppm	*70*
Ge	ppm	*1.49*	S	wt.%	*0.061*			
4-Acid Digestion								
B	ppm	*< 5*	Se	ppm	*0.40*			
Re	ppm	*< 0.002*	Te	ppm	*< 0.04*			
Aqua Regia Digestion (sample weights 0.15-50g)								
Au	ppb	*1.64*	Pr	ppm	*8.23*	Se	ppm	*0.25*
B	ppm	*< 10*	Pt	ppb	*1.51*	Si	wt.%	*14.64*
Hg	ppm	*< 0.004*	Re	ppm	*0.001*	Te	ppm	*0.011*
Pd	ppb	*< 1*	Ru	ppb	*< 5*	Tm	ppm	*0.26*
Miscellaneous Assay Methods								
F	ppm	*557*						

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
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.

OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

SOURCE MATERIALS

OREAS 20a has been prepared from barren I-Type hornblende-bearing granodiorite sourced from the Upper Devonian Lysterfield granodiorite complex located in south-eastern Melbourne, Australia. It is characterised by very low background gold of less than 3 parts per billion.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 20a was prepared in the following manner:

- Drying to constant mass at 105°C;
- Milling to 98% minus 75 microns;
- Homogenisation;
- Packaging in 10g and 60g units in laminated foil pouches and 1kg units in plastic wide-mouth jars.

ANALYTICAL PROGRAM

Sixteen commercial analytical laboratories participated in the program to characterise the elements reported in Table 1. The following methods were employed:

- Au, Pt and Pd by fire assay with AAS (1 laboratory), ICP-OES (9 laboratories) or ICP-MS (4 laboratories) finish;
- Low level 4-acid digestion for full suite elemental package by ICP-OES and/or ICP-MS finish (up to 16 laboratories depending on the element);
- Low level aqua regia digestion for full suite elemental package by ICP-OES and/or ICP-MS finish (up to 15 laboratories depending on the element);
- Lithium borate or sodium peroxide fusion with full suite elemental package by ICP-OES and/or ICP-MS finish (up to 13 laboratories depending on the element);
- Lithium borate fusion for full suite elemental package by X-ray fluorescence (up to 14 laboratories depending on the analyte);
- Thermogravimetry for LOI at 1000°C (15 laboratories);
- Infra-red combustion furnace for C and S (16 laboratories).

Fluorine by peroxide fusion followed by ion selective electrode was also undertaken by one laboratory (see 'Table 2 Indicative Values').

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. Aqua regia is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions which can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements.

The approach applied here is to report certified values in those instances where reasonable agreement exists amongst a majority of participating laboratories. The results of specific laboratories may differ significantly from the certified values, but will, nonetheless, be valid and reproducible in the context of the specifics of the aqua regia method in use. Users of this reference material should, therefore, be mindful of this limitation when applying the certified values in a quality control program.

For the round robin program twelve 1.1kg 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 120g scoop splits from each of three separate 1.1kg 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 175 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 66 indicative values. Homogeneity has been evaluated by a nested ANOVA program (see '**nested ANOVA**' section) and Table 3 provides performance gate intervals for the certified values of each method group based on their pooled 1SD's. Tabulated results of all analytes together with uncorrected means, medians, standard deviations, relative standard deviations and

percent deviation of lab means from the corrected mean of means (PDM^3) are presented in the detailed certification data for this CRM (**OREAS 20a DataPack-1.0.181002_164411.xlsx**).

STATISTICAL ANALYSIS

Certified Values, Standard Deviations, Confidence and Tolerance Limits have been determined for each analytical method following removal of individual and laboratory outliers (Table 1). Certified Values are the mean of means after outlier filtering. The 95% Confidence Limit is a measure of the reliability of the certified value, i.e. the narrower the Confidence Interval the greater the certainty in the Certified Value. It should not be used as a control limit for laboratory performance.

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.*

Indicative (uncertified) values (Table 2) are provided where i) the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification; ii) interlaboratory consensus is poor; or iii) a significant proportion of results are outlying or reported as less than detection limits.

Standard Deviation values (1SDs) are reported in Table 1. They 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. They 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 Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

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 all 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.**

As a guide two or more analytical results lying outside the 2SD window may be regarded as warning or rejection, and rejection for single results lying outside the 3SD window in QC monitoring, although their precise application should be at the discretion of the QC manager concerned.

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. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL) ± 10%.

i.e. Certified Value ± 10% ± 2DL (adapted from Govett, 1983)

Table 3. Performance Gates for OREAS 20a.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
Pb Fire Assay											
Au, ppb	< 3	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Borate Fusion XRF											
Al_2O_3, wt.%	15.28	0.105	15.07	15.49	14.97	15.60	0.68%	1.37%	2.05%	14.52	16.05
BaO, ppm	1239	78	1083	1394	1006	1471	6.27%	12.53%	18.80%	1177	1301
CaO, wt.%	3.61	0.020	3.57	3.65	3.55	3.67	0.56%	1.11%	1.67%	3.43	3.79
Fe_2O_3, wt.%	5.33	0.029	5.27	5.39	5.24	5.42	0.54%	1.08%	1.63%	5.06	5.60
K_2O, wt.%	4.00	0.027	3.94	4.05	3.92	4.08	0.67%	1.33%	2.00%	3.80	4.20
MgO, wt.%	2.40	0.030	2.34	2.46	2.30	2.49	1.27%	2.54%	3.81%	2.28	2.52
MnO, wt.%	0.070	0.001	0.068	0.073	0.067	0.074	1.67%	3.33%	5.00%	0.067	0.074
Na_2O, wt.%	2.73	0.054	2.62	2.83	2.56	2.89	1.99%	3.98%	5.98%	2.59	2.86
P_2O_5, wt.%	0.231	0.004	0.223	0.238	0.219	0.242	1.69%	3.38%	5.07%	0.219	0.242
S, wt.%	0.063	0.001	0.060	0.066	0.059	0.068	2.34%	4.67%	7.01%	0.060	0.067
SiO_2, wt.%	64.49	0.339	63.81	65.16	63.47	65.50	0.53%	1.05%	1.58%	61.26	67.71
Sr, ppm	292	36	220	363	185	398	12.22%	24.44%	36.65%	277	306
TiO_2, wt.%	0.828	0.011	0.805	0.851	0.794	0.862	1.36%	2.72%	4.08%	0.787	0.869
V_2O_5, ppm	205	17	170	240	153	257	8.52%	17.03%	25.55%	195	215
Thermogravimetry											
LOI^{1000}, wt.%	0.611	0.042	0.527	0.694	0.486	0.736	6.83%	13.66%	20.50%	0.580	0.642
Borate / Peroxide Fusion ICP											
Al, wt.%	7.99	0.157	7.68	8.30	7.52	8.46	1.96%	3.92%	5.88%	7.59	8.39
Ba, ppm	1082	31	1019	1145	988	1176	2.91%	5.81%	8.72%	1028	1136
Be, ppm	3.60	0.66	2.28	4.92	1.62	5.57	18.33%	36.66%	54.99%	3.42	3.78
Ca, wt.%	2.61	0.047	2.52	2.70	2.47	2.75	1.81%	3.61%	5.42%	2.48	2.74
Ce, ppm	82	2.6	77	87	74	90	3.19%	6.37%	9.56%	78	86
Co, ppm	13.7	0.68	12.3	15.0	11.7	15.7	4.96%	9.91%	14.87%	13.0	14.4
Cr, ppm	87	10	66	108	56	118	11.96%	23.91%	35.87%	83	91
Cs, ppm	15.3	0.69	13.9	16.7	13.3	17.4	4.50%	9.00%	13.51%	14.6	16.1
Cu, ppm	46.5	4.15	38.1	54.8	34.0	58.9	8.94%	17.88%	26.82%	44.1	48.8
Dy, ppm	5.24	0.280	4.68	5.80	4.40	6.08	5.34%	10.67%	16.01%	4.98	5.51
Er, ppm	3.08	0.140	2.80	3.37	2.66	3.51	4.55%	9.10%	13.65%	2.93	3.24
Eu, ppm	1.44	0.078	1.29	1.60	1.21	1.68	5.38%	10.77%	16.15%	1.37	1.51
Fe, wt.%	3.78	0.085	3.61	3.95	3.53	4.04	2.25%	4.49%	6.74%	3.59	3.97
Ga, ppm	19.4	1.14	17.1	21.7	16.0	22.8	5.87%	11.75%	17.62%	18.4	20.4
Gd, ppm	5.79	0.296	5.20	6.39	4.91	6.68	5.11%	10.22%	15.33%	5.50	6.08
Hf, ppm	7.91	0.411	7.09	8.73	6.68	9.14	5.19%	10.38%	15.57%	7.52	8.31
Ho, ppm	1.07	0.049	0.97	1.16	0.92	1.21	4.57%	9.15%	13.72%	1.01	1.12

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
Borate / Peroxide Fusion ICP continued											
K, wt.%	3.34	0.070	3.20	3.48	3.13	3.55	2.10%	4.19%	6.29%	3.17	3.51
La, ppm	41.9	1.99	38.0	45.9	36.0	47.9	4.75%	9.49%	14.24%	39.8	44.0
Li, ppm	37.5	2.66	32.2	42.8	29.5	45.4	7.09%	14.18%	21.26%	35.6	39.4
Lu, ppm	0.45	0.028	0.39	0.51	0.37	0.53	6.21%	12.43%	18.64%	0.43	0.47
Mg, wt.%	1.45	0.025	1.40	1.50	1.37	1.52	1.70%	3.39%	5.09%	1.38	1.52
Mn, wt.%	0.054	0.001	0.052	0.057	0.051	0.058	2.16%	4.33%	6.49%	0.052	0.057
Nd, ppm	35.2	1.10	33.0	37.4	31.9	38.5	3.13%	6.25%	9.38%	33.4	36.9
Ni, ppm	40.6	4.2	32.2	49.0	28.0	53.3	10.38%	20.77%	31.15%	38.6	42.6
P, wt.%	0.099	0.005	0.089	0.109	0.084	0.114	5.04%	10.09%	15.13%	0.094	0.104
Pb, ppm	21.4	1.73	17.9	24.8	16.2	26.5	8.08%	16.15%	24.23%	20.3	22.4
Pr, ppm	9.36	0.359	8.64	10.08	8.28	10.44	3.84%	7.67%	11.51%	8.89	9.83
Rb, ppm	233	10	213	254	203	264	4.30%	8.61%	12.91%	222	245
Si, wt.%	30.20	0.414	29.37	31.03	28.96	31.44	1.37%	2.74%	4.11%	28.69	31.71
Sm, ppm	6.66	0.199	6.26	7.06	6.06	7.26	2.99%	5.97%	8.96%	6.33	6.99
Sn, ppm	4.07	0.57	2.94	5.21	2.37	5.77	13.91%	27.81%	41.72%	3.87	4.28
Sr, ppm	299	12	275	324	262	336	4.12%	8.23%	12.35%	284	314
Ta, ppm	1.60	0.106	1.38	1.81	1.28	1.92	6.67%	13.33%	20.00%	1.52	1.68
Tb, ppm	0.88	0.051	0.78	0.98	0.73	1.03	5.82%	11.63%	17.45%	0.84	0.92
Th, ppm	22.0	0.82	20.4	23.6	19.5	24.4	3.71%	7.42%	11.12%	20.9	23.1
Ti, wt.%	0.503	0.011	0.481	0.525	0.471	0.535	2.15%	4.29%	6.44%	0.478	0.528
Tl, ppm	1.14	0.11	0.91	1.37	0.80	1.48	10.01%	20.02%	30.03%	1.08	1.20
Tm, ppm	0.45	0.015	0.42	0.48	0.41	0.50	3.25%	6.50%	9.76%	0.43	0.48
U, ppm	6.69	0.358	5.97	7.40	5.61	7.76	5.35%	10.70%	16.05%	6.35	7.02
V, ppm	114	10	93	134	83	144	8.95%	17.90%	26.85%	108	120
W, ppm	3.85	0.75	2.35	5.34	1.60	6.09	19.44%	38.88%	58.32%	3.66	4.04
Y, ppm	29.2	0.99	27.2	31.2	26.2	32.2	3.40%	6.79%	10.19%	27.7	30.7
Yb, ppm	2.96	0.195	2.57	3.35	2.38	3.55	6.59%	13.18%	19.78%	2.81	3.11
Zr, ppm	303	23	257	349	234	372	7.55%	15.10%	22.64%	288	318
4-Acid Digestion											
Ag, ppm	0.061	0.007	0.047	0.076	0.039	0.083	12.05%	24.09%	36.14%	0.058	0.064
Al, wt.%	7.72	0.316	7.09	8.35	6.77	8.67	4.09%	8.19%	12.28%	7.33	8.10
As, ppm	17.0	2.1	12.8	21.2	10.6	23.3	12.44%	24.89%	37.33%	16.1	17.8
Ba, ppm	1070	43	983	1156	939	1200	4.06%	8.12%	12.18%	1016	1123
Be, ppm	3.65	0.218	3.22	4.09	3.00	4.31	5.95%	11.91%	17.86%	3.47	3.84
Bi, ppm	0.14	0.02	0.10	0.18	0.07	0.20	15.50%	30.99%	46.49%	0.13	0.15
Ca, wt.%	2.52	0.090	2.34	2.70	2.25	2.79	3.56%	7.12%	10.68%	2.40	2.65
Cd, ppm	0.086	0.015	0.056	0.115	0.041	0.130	17.50%	35.00%	52.49%	0.081	0.090
Ce, ppm	77	3.4	70	84	67	87	4.40%	8.81%	13.21%	73	81
Co, ppm	13.4	0.53	12.3	14.4	11.8	15.0	3.95%	7.89%	11.84%	12.7	14.1
Cr, ppm	65	4.9	56	75	51	80	7.54%	15.07%	22.61%	62	69
Cs, ppm	15.2	0.69	13.8	16.6	13.1	17.3	4.57%	9.14%	13.71%	14.4	16.0
Cu, ppm	45.4	2.50	40.4	50.4	37.9	52.9	5.51%	11.02%	16.53%	43.2	47.7
Dy, ppm	5.15	0.214	4.72	5.58	4.51	5.79	4.16%	8.32%	12.49%	4.89	5.41
Er, ppm	2.94	0.179	2.59	3.30	2.41	3.48	6.08%	12.16%	18.24%	2.80	3.09

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
Eu, ppm	1.42	0.124	1.18	1.67	1.05	1.80	8.70%	17.40%	26.09%	1.35	1.50
Fe, wt.%	3.60	0.113	3.37	3.82	3.26	3.94	3.14%	6.28%	9.42%	3.42	3.78
Ga, ppm	19.6	0.41	18.8	20.4	18.3	20.8	2.10%	4.20%	6.31%	18.6	20.6
Gd, ppm	5.56	0.363	4.83	6.29	4.47	6.65	6.53%	13.07%	19.60%	5.28	5.84
Ge, ppm	0.17	0.03	0.10	0.23	0.07	0.26	19.05%	38.10%	57.15%	0.16	0.18
Hf, ppm	2.89	0.172	2.55	3.24	2.38	3.41	5.95%	11.90%	17.85%	2.75	3.04
Ho, ppm	1.00	0.048	0.90	1.09	0.85	1.14	4.86%	9.71%	14.57%	0.95	1.05
In, ppm	0.050	0.006	0.038	0.062	0.032	0.068	11.80%	23.60%	35.39%	0.047	0.052
K, wt.%	3.27	0.085	3.10	3.44	3.02	3.53	2.59%	5.19%	7.78%	3.11	3.44
La, ppm	36.5	3.02	30.5	42.6	27.5	45.6	8.26%	16.52%	24.78%	34.7	38.4
Li, ppm	38.5	2.18	34.1	42.8	32.0	45.0	5.66%	11.31%	16.97%	36.6	40.4
Lu, ppm	0.40	0.021	0.35	0.44	0.33	0.46	5.28%	10.56%	15.83%	0.38	0.42
Mg, wt.%	1.36	0.059	1.25	1.48	1.19	1.54	4.32%	8.64%	12.96%	1.30	1.43
Mn, wt.%	0.052	0.001	0.049	0.054	0.048	0.056	2.67%	5.34%	8.01%	0.049	0.054
Mo, ppm	3.25	0.277	2.69	3.80	2.42	4.08	8.52%	17.05%	25.57%	3.09	3.41
Na, wt.%	1.98	0.052	1.88	2.08	1.82	2.14	2.64%	5.27%	7.91%	1.88	2.08
Nb, ppm	20.4	1.13	18.1	22.6	17.0	23.8	5.54%	11.08%	16.62%	19.4	21.4
Nd, ppm	33.0	0.79	31.4	34.6	30.6	35.3	2.39%	4.78%	7.18%	31.3	34.6
Ni, ppm	39.0	1.63	35.7	42.3	34.1	43.9	4.19%	8.38%	12.57%	37.0	40.9
P, wt.%	0.101	0.004	0.094	0.108	0.090	0.111	3.48%	6.95%	10.43%	0.096	0.106
Pb, ppm	21.9	0.94	20.0	23.8	19.1	24.7	4.29%	8.59%	12.88%	20.8	23.0
Pr, ppm	9.14	0.513	8.11	10.16	7.60	10.68	5.62%	11.24%	16.85%	8.68	9.59
Rb, ppm	218	17	183	252	166	269	7.89%	15.77%	23.66%	207	229
S, wt.%	0.064	0.004	0.055	0.073	0.051	0.077	6.88%	13.76%	20.64%	0.061	0.067
Sb, ppm	0.57	0.042	0.48	0.65	0.44	0.69	7.46%	14.93%	22.39%	0.54	0.60
Sc, ppm	12.3	0.84	10.6	14.0	9.8	14.8	6.81%	13.62%	20.44%	11.7	12.9
Sm, ppm	6.60	0.414	5.77	7.42	5.35	7.84	6.28%	12.55%	18.83%	6.27	6.93
Sn, ppm	4.03	0.195	3.64	4.41	3.44	4.61	4.83%	9.67%	14.50%	3.82	4.23
Sr, ppm	296	8	280	311	272	319	2.63%	5.26%	7.89%	281	311
Ta, ppm	1.56	0.083	1.39	1.72	1.31	1.81	5.31%	10.62%	15.93%	1.48	1.64
Tb, ppm	0.86	0.044	0.77	0.94	0.73	0.99	5.09%	10.17%	15.26%	0.81	0.90
Th, ppm	21.9	1.17	19.6	24.2	18.4	25.4	5.33%	10.66%	16.00%	20.8	23.0
Ti, wt.%	0.489	0.015	0.460	0.518	0.445	0.532	2.97%	5.95%	8.92%	0.464	0.513
Tl, ppm	1.13	0.065	1.00	1.26	0.94	1.33	5.72%	11.43%	17.15%	1.08	1.19
Tm, ppm	0.43	0.036	0.35	0.50	0.32	0.53	8.44%	16.89%	25.33%	0.40	0.45
U, ppm	6.37	0.432	5.51	7.23	5.07	7.67	6.78%	13.56%	20.34%	6.05	6.69
V, ppm	110	3	104	116	101	119	2.84%	5.69%	8.53%	104	115
W, ppm	3.38	0.43	2.52	4.24	2.09	4.67	12.70%	25.39%	38.09%	3.21	3.55
Y, ppm	26.8	1.89	23.0	30.6	21.1	32.5	7.06%	14.11%	21.17%	25.5	28.2
Yb, ppm	2.66	0.152	2.35	2.96	2.20	3.12	5.73%	11.46%	17.18%	2.53	2.79
Zn, ppm	69	2.3	65	74	63	76	3.25%	6.51%	9.76%	66	73
Zr, ppm	89	5.9	78	101	72	107	6.57%	13.13%	19.70%	85	94
Aqua Regia Digestion (sample weights 0.15-50g)											
Ag, ppm	0.061	0.005	0.050	0.072	0.045	0.077	8.84%	17.69%	26.53%	0.058	0.064

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
Aqua Regia Digestion (sample weights 0.15-50g) continued											
Al, wt.%	2.37	0.133	2.10	2.63	1.97	2.77	5.60%	11.20%	16.80%	2.25	2.49
As, ppm	17.2	1.29	14.6	19.8	13.3	21.0	7.51%	15.01%	22.52%	16.3	18.0
Ba, ppm	487	17	452	522	435	539	3.57%	7.13%	10.70%	463	512
Be, ppm	0.65	0.07	0.51	0.78	0.44	0.85	10.63%	21.27%	31.90%	0.61	0.68
Bi, ppm	0.14	0.02	0.11	0.18	0.09	0.19	11.43%	22.86%	34.29%	0.14	0.15
Ca, wt.%	0.834	0.050	0.735	0.933	0.686	0.983	5.94%	11.87%	17.81%	0.792	0.876
Cd, ppm	0.036	0.005	0.027	0.045	0.022	0.050	12.67%	25.35%	38.02%	0.034	0.038
Ce, ppm	72	2.8	66	77	63	80	3.87%	7.73%	11.60%	68	75
Co, ppm	12.5	0.64	11.2	13.7	10.5	14.4	5.13%	10.25%	15.38%	11.8	13.1
Cr, ppm	67	3.9	59	74	55	78	5.88%	11.76%	17.64%	63	70
Cs, ppm	13.5	0.85	11.8	15.2	10.9	16.0	6.32%	12.65%	18.97%	12.8	14.1
Cu, ppm	45.9	2.39	41.1	50.6	38.7	53.0	5.22%	10.44%	15.66%	43.6	48.2
Dy, ppm	3.60	0.226	3.15	4.05	2.92	4.28	6.28%	12.56%	18.84%	3.42	3.78
Er, ppm	1.91	0.153	1.61	2.22	1.46	2.37	7.99%	15.98%	23.97%	1.82	2.01
Eu, ppm	0.38	0.06	0.27	0.49	0.21	0.54	14.60%	29.20%	43.81%	0.36	0.40
Fe, wt.%	3.27	0.172	2.93	3.61	2.75	3.78	5.25%	10.50%	15.75%	3.11	3.43
Ga, ppm	8.77	0.456	7.86	9.68	7.40	10.14	5.20%	10.41%	15.61%	8.33	9.21
Gd, ppm	4.42	0.419	3.59	5.26	3.17	5.68	9.46%	18.92%	28.38%	4.20	4.65
Ge, ppm	0.18	0.017	0.15	0.21	0.13	0.23	9.35%	18.70%	28.05%	0.17	0.19
Hf, ppm	0.46	0.019	0.42	0.50	0.40	0.52	4.17%	8.35%	12.52%	0.44	0.48
Ho, ppm	0.69	0.049	0.59	0.78	0.54	0.83	7.07%	14.15%	21.22%	0.65	0.72
In, ppm	0.030	0.003	0.024	0.036	0.020	0.039	10.65%	21.29%	31.94%	0.028	0.031
K, wt.%	1.35	0.069	1.21	1.48	1.14	1.55	5.13%	10.25%	15.38%	1.28	1.41
La, ppm	34.8	1.84	31.1	38.5	29.3	40.3	5.30%	10.60%	15.89%	33.1	36.5
Li, ppm	37.7	1.71	34.3	41.2	32.6	42.9	4.54%	9.07%	13.61%	35.9	39.6
Lu, ppm	0.24	0.03	0.19	0.30	0.16	0.33	11.68%	23.36%	35.03%	0.23	0.25
Mg, wt.%	1.17	0.092	0.99	1.36	0.90	1.45	7.84%	15.67%	23.51%	1.11	1.23
Mn, wt.%	0.036	0.002	0.032	0.039	0.031	0.041	4.84%	9.69%	14.53%	0.034	0.038
Mo, ppm	3.01	0.32	2.37	3.66	2.05	3.98	10.66%	21.32%	31.98%	2.86	3.16
Na, wt.%	0.257	0.013	0.230	0.283	0.216	0.297	5.23%	10.46%	15.69%	0.244	0.269
Nb, ppm	1.15	0.13	0.88	1.41	0.75	1.54	11.45%	22.90%	34.35%	1.09	1.20
Nd, ppm	30.1	2.21	25.7	34.5	23.5	36.7	7.35%	14.71%	22.06%	28.6	31.6
Ni, ppm	36.3	2.13	32.0	40.5	29.9	42.7	5.86%	11.73%	17.59%	34.5	38.1
P, wt.%	0.097	0.004	0.089	0.104	0.085	0.108	3.98%	7.96%	11.94%	0.092	0.101
Pb, ppm	5.82	0.463	4.90	6.75	4.44	7.21	7.95%	15.90%	23.85%	5.53	6.12
Rb, ppm	164	9	146	182	137	191	5.50%	11.00%	16.50%	156	172
S, wt.%	0.070	0.011	0.048	0.092	0.037	0.103	15.74%	31.49%	47.23%	0.067	0.074
Sb, ppm	0.28	0.03	0.21	0.35	0.17	0.38	12.66%	25.32%	37.98%	0.26	0.29
Sc, ppm	7.65	0.77	6.12	9.19	5.36	9.95	10.00%	20.00%	30.01%	7.27	8.04
Sm, ppm	5.21	0.54	4.14	6.28	3.60	6.82	10.31%	20.61%	30.92%	4.95	5.47
Sn, ppm	3.37	0.217	2.93	3.80	2.72	4.02	6.44%	12.87%	19.31%	3.20	3.54
Sr, ppm	60	5.3	49	70	44	75	8.84%	17.68%	26.51%	57	63
Ta, ppm	0.009	0.001	0.006	0.012	0.005	0.013	15.50%	31.01%	46.51%	0.008	0.009
Tb, ppm	0.64	0.036	0.57	0.72	0.54	0.75	5.59%	11.17%	16.76%	0.61	0.68

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
Note: intervals may appear asymmetric due to rounding.

Table 3 continued.

Constituent	Certified Value	1SD	2SD window		3SD window		Relative Standard Deviations			5% window	
			Low	High	Low	High	1RSD	2RSD	3RSD	Low	High
Aqua Regia Digestion (sample weights 0.15-50g) continued											
Th, ppm	21.1	1.63	17.8	24.4	16.2	26.0	7.74%	15.48%	23.23%	20.0	22.1
Ti, wt.%	0.366	0.034	0.298	0.435	0.264	0.469	9.34%	18.68%	28.02%	0.348	0.384
Tl, ppm	0.86	0.051	0.75	0.96	0.70	1.01	5.95%	11.89%	17.84%	0.81	0.90
U, ppm	5.91	0.347	5.22	6.60	4.87	6.95	5.87%	11.74%	17.61%	5.62	6.21
V, ppm	105	5	95	115	90	120	4.80%	9.60%	14.40%	100	110
W, ppm	2.27	0.24	1.79	2.75	1.56	2.99	10.50%	21.00%	31.51%	2.16	2.39
Y, ppm	19.3	0.72	17.9	20.7	17.1	21.4	3.72%	7.43%	11.15%	18.3	20.3
Yb, ppm	1.66	0.20	1.26	2.06	1.06	2.26	12.02%	24.03%	36.05%	1.58	1.74
Zn, ppm	63	4.1	55	71	50	75	6.57%	13.15%	19.72%	60	66
Zr, ppm	10.6	0.49	9.6	11.5	9.1	12.0	4.62%	9.24%	13.86%	10.0	11.1
Infrared Combustion											
C, wt.%	0.054	0.010	0.034	0.074	0.024	0.084	18.45%	36.90%	55.36%	0.051	0.057
S, wt.%	0.059	0.005	0.048	0.069	0.043	0.074	8.94%	17.87%	26.81%	0.056	0.062

SI unit equivalents: ppm, parts per million ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb, parts per billion.
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 copper by 4-acid digestion, where 99% of the time (1-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 43.6 and 47.3 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.*

ANOVA Study

The homogeneity of OREAS 20a has also been evaluated in an ANOVA study for all certified analytes occurring at least 20 times the lower limit of detection. No significant *p*-values were found indicating that no evidence exists that between-unit variance is greater than within-unit variance.

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 20a 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 interlaboratory certification program it can be concluded that OREAS 20a is sufficiently homogenous and is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. ALS, Brisbane, QLD, Australia
2. ALS, Lima, Peru
3. ALS, Loughrea, Galway, Ireland
4. ALS, Perth, WA, Australia
5. ALS, Vancouver, BC, Canada
6. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
7. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
8. Bureau Veritas Geoanalytical, Perth, WA, Australia
9. Inspectorate (BV), Lima, Peru
10. Intertek Genalysis, Perth, WA, Australia
11. Nagrom, Perth, WA, Australia
12. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
13. Reminex Centre de Recherche, Marrakesh, Marrakesh-Safi, Morocco
14. SGS Australia Mineral Services, Perth, WA, Australia
15. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
16. SGS Mineral Services, Townsville, QLD, Australia

PREPARER AND SUPPLIER

Certified reference material OREAS 20a is prepared, certified and supplied by:

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It is packaged in 10 and 60g units in laminated foil packets and in 1kg units in wide-mouth plastic jars.

METROLOGICAL 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 undertaken by ORE Pty Ltd) 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.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states,

"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. In other cases, ***only a comparison among different laboratories using the same method is possible. In this case, certification takes place on the basis of agreement among independent measurement results*** *(see ISO Guide 35:2006, Clause 10)."*

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. All OREAS CRMs are sourced from natural ore minerals meaning they will display similar behaviour as routine 'field' samples in the relevant measurement process. Care should be taken to ensure 'matrix matching' as close as practically achievable. The matrix and mineralisation style of the CRM is described in the 'Source Material' section and users should select appropriate CRMs matching these attributes to their field samples.

INTENDED USE

OREAS 20a is intended to cover all activities needed to produce a measurement result. This includes extraction, possible separation steps and the actual measurement process (the signal producing step). OREAS 20a may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 20a 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 20a was sourced from barren I-type hornblende-bearing granodiorite from the Late Devonian Lysterfield granodiorite complex located in the Melbourne Province of Australia. 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 for lithium borate fusion XRF and for LOI are on a 'dry sample' basis whilst all other certified values are reported on a 'sample as received' 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.

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
0	11th October, 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

11th October, 2018

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

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