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CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 20b

Granodiorite Lithogeochem / Blank (Victoria, Australia)

Accredited for compliance with ISO 17034

COA-1766-OREAS20b-R0 BUP-70-10-01 Rev:2.0	6-July-2023

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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 Fire Assay											
Au, ppb	4.3	1.78	0.7	7.9	0.0	9.6	41.66%	83.31%	125.0%	4.1	4.5
Pd, ppb	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Pt, ppb	< 5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Borate Fusion XRF											
Al_2O_3, wt.%	15.18	0.119	14.94	15.41	14.82	15.53	0.78%	1.56%	2.35%	14.42	15.94
BaO, ppm	1145	99	947	1344	848	1443	8.66%	17.32%	25.99%	1088	1203
CaO, wt.%	2.44	0.028	2.39	2.50	2.36	2.53	1.15%	2.30%	3.45%	2.32	2.57
Cr_2O_3, ppm	119	30	59	179	28	209	25.37%	50.73%	76.10%	113	125
Fe_2O_3, wt.%	4.32	0.035	4.25	4.39	4.22	4.42	0.81%	1.62%	2.43%	4.10	4.54
K_2O, wt.%	3.57	0.048	3.47	3.66	3.42	3.71	1.35%	2.69%	4.04%	3.39	3.74
MgO, wt.%	1.28	0.017	1.25	1.32	1.23	1.34	1.31%	2.62%	3.92%	1.22	1.35
MnO, wt.%	0.048	0.004	0.040	0.056	0.036	0.061	8.39%	16.78%	25.17%	0.046	0.051
Na_2O, wt.%	2.78	0.056	2.67	2.89	2.61	2.95	2.01%	4.03%	6.04%	2.64	2.92
P_2O_5, wt.%	0.195	0.005	0.184	0.205	0.179	0.210	2.65%	5.30%	7.94%	0.185	0.204
SiO_2, wt.%	68.28	0.440	67.40	69.16	66.96	69.60	0.64%	1.29%	1.93%	64.86	71.69
SO_3, wt.%	0.316	0.022	0.272	0.360	0.251	0.382	6.91%	13.81%	20.72%	0.300	0.332
SrO, ppm	207	19	170	244	151	262	8.98%	17.96%	26.94%	196	217
TiO_2, wt.%	0.629	0.014	0.601	0.656	0.588	0.669	2.16%	4.33%	6.49%	0.597	0.660
Thermogravimetry											
LOI^{1000}, wt.%	0.783	0.094	0.595	0.971	0.501	1.065	12.01%	24.03%	36.04%	0.744	0.822
Borate / Peroxide Fusion ICP											
Al, wt.%	8.08	0.230	7.62	8.54	7.39	8.77	2.84%	5.69%	8.53%	7.67	8.48
Ba, ppm	1042	39	965	1119	926	1157	3.70%	7.40%	11.11%	990	1094
Be, ppm	2.93	0.36	2.22	3.64	1.86	4.00	12.13%	24.27%	36.40%	2.79	3.08
Ca, wt.%	1.75	0.063	1.63	1.88	1.57	1.94	3.60%	7.21%	10.81%	1.67	1.84
Ce, ppm	80	3.5	73	87	69	90	4.40%	8.80%	13.20%	76	83
Co, ppm	8.41	0.750	6.91	9.91	6.16	10.66	8.92%	17.84%	26.77%	7.99	8.83
Cr, ppm	63	5.8	51	75	46	80	9.23%	18.46%	27.69%	60	66
Cs, ppm	11.7	0.39	10.9	12.5	10.6	12.9	3.35%	6.69%	10.04%	11.1	12.3
Cu, ppm	27.0	7.7	11.6	42.4	3.9	50.1	28.58%	57.15%	85.73%	25.6	28.3
Dy, ppm	5.96	0.324	5.32	6.61	4.99	6.94	5.44%	10.87%	16.31%	5.67	6.26
Er, ppm	3.07	0.228	2.61	3.52	2.38	3.75	7.44%	14.89%	22.33%	2.91	3.22
Eu, ppm	1.45	0.076	1.30	1.61	1.23	1.68	5.22%	10.44%	15.66%	1.38	1.53
Fe, wt.%	3.06	0.109	2.84	3.27	2.73	3.38	3.56%	7.12%	10.68%	2.90	3.21
Ga, ppm	21.3	1.17	19.0	23.6	17.8	24.8	5.47%	10.95%	16.42%	20.2	22.4
Gd, ppm	6.99	0.291	6.40	7.57	6.11	7.86	4.16%	8.32%	12.48%	6.64	7.34
Ge, ppm	1.84	0.29	1.26	2.42	0.97	2.71	15.78%	31.57%	47.35%	1.75	1.93
Hf, ppm	6.96	0.382	6.19	7.72	5.81	8.10	5.49%	10.98%	16.46%	6.61	7.30
Ho, ppm	1.12	0.067	0.99	1.26	0.92	1.33	5.98%	11.95%	17.93%	1.07	1.18
In, ppm	< 0.2	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/kg; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding; IND: indeterminate.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 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
Borate / Peroxide Fusion ICP continued											
K, wt.%	2.98	0.135	2.71	3.25	2.58	3.39	4.52%	9.04%	13.55%	2.83	3.13
La, ppm	38.9	1.89	35.1	42.7	33.3	44.6	4.85%	9.69%	14.54%	37.0	40.9
Li, ppm	54	6	42	66	36	72	11.13%	22.27%	33.40%	51	57
Lu, ppm	0.40	0.021	0.36	0.44	0.34	0.46	5.19%	10.37%	15.56%	0.38	0.42
Mg, wt.%	0.788	0.018	0.753	0.823	0.735	0.841	2.23%	4.46%	6.70%	0.749	0.828
Mn, wt.%	0.038	0.001	0.036	0.040	0.036	0.040	2.10%	4.19%	6.29%	0.036	0.040
Na, wt.%	2.04	0.046	1.95	2.13	1.90	2.18	2.26%	4.51%	6.77%	1.94	2.14
Nb, ppm	13.4	1.06	11.3	15.5	10.2	16.6	7.95%	15.90%	23.85%	12.7	14.1
Nd, ppm	36.5	1.41	33.7	39.3	32.3	40.7	3.87%	7.73%	11.60%	34.7	38.3
Ni, ppm	22.8	7.0	8.8	36.8	1.8	43.9	30.72%	61.44%	92.16%	21.7	24.0
P, wt.%	0.081	0.004	0.073	0.089	0.070	0.093	4.78%	9.56%	14.35%	0.077	0.085
Pb, ppm	26.8	6.3	14.2	39.3	7.9	45.6	23.46%	46.93%	70.39%	25.4	28.1
Pr, ppm	9.34	0.314	8.72	9.97	8.40	10.29	3.36%	6.71%	10.07%	8.88	9.81
Rb, ppm	176	9	158	194	149	203	5.17%	10.33%	15.50%	167	185
S, wt.%	0.129	0.010	0.109	0.149	0.099	0.159	7.78%	15.56%	23.33%	0.122	0.135
Sc, ppm	9.23	0.651	7.92	10.53	7.27	11.18	7.05%	14.10%	21.16%	8.76	9.69
Si, wt.%	31.89	1.301	29.29	34.50	27.99	35.80	4.08%	8.16%	12.24%	30.30	33.49
Sm, ppm	7.79	0.320	7.15	8.43	6.83	8.75	4.10%	8.21%	12.31%	7.40	8.18
Sn, ppm	5.21	0.374	4.46	5.96	4.09	6.33	7.17%	14.34%	21.51%	4.95	5.47
Sr, ppm	160	9	142	178	132	188	5.75%	11.49%	17.24%	152	168
Ta, ppm	1.19	0.108	0.97	1.40	0.86	1.51	9.12%	18.23%	27.35%	1.13	1.25
Tb, ppm	1.04	0.053	0.93	1.14	0.88	1.20	5.08%	10.16%	15.23%	0.99	1.09
Th, ppm	15.8	1.02	13.8	17.8	12.8	18.9	6.43%	12.87%	19.30%	15.0	16.6
Ti, wt.%	0.376	0.015	0.346	0.407	0.330	0.422	4.06%	8.12%	12.18%	0.357	0.395
Tl, ppm	1.04	0.086	0.87	1.21	0.78	1.30	8.25%	16.50%	24.75%	0.99	1.09
Tm, ppm	0.43	0.027	0.38	0.49	0.35	0.51	6.32%	12.63%	18.95%	0.41	0.45
U, ppm	4.74	0.471	3.79	5.68	3.32	6.15	9.96%	19.91%	29.87%	4.50	4.97
V, ppm	68	2.8	62	73	59	76	4.12%	8.24%	12.35%	64	71
W, ppm	11.6	1.6	8.4	14.9	6.7	16.5	13.99%	27.98%	41.98%	11.0	12.2
Y, ppm	31.5	1.55	28.4	34.6	26.9	36.2	4.92%	9.85%	14.77%	29.9	33.1
Yb, ppm	2.69	0.258	2.18	3.21	1.92	3.47	9.57%	19.13%	28.70%	2.56	2.83
Zn, ppm	83	6.6	70	96	64	103	7.88%	15.76%	23.64%	79	88
Zr, ppm	254	8	237	270	229	278	3.23%	6.45%	9.68%	241	266
4-Acid Digestion											
Ag, ppm	0.088	0.014	0.059	0.117	0.045	0.131	16.32%	32.64%	48.97%	0.084	0.092
Al, wt.%	7.63	0.285	7.06	8.20	6.78	8.49	3.73%	7.46%	11.19%	7.25	8.02
As, ppm	2.05	0.56	0.92	3.17	0.36	3.73	27.44%	54.89%	82.33%	1.95	2.15
Ba, ppm	1056	41	974	1139	933	1180	3.90%	7.80%	11.70%	1004	1109
Be, ppm	2.68	0.173	2.33	3.03	2.16	3.20	6.47%	12.93%	19.40%	2.55	2.82
Bi, ppm	0.79	0.13	0.54	1.05	0.41	1.18	16.25%	32.50%	48.75%	0.75	0.83

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 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											
Ca, wt.%	1.73	0.044	1.64	1.82	1.60	1.86	2.55%	5.10%	7.65%	1.64	1.81
Cd, ppm	0.19	0.018	0.16	0.23	0.14	0.25	9.21%	18.41%	27.62%	0.19	0.20
Ce, ppm	79	5.0	69	89	64	94	6.36%	12.72%	19.08%	75	83
Co, ppm	8.40	0.381	7.64	9.17	7.26	9.55	4.54%	9.07%	13.61%	7.98	8.82
Cr, ppm	47.9	8.5	30.9	65.0	22.3	73.5	17.80%	35.61%	53.41%	45.5	50.3
Cs, ppm	12.0	0.90	10.2	13.8	9.3	14.7	7.46%	14.91%	22.37%	11.4	12.6
Cu, ppm	22.7	1.64	19.5	26.0	17.8	27.6	7.20%	14.40%	21.60%	21.6	23.9
Dy, ppm	3.76	0.195	3.37	4.15	3.18	4.35	5.17%	10.35%	15.52%	3.57	3.95
Er, ppm	1.43	0.094	1.24	1.62	1.15	1.71	6.59%	13.18%	19.77%	1.36	1.50
Eu, ppm	1.50	0.087	1.32	1.67	1.23	1.76	5.83%	11.66%	17.48%	1.42	1.57
Fe, wt.%	2.98	0.147	2.69	3.28	2.54	3.43	4.94%	9.88%	14.82%	2.83	3.13
Ga, ppm	21.0	0.82	19.4	22.6	18.6	23.5	3.89%	7.78%	11.67%	20.0	22.1
Gd, ppm	6.09	0.260	5.57	6.61	5.31	6.87	4.26%	8.52%	12.78%	5.79	6.40
Ge, ppm	0.16	0.05	0.07	0.26	0.02	0.30	29.56%	59.13%	88.69%	0.15	0.17
Hf, ppm	1.96	0.141	1.68	2.24	1.54	2.39	7.18%	14.36%	21.54%	1.86	2.06
Ho, ppm	0.60	0.06	0.48	0.72	0.42	0.78	10.12%	20.24%	30.35%	0.57	0.63
In, ppm	0.067	0.005	0.057	0.078	0.051	0.083	7.78%	15.57%	23.35%	0.064	0.070
K, wt.%	2.95	0.070	2.81	3.09	2.74	3.15	2.37%	4.73%	7.10%	2.80	3.09
La, ppm	38.1	2.67	32.8	43.4	30.1	46.1	7.00%	13.99%	20.99%	36.2	40.0
Li, ppm	56	2.0	52	60	50	62	3.60%	7.20%	10.80%	53	58
Lu, ppm	0.17	0.03	0.12	0.22	0.10	0.25	14.70%	29.41%	44.11%	0.16	0.18
Mg, wt.%	0.749	0.033	0.683	0.814	0.650	0.847	4.39%	8.78%	13.17%	0.711	0.786
Mn, wt.%	0.036	0.001	0.034	0.039	0.032	0.040	3.65%	7.30%	10.94%	0.035	0.038
Mo, ppm	2.65	0.198	2.26	3.05	2.06	3.25	7.46%	14.93%	22.39%	2.52	2.78
Na, wt.%	2.04	0.045	1.95	2.13	1.90	2.18	2.22%	4.45%	6.67%	1.94	2.14
Nb, ppm	13.2	0.62	12.0	14.4	11.4	15.1	4.66%	9.33%	13.99%	12.6	13.9
Nd, ppm	34.5	2.25	30.0	39.0	27.8	41.3	6.51%	13.03%	19.54%	32.8	36.3
Ni, ppm	18.7	0.79	17.1	20.3	16.3	21.1	4.24%	8.49%	12.73%	17.8	19.7
P, wt.%	0.083	0.002	0.079	0.088	0.076	0.091	2.86%	5.72%	8.57%	0.079	0.088
Pb, ppm	24.5	1.11	22.3	26.7	21.2	27.8	4.53%	9.05%	13.58%	23.3	25.7
Pr, ppm	8.96	0.616	7.73	10.20	7.12	10.81	6.87%	13.74%	20.60%	8.52	9.41
Rb, ppm	173	8	157	189	150	197	4.54%	9.08%	13.61%	165	182
Re, ppm	< 0.002	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt.%	0.129	0.005	0.119	0.138	0.114	0.143	3.70%	7.40%	11.10%	0.122	0.135
Sb, ppm	0.26	0.025	0.21	0.31	0.18	0.33	9.68%	19.37%	29.05%	0.24	0.27
Sc, ppm	8.78	0.590	7.60	9.96	7.01	10.55	6.72%	13.43%	20.15%	8.34	9.22
Sm, ppm	7.15	0.416	6.31	7.98	5.90	8.40	5.83%	11.65%	17.48%	6.79	7.51
Sn, ppm	5.05	0.320	4.41	5.69	4.09	6.01	6.34%	12.67%	19.01%	4.80	5.30
Sr, ppm	161	5	151	172	146	177	3.17%	6.34%	9.52%	153	169
Ta, ppm	1.17	0.081	1.01	1.33	0.93	1.42	6.95%	13.89%	20.84%	1.11	1.23

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

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Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 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											
Tb, ppm	0.77	0.069	0.63	0.91	0.56	0.98	8.94%	17.87%	26.81%	0.73	0.81
Te, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Th, ppm	15.1	1.28	12.5	17.6	11.3	18.9	8.46%	16.93%	25.39%	14.3	15.8
Ti, wt.%	0.371	0.011	0.350	0.393	0.339	0.403	2.87%	5.74%	8.60%	0.353	0.390
Tl, ppm	0.97	0.056	0.85	1.08	0.80	1.14	5.83%	11.66%	17.50%	0.92	1.01
Tm, ppm	0.19	0.012	0.17	0.22	0.16	0.23	6.49%	12.99%	19.48%	0.18	0.20
U, ppm	4.04	0.384	3.27	4.81	2.89	5.19	9.51%	19.02%	28.53%	3.84	4.24
V, ppm	62	2.1	58	66	56	68	3.43%	6.86%	10.29%	59	65
W, ppm	11.3	1.3	8.7	13.9	7.5	15.2	11.43%	22.86%	34.29%	10.8	11.9
Y, ppm	15.8	1.49	12.8	18.8	11.3	20.2	9.46%	18.93%	28.39%	15.0	16.6
Yb, ppm	1.07	0.090	0.89	1.25	0.80	1.34	8.41%	16.82%	25.23%	1.01	1.12
Zn, ppm	82	2.4	78	87	75	89	2.90%	5.80%	8.71%	78	86
Zr, ppm	62	4.3	53	70	49	74	6.89%	13.78%	20.67%	59	65
Aqua Regia Digestion											
Ag, ppm	0.085	0.011	0.063	0.106	0.053	0.117	12.63%	25.25%	37.88%	0.081	0.089
Al, wt.%	2.15	0.105	1.94	2.36	1.84	2.47	4.88%	9.76%	14.63%	2.04	2.26
As, ppm	2.09	0.23	1.63	2.55	1.40	2.78	11.03%	22.07%	33.10%	1.98	2.19
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ba, ppm	532	20	491	573	471	594	3.84%	7.68%	11.52%	506	559
Be, ppm	1.77	0.111	1.55	1.99	1.44	2.10	6.25%	12.50%	18.75%	1.68	1.86
Bi, ppm	0.83	0.13	0.57	1.10	0.44	1.23	15.83%	31.66%	47.49%	0.79	0.87
Ca, wt.%	0.403	0.040	0.324	0.483	0.284	0.523	9.86%	19.73%	29.59%	0.383	0.423
Cd, ppm	0.084	0.012	0.061	0.107	0.050	0.119	13.75%	27.51%	41.26%	0.080	0.089
Ce, ppm	39.2	5.6	28.0	50.4	22.5	55.9	14.23%	28.47%	42.70%	37.2	41.2
Co, ppm	8.23	0.383	7.46	9.00	7.08	9.38	4.66%	9.31%	13.97%	7.82	8.64
Cr, ppm	57	3.5	50	64	46	67	6.11%	12.21%	18.32%	54	59
Cs, ppm	10.2	0.46	9.2	11.1	8.8	11.6	4.57%	9.13%	13.70%	9.7	10.7
Cu, ppm	22.5	1.26	20.0	25.0	18.7	26.3	5.58%	11.16%	16.74%	21.4	23.6
Fe, wt.%	2.87	0.082	2.71	3.04	2.63	3.12	2.87%	5.74%	8.61%	2.73	3.02
Ga, ppm	9.95	0.541	8.87	11.03	8.33	11.57	5.43%	10.87%	16.30%	9.45	10.45
Ge, ppm	0.12	0.02	0.08	0.15	0.07	0.16	13.23%	26.46%	39.69%	0.11	0.12
Hf, ppm	0.33	0.04	0.25	0.40	0.22	0.44	11.26%	22.52%	33.78%	0.31	0.34
Hg, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
In, ppm	0.063	0.004	0.055	0.071	0.051	0.075	6.49%	12.97%	19.46%	0.060	0.066
K, wt.%	1.04	0.043	0.95	1.12	0.91	1.17	4.14%	8.27%	12.41%	0.99	1.09
La, ppm	18.8	1.63	15.6	22.1	14.0	23.7	8.65%	17.30%	25.95%	17.9	19.8
Li, ppm	45.0	1.89	41.2	48.7	39.3	50.6	4.20%	8.41%	12.61%	42.7	47.2
Mg, wt.%	0.728	0.031	0.666	0.790	0.635	0.821	4.27%	8.53%	12.80%	0.692	0.764
Mn, wt.%	0.031	0.001	0.028	0.033	0.027	0.034	3.91%	7.82%	11.73%	0.029	0.032
Mo, ppm	2.31	0.151	2.01	2.61	1.86	2.76	6.52%	13.04%	19.55%	2.20	2.43

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding; IND: indeterminate.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 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
Aqua Regia Digestion continued											
Na, wt.%	0.156	0.011	0.133	0.178	0.121	0.190	7.32%	14.65%	21.97%	0.148	0.163
Nb, ppm	0.81	0.19	0.43	1.19	0.24	1.38	23.58%	47.16%	70.74%	0.77	0.85
Ni, ppm	18.5	0.59	17.3	19.7	16.7	20.2	3.17%	6.34%	9.51%	17.6	19.4
P, wt.%	0.063	0.002	0.059	0.067	0.057	0.069	3.11%	6.22%	9.33%	0.060	0.066
Pb, ppm	4.42	0.434	3.56	5.29	3.12	5.73	9.82%	19.64%	29.46%	4.20	4.65
Rb, ppm	110	3	103	116	100	119	2.95%	5.90%	8.85%	104	115
Re, ppm	< 0.001	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt.%	0.135	0.005	0.125	0.144	0.120	0.149	3.54%	7.08%	10.62%	0.128	0.141
Sb, ppm	0.13	0.02	0.09	0.17	0.06	0.20	16.84%	33.69%	50.53%	0.12	0.14
Sc, ppm	8.37	0.420	7.53	9.21	7.11	9.63	5.01%	10.02%	15.03%	7.95	8.79
Se, ppm	0.34	0.09	0.16	0.53	0.06	0.62	27.21%	54.43%	81.64%	0.32	0.36
Sn, ppm	3.85	0.135	3.58	4.12	3.44	4.25	3.51%	7.02%	10.54%	3.65	4.04
Sr, ppm	19.0	1.82	15.4	22.7	13.5	24.5	9.59%	19.19%	28.78%	18.1	20.0
Tb, ppm	0.51	0.035	0.44	0.58	0.41	0.62	6.84%	13.68%	20.53%	0.49	0.54
Th, ppm	8.07	0.99	6.10	10.04	5.11	11.02	12.21%	24.43%	36.64%	7.66	8.47
Ti, wt.%	0.292	0.020	0.251	0.333	0.230	0.353	7.03%	14.05%	21.08%	0.277	0.306
Tl, ppm	0.67	0.045	0.58	0.76	0.53	0.80	6.71%	13.41%	20.12%	0.63	0.70
U, ppm	3.52	0.279	2.97	4.08	2.69	4.36	7.92%	15.84%	23.76%	3.35	3.70
V, ppm	62	2.5	57	67	55	69	3.97%	7.95%	11.92%	59	65
W, ppm	6.95	1.25	4.45	9.46	3.19	10.71	18.03%	36.06%	54.08%	6.60	7.30
Y, ppm	10.7	0.75	9.2	12.2	8.5	13.0	6.99%	13.98%	20.97%	10.2	11.2
Yb, ppm	0.72	0.030	0.66	0.77	0.63	0.80	4.14%	8.29%	12.43%	0.68	0.75
Zn, ppm	78	5.3	68	89	63	94	6.78%	13.56%	20.34%	75	82
Zr, ppm	7.94	1.30	5.34	10.53	4.05	11.83	16.34%	32.69%	49.03%	7.54	8.34
Infrared Combustion											
C, wt.%	0.047	0.019	0.009	0.085	0.000	0.104	40.59%	81.18%	121.8%	0.045	0.049
S, wt.%	0.125	0.009	0.107	0.142	0.098	0.151	7.01%	14.03%	21.04%	0.118	0.131

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding; IND: indeterminate.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 2. Indicative Values for OREAS 20b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate Fusion XRF								
As	ppm	*< 100*	La	ppm	*< 100*	Ta	ppm	*< 100*
Bi	ppm	*< 100*	Mo	ppm	*< 100*	Th	ppm	*< 50*
Ce	ppm	*< 100*	Nb	ppm	*< 100*	TOT_XRF	wt.%	*100.17*
Cl	ppm	*112*	Nd	ppm	*< 100*	U	ppm	*< 50*
Co	ppm	*< 37*	Ni	ppm	*< 80*	V_2O_5	ppm	*101*
Cu	ppm	*< 40*	Pb	ppm	*48.0*	W	ppm	*< 100*
Dy	ppm	*< 90*	Pr	ppm	*< 100*	Y	ppm	*< 100*
Eu	ppm	*< 100*	Rb	ppm	*200*	Zn	ppm	*< 100*
F	ppm	*< 500*	Sb	ppm	*< 100*	ZrO_2	ppm	*338*
Gd	ppm	*< 100*	Sm	ppm	*< 100*			
Hf	ppm	*< 100*	Sn	ppm	*< 100*			
Borate / Peroxide Fusion ICP								
Ag	ppm	*< 5*	Cd	ppm	*< 10*	Se	ppm	*< 20*
As	ppm	*< 20*	Mo	ppm	*3.23*	Te	ppm	*< 1*
B	ppm	*< 50*	Re	ppm	*< 0.1*			
Bi	ppm	*0.81*	Sb	ppm	*< 0.5*			
4-Acid Digestion								
Se	ppm	*0.73*						
Aqua Regia Digestion								
Au	ppb	*1.8*	Ho	ppm	*0.42*	Pt	ppb	*< 1*
Dy	ppm	*2.70*	Lu	ppm	*0.092*	Sm	ppm	*4.24*
Er	ppm	*1.00*	Nd	ppm	*20.6*	Ta	ppm	*0.010*
Eu	ppm	*0.33*	Pd	ppb	*1.42*	Te	ppm	*0.029*
Gd	ppm	*3.85*	Pr	ppm	*4.80*	Tm	ppm	*0.11*

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/kg; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

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 MATERIAL

OREAS 20b has been prepared from barren I-Type hornblende-bearing granodiorite sourced from the Upper Devonian Lysterfield granodiorite complex located in south-eastern Melbourne, Australia.

PERFORMANCE GATES

Table 1 above shows intervals 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 (also see 'Intended Use' section below). Westgard Rules extend the basics of single-rule QC monitoring using multi-rules (for more information visit www.westgard.com/mltirule.htm). 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).

PHYSICAL PROPERTIES

OREAS 20b was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 3 presents the bulk density, moisture percentage and Munsell color code for OREAS 20b. These findings should be used for informational purposes only.

Table 3. Physical properties of OREAS 20b.

Bulk Density (g/L)	Moisture (%)	Munsell Notation‡	Munsell Color‡
778	0.39	N7	Light Gray

‡The Munsell Rock Colour Chart helps geologists and archeologists communicate with colour more effectively by cross-referencing ISCC-NBS colour names with unique Munsell alpha-numeric colour notations for rock colour samples.

COMMINUTION AND HOMOGENISATION PROCEDURES

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

- Drying to constant mass at 105°C;
- Crushing and multi-stage milling to >98% minus 75 microns;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 10 and 60g units in laminated foil pouches and 500g units in plastic jars.

ANALYTICAL PROGRAM

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

- Au, Pt and Pd by low level (1ppb reading resolution) fire assay with ICP-OES or MS finish (12 laboratories) and AAS finish (3 laboratories);
- Lithium borate fusion for full suite X-ray fluorescence including LOI at 1000 degrees (up to 13 laboratories depending on the element);
- Sodium peroxide fusion or lithium borate fusion for full suite ICP-OES and ICP-MS (up to 15 laboratories depending on the element);
- 4-acid (HF-HNO_3-$HClO_4$-HCl) digestion for full ICP-OES and ICP-MS elemental suites (up to 15 laboratories depending on the element);
- Aqua regia digestion for full ICP-OES and ICP-MS elemental suites (up to 15 laboratories depending on the element);
- Infra-red combustion furnace for Total C and S (15 laboratories).

For the round robin program twelve 1.6kg test units were taken at predetermined intervals during the bagging stage, immediately following final blending, 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 1.6kg test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity.

Tabulated results of all elements together with 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 20b-DataPack.1.0.230628_065456.xlsx**).

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Table 4 below) 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. 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. However, while statistics are taken into account, the exercise of a statistician's prerogative plays a significant role in identifying outliers.

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value.

The 95% Expanded Uncertainty provides a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits and is calculated according to the method in ISO Guides [5,15]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 2) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification. These major and trace element characterisation values are presented for informational purposes only.

Standard Deviation intervals (Table 1) 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.

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 (see 'Intended Use' section for more detail).

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.

Table 4. 95% Uncertainty & Tolerance Limits for OREAS 20b.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppb)	4.3	1.7	6.8	IND	IND
Pd, Palladium (ppb)	< 1	IND	IND	IND	IND
Pt, Platinum (ppb)	< 5	IND	IND	IND	IND
Borate Fusion XRF					
Al_2O_3, Aluminium(III) oxide (wt.%)	15.18	15.05	15.30	15.10	15.26
BaO, Barium oxide (ppm)	1145	1044	1247	IND	IND
CaO, Calcium oxide (wt.%)	2.44	2.41	2.48	2.43	2.46
Cr_2O_3, Chromium(III) oxide (ppm)	119	87	151	IND	IND
Fe_2O_3, Iron(III) oxide (wt.%)	4.32	4.28	4.36	4.27	4.37
K_2O, Potassium oxide (wt.%)	3.57	3.52	3.61	3.55	3.58
MgO, Magnesium oxide (wt.%)	1.28	1.26	1.30	1.27	1.30
MnO, Manganese oxide (wt.%)	0.048	0.044	0.052	IND	IND
Na_2O, Sodium oxide (wt.%)	2.78	2.74	2.83	2.76	2.81
P_2O_5, Phosphorus(V) oxide (wt.%)	0.195	0.190	0.199	0.190	0.199
SiO_2, Silicon dioxide (wt.%)	68.28	67.79	68.77	68.07	68.49
SO_3, Sulphur trioxide (wt.%)	0.316	0.294	0.338	0.305	0.328
SrO, Strontium oxide (ppm)	207	189	224	IND	IND
TiO_2, Titanium dioxide (wt.%)	0.629	0.616	0.641	0.618	0.639
Thermogravimetry					
LOI^{1000}, Loss On Ignition @1000°C (wt.%)	0.783	0.679	0.888	0.756	0.811
Borate / Peroxide Fusion ICP					
Al, Aluminium (wt.%)	8.08	7.82	8.33	7.94	8.22
Ba, Barium (ppm)	1042	1006	1078	1018	1065
Be, Beryllium (ppm)	2.93	2.40	3.47	IND	IND
Ca, Calcium (wt.%)	1.75	1.67	1.84	1.71	1.80
Ce, Cerium (ppm)	80	76	83	76	83
Co, Cobalt (ppm)	8.41	7.69	9.13	7.72	9.10
Cr, Chromium (ppm)	63	59	67	59	66
Cs, Caesium (ppm)	11.7	11.4	12.1	11.3	12.1
Cu, Copper (ppm)	27.0	15.0	39.0	IND	IND
Dy, Dysprosium (ppm)	5.96	5.49	6.44	5.53	6.40
Er, Erbium (ppm)	3.07	2.72	3.41	2.79	3.34
Eu, Europium (ppm)	1.45	1.33	1.58	1.38	1.53
Fe, Iron (wt.%)	3.06	2.97	3.14	3.00	3.12
Ga, Gallium (ppm)	21.3	20.3	22.3	20.1	22.5
Gd, Gadolinium (ppm)	6.99	6.59	7.38	6.64	7.34

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/kg; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction). IND: indeterminate (due to limited reading resolution of the methods employed; for practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of an upper bound/non-detect limit value). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Borate / Peroxide Fusion ICP continued					
Ge, Germanium (ppm)	1.84	1.52	2.17	IND	IND
Hf, Hafnium (ppm)	6.96	6.53	7.39	6.50	7.41
Ho, Holmium (ppm)	1.12	0.99	1.25	1.03	1.22
In, Indium (ppm)	< 0.2	IND	IND	IND	IND
K, Potassium (wt.%)	2.98	2.86	3.10	2.89	3.07
La, Lanthanum (ppm)	38.9	35.9	42.0	37.4	40.5
Li, Lithium (ppm)	54	45	63	50	58
Lu, Lutetium (ppm)	0.40	0.37	0.44	0.38	0.43
Mg, Magnesium (wt.%)	0.788	0.763	0.814	0.774	0.803
Mn, Manganese (wt.%)	0.038	0.037	0.039	0.037	0.039
Na, Sodium (wt.%)	2.04	1.98	2.09	1.98	2.10
Nb, Niobium (ppm)	13.4	12.5	14.3	12.8	14.0
Nd, Neodymium (ppm)	36.5	34.2	38.7	34.6	38.4
Ni, Nickel (ppm)	22.8	12.5	33.2	IND	IND
P, Phosphorus (wt.%)	0.081	0.073	0.089	0.079	0.083
Pb, Lead (ppm)	26.8	17.4	36.1	20.3	33.2
Pr, Praseodymium (ppm)	9.34	8.77	9.92	8.91	9.78
Rb, Rubidium (ppm)	176	168	183	172	180
S, Sulphur (wt.%)	0.129	0.115	0.142	IND	IND
Sc, Scandium (ppm)	9.23	8.08	10.37	7.80	10.65
Si, Silicon (wt.%)	31.89	30.67	33.12	31.44	32.35
Sm, Samarium (ppm)	7.79	7.40	8.18	7.44	8.14
Sn, Tin (ppm)	5.21	4.50	5.93	4.72	5.70
Sr, Strontium (ppm)	160	153	168	155	165
Ta, Tantalum (ppm)	1.19	1.06	1.32	IND	IND
Tb, Terbium (ppm)	1.04	0.99	1.09	0.97	1.11
Th, Thorium (ppm)	15.8	14.9	16.7	15.1	16.6
Ti, Titanium (wt.%)	0.376	0.357	0.395	0.364	0.388
Tl, Thallium (ppm)	1.04	0.85	1.23	IND	IND
Tm, Thulium (ppm)	0.43	0.39	0.48	0.39	0.47
U, Uranium (ppm)	4.74	3.93	5.54	4.32	5.15
V, Vanadium (ppm)	68	64	71	65	70
W, Tungsten (ppm)	11.6	8.8	14.5	9.9	13.3
Y, Yttrium (ppm)	31.5	29.4	33.6	29.7	33.3
Yb, Ytterbium (ppm)	2.69	2.43	2.96	2.47	2.92
Zn, Zinc (ppm)	83	74	93	79	88
Zr, Zirconium (ppm)	254	238	270	242	266

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

IND: indeterminate (due to limited reading resolution of the methods employed; for practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of an upper bound/non-detect limit value). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion					
Ag, Silver (ppm)	0.088	0.064	0.112	IND	IND
Al, Aluminium (wt.%)	7.63	7.31	7.96	7.44	7.83
As, Arsenic (ppm)	2.05	1.41	2.69	1.69	2.41
Ba, Barium (ppm)	1056	1015	1098	1036	1077
Be, Beryllium (ppm)	2.68	2.52	2.85	2.56	2.80
Bi, Bismuth (ppm)	0.79	0.62	0.97	0.63	0.95
Ca, Calcium (wt.%)	1.73	1.67	1.78	1.69	1.77
Cd, Cadmium (ppm)	0.19	0.17	0.22	0.17	0.22
Ce, Cerium (ppm)	79	73	84	74	84
Co, Cobalt (ppm)	8.40	7.89	8.91	8.14	8.66
Cr, Chromium (ppm)	47.9	42.7	53.1	45.5	50.3
Cs, Caesium (ppm)	12.0	11.3	12.8	11.6	12.4
Cu, Copper (ppm)	22.7	20.9	24.5	21.3	24.2
Dy, Dysprosium (ppm)	3.76	3.44	4.08	3.48	4.04
Er, Erbium (ppm)	1.43	1.19	1.67	IND	IND
Eu, Europium (ppm)	1.50	1.37	1.62	1.34	1.65
Fe, Iron (wt.%)	2.98	2.88	3.09	2.92	3.04
Ga, Gallium (ppm)	21.0	20.1	21.9	20.4	21.6
Gd, Gadolinium (ppm)	6.09	5.58	6.60	5.69	6.50
Ge, Germanium (ppm)	0.16	0.09	0.23	0.14	0.18
Hf, Hafnium (ppm)	1.96	1.83	2.09	1.85	2.08
Ho, Holmium (ppm)	0.60	0.52	0.68	IND	IND
In, Indium (ppm)	0.067	0.061	0.073	0.061	0.073
K, Potassium (wt.%)	2.95	2.85	3.04	2.87	3.03
La, Lanthanum (ppm)	38.1	34.5	41.7	35.9	40.4
Li, Lithium (ppm)	56	54	58	54	57
Lu, Lutetium (ppm)	0.17	0.15	0.20	IND	IND
Mg, Magnesium (wt.%)	0.749	0.719	0.778	0.731	0.767
Mn, Manganese (wt.%)	0.036	0.035	0.038	0.036	0.037
Mo, Molybdenum (ppm)	2.65	2.44	2.86	2.51	2.80
Na, Sodium (wt.%)	2.04	2.00	2.08	2.00	2.08
Nb, Niobium (ppm)	13.2	12.6	13.8	12.8	13.6
Nd, Neodymium (ppm)	34.5	31.1	38.0	31.1	38.0
Ni, Nickel (ppm)	18.7	17.8	19.6	18.1	19.4
P, Phosphorus (wt.%)	0.083	0.081	0.086	0.082	0.085
Pb, Lead (ppm)	24.5	23.2	25.8	23.5	25.5
Pr, Praseodymium (ppm)	8.96	7.97	9.95	8.23	9.70
Rb, Rubidium (ppm)	173	166	181	167	179

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

IND: indeterminate (due to limited reading resolution of the methods employed). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Re, Rhenium (ppm)	< 0.002	IND	IND	IND	IND
S, Sulphur (wt.%)	0.129	0.123	0.135	0.122	0.135
Sb, Antimony (ppm)	0.26	0.23	0.29	0.22	0.29
Sc, Scandium (ppm)	8.78	8.25	9.31	8.50	9.06
Sm, Samarium (ppm)	7.15	6.60	7.70	6.80	7.50
Sn, Tin (ppm)	5.05	4.73	5.38	4.79	5.31
Sr, Strontium (ppm)	161	155	167	158	165
Ta, Tantalum (ppm)	1.17	1.09	1.25	1.12	1.23
Tb, Terbium (ppm)	0.77	0.68	0.87	0.71	0.83
Te, Tellurium (ppm)	< 0.05	IND	IND	IND	IND
Th, Thorium (ppm)	15.1	13.8	16.4	14.4	15.8
Ti, Titanium (wt.%)	0.371	0.360	0.383	0.361	0.382
Tl, Thallium (ppm)	0.97	0.91	1.03	0.93	1.01
Tm, Thulium (ppm)	0.19	0.18	0.21	IND	IND
U, Uranium (ppm)	4.04	3.51	4.57	3.62	4.46
V, Vanadium (ppm)	62	60	65	60	64
W, Tungsten (ppm)	11.3	10.1	12.6	10.3	12.3
Y, Yttrium (ppm)	15.8	14.5	17.0	15.4	16.1
Yb, Ytterbium (ppm)	1.07	0.94	1.20	IND	IND
Zn, Zinc (ppm)	82	79	86	80	84
Zr, Zirconium (ppm)	62	58	65	59	64
Aqua Regia Digestion					
Ag, Silver (ppm)	0.085	0.069	0.101	0.076	0.094
Al, Aluminium (wt.%)	2.15	2.07	2.23	2.12	2.18
As, Arsenic (ppm)	2.09	1.72	2.46	1.73	2.45
B, Boron (ppm)	< 10	IND	IND	IND	IND
Ba, Barium (ppm)	532	518	547	522	543
Be, Beryllium (ppm)	1.77	1.65	1.89	1.72	1.82
Bi, Bismuth (ppm)	0.83	0.56	1.10	0.68	0.98
Ca, Calcium (wt.%)	0.403	0.374	0.432	0.393	0.414
Cd, Cadmium (ppm)	0.084	0.067	0.101	IND	IND
Ce, Cerium (ppm)	39.2	34.4	44.0	37.8	40.7
Co, Cobalt (ppm)	8.23	7.87	8.59	8.07	8.39
Cr, Chromium (ppm)	57	54	59	55	58
Cs, Caesium (ppm)	10.2	9.7	10.6	10.0	10.4
Cu, Copper (ppm)	22.5	21.5	23.5	21.7	23.3

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
IND: indeterminate (due to limited reading resolution of the methods employed; for practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of an upper bound/non-detect limit value). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Aqua Regia Digestion continued					
Fe, Iron (wt.%)	2.87	2.79	2.95	2.84	2.91
Ga, Gallium (ppm)	9.95	9.48	10.42	9.68	10.22
Ge, Germanium (ppm)	0.12	0.09	0.14	IND	IND
Hf, Hafnium (ppm)	0.33	0.29	0.36	0.31	0.34
Hg, Mercury (ppm)	< 0.01	IND	IND	IND	IND
In, Indium (ppm)	0.063	0.057	0.069	0.059	0.067
K, Potassium (wt.%)	1.04	1.01	1.07	1.02	1.05
La, Lanthanum (ppm)	18.8	17.6	20.1	18.2	19.5
Li, Lithium (ppm)	45.0	43.1	46.8	44.1	45.8
Mg, Magnesium (wt.%)	0.728	0.704	0.752	0.712	0.743
Mn, Manganese (wt.%)	0.031	0.030	0.032	0.030	0.032
Mo, Molybdenum (ppm)	2.31	2.09	2.54	2.14	2.48
Na, Sodium (wt.%)	0.156	0.147	0.164	0.151	0.160
Nb, Niobium (ppm)	0.81	0.55	1.07	0.74	0.87
Ni, Nickel (ppm)	18.5	17.9	19.1	18.0	19.0
P, Phosphorus (wt.%)	0.063	0.062	0.065	0.062	0.064
Pb, Lead (ppm)	4.42	4.09	4.76	4.22	4.63
Rb, Rubidium (ppm)	110	106	113	107	112
Re, Rhenium (ppm)	< 0.001	IND	IND	IND	IND
S, Sulphur (wt.%)	0.135	0.129	0.140	IND	IND
Sb, Antimony (ppm)	0.13	0.11	0.15	IND	IND
Sc, Scandium (ppm)	8.37	7.99	8.76	8.16	8.58
Se, Selenium (ppm)	0.34	0.17	0.51	IND	IND
Sn, Tin (ppm)	3.85	3.72	3.97	3.70	4.00
Sr, Strontium (ppm)	19.0	17.8	20.3	18.7	19.4
Tb, Terbium (ppm)	0.51	0.44	0.58	0.49	0.53
Th, Thorium (ppm)	8.07	7.26	8.88	7.78	8.36
Ti, Titanium (wt.%)	0.292	0.278	0.306	0.285	0.298
Tl, Thallium (ppm)	0.67	0.62	0.71	0.64	0.69
U, Uranium (ppm)	3.52	3.00	4.05	3.25	3.80
V, Vanadium (ppm)	62	60	64	61	63
W, Tungsten (ppm)	6.95	5.86	8.04	6.59	7.31
Y, Yttrium (ppm)	10.7	10.1	11.3	10.5	11.0
Yb, Ytterbium (ppm)	0.72	0.66	0.77	IND	IND
Zn, Zinc (ppm)	78	75	82	77	80
Zr, Zirconium (ppm)	7.94	7.11	8.77	7.72	8.15

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
IND: indeterminate (due to limited reading resolution of the methods employed; for practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of an upper bound/non-detect limit value). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 4. continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Infrared Combustion					
C, Carbon (wt.%)	0.047	0.030	0.063	IND	IND
S, Sulphur (wt.%)	0.125	0.114	0.135	IND	IND

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
IND: indeterminate (due to limited reading resolution of the methods employed). Note 1: intervals may appear asymmetric due to rounding. Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Tables 4 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 21.3 and 24.2 ppm. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35).

Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.

The homogeneity of OREAS 20b has also been evaluated in a **nested ANOVA** of the round robin program. Each of the fifteen 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 twelve 1.6kg 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 20b. 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.

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 extent of certified values. The null hypothesis is retained.

Only results for constituents present in concentrations well above the detection levels (i.e., >20 x Lower Limit of Detection) for the various methods undertaken were considered for the objective of evaluating homogeneity. 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 20b and whether the variance between two subsamples from the same unit is statistically distinguishable from the variance of two subsamples taken from any two separate units. A reference material therefore can possess poor absolute homogeneity yet still pass a relative homogeneity (ANOVA) 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 20b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. AGAT Laboratories, Calgary, Alberta, Canada
3. ALS, Lima, Peru
4. ALS, Loughrea, Galway, Ireland
5. ALS, Malaga, WA, Australia
6. ALS, Vancouver, BC, Canada
7. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
8. Inspectorate (BV), Lima, Peru
9. Intertek Genalysis, Perth, WA, Australia
10. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
11. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
12. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
13. SGS, Randfontein, Gauteng, South Africa
14. SGS Australia Mineral Services, Perth, WA, Australia
15. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil

PREPARER AND SUPPLIER

Certified reference material OREAS 20b was prepared, certified and supplied by:

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METROLOGICAL TRACEABILITY

The interlaboratory results that underpin the certified values are metrologically traceable to the international measurement scale (SI) of mass (either as a % mass fraction, as milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg)). In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%), parts per million (ppm) or parts per billion (ppb).

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 procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand*** *(ISO Guide 35:2017, 9.2.4c)."* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

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 naturally occurring rocks and sediments 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 20b 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 20b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 20b 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.

MINIMUM SAMPLE SIZE

To relate analytical determinations to the values in this certificate, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory (round robin) certification program. This means that different minimum sample masses should be used depending on the operationally defined methodology as follows:

- Au by fire assay: ≥25g;
- Lithium borate fusion with XRF finish including LOI at 1000 degrees: ≥0.2g;
- Peroxide fusion for full elemental suite with ICP-OES and/or MS finish: ≥0.1g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥0.5g;
- C and S by infrared combustion furnace/CS analyser: ≥0.1g.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 20b remains valid, within the specified measurement uncertainties, until March 2038, provided the CRM is handled and stored in accordance with the instructions given below. This certification is nullified if the CRM is any way changed or contaminated.

Store in a clean and cool dry place away from direct sunlight.

Long-term stability will be monitored at appropriate intervals and purchasers notified if any changes are observed. The period of validity may well be indefinite and will be reassessed prior to expiry with the aim of extending the validity if possible.

INSTRUCTIONS FOR HANDLING & 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.

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [12].

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

Single-use sachets

Following analysis, it is the manufacturer's expectation that any remaining material is discarded unless the sachet is promptly resealed. It is the user's responsibility to prevent contamination and minimise exposure to the atmosphere.

Repeat-use packaging (e.g., 500g unit sizes)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 20b contains a non-hygroscopic* matrix with an indicative value for moisture provided to enable users to check for changes to stored material by determining moisture in the user's laboratory and comparing the result to the value in Table 3 in this certificate.

The stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is negligible given its low sulphur concentration (0.125 wt.% S).

*A non-hygroscopic matrix means exposure to atmospheres significantly different, in terms of temperature and humidity, from the climate during manufacturing should have negligible impact on the precision of results. Hygroscopic moisture is the amount of adsorped moisture (weakly held H_2O- molecules on the surface of exposed material) following exposure to the local atmosphere. Usually, equilibration of material to the local atmosphere will only occur if the material is spread into a thin (~2mm thick) layer and left exposed for a period of 2 hours.

QC monitoring using multiples of the Standard Deviation (SD)

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 interlaboratory 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.

The performance gates shown in Table 1 are intended only to be used as a preliminary guide as to what a laboratory may be able to achieve. Over a period of time monitoring your own laboratory's data for this CRM, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the expanded uncertainty then generally there is no cause for concern in regard to bias.

For use with the aqua regia digestion method

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. This method is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions and 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.

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	6th July, 2023	First publication.

QMS CERTIFICATION

ORE Pty Ltd is accredited for compliance with ISO 17034.

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

CERTIFYING OFFICER

6th July, 2023

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

REFERENCES

[1] Govett, G.J.S. (1983). Handbook of Exploration Geochemistry, Volume 2: Statistics and Data Analysis in Geochemical Prospecting (Variations of accuracy and precision).

[2] ISO Guide 30:2015. Terms and definitions used in connection with reference materials.

[3] ISO Guide 31:2015. Reference materials – Contents of certificates and labels.

[4] ISO Guide 35:2017. Certification of reference materials - General and statistical principals.

[5] ISO Guide 98-3:2008. Guide to the expression of uncertainty in measurement (GUM:1995).

[6] ISO 16269-6:2014, Statistical interpretation of data – Determination of statistical tolerance intervals.

[7] ISO/TR 16476:2016, Reference Materials – Establishing and expressing metrological traceability of quantity values assigned to reference materials.

[8] ISO 17025:2017, General requirements for the competence of testing and calibration laboratories.

[9] ISO Guide 17034:2016. General requirements for the competence of reference material producers.

[10] Munsell Rock Color Book (2014). Rock-Color Chart Committee, Geological Society of America (GSA), Minnesota (USA).

[11] OREAS-BUP-70-09-11: Statistical Analysis - OREAS Evaluation Method.

[12] OREAS-TN-04-1498: Stability under transport; an experimental study of OREAS CRMs.

[13] OREAS-TN-05-1674: Long-term storage stability; an experimental study of OREAS CRMs.

[14] Thompson, A.; Taylor, B.N.; Guide for the Use of the International System of Units (SI); NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at: https://physics.nist.gov/cuu/pdf/sp811.pdf (accessed Nov 2021).

[15] Van der Veen AMH and Pauwels, J. (2001), Accred Qual Assur 6: 290-294.