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CERTIFICATE OF ANALYSIS FOR

Ni-Cu-Co Ore

(Nova Mine, Western Australia, Australia)

CERTIFIED REFERENCE MATERIAL

OREAS 86

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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	87	4.4	78	96	73	100	5.13%	10.26%	15.39%	82	91
Pd, ppb	18.3	1.6	15.2	21.4	13.6	23.0	8.56%	17.13%	25.69%	17.4	19.2
Pt, ppb	7.4	1.1	5.2	9.6	4.2	10.7	14.66%	29.32%	43.99%	7.1	7.8
Aqua Regia Digestion (sample weights 10-50g)											
Au, ppb	83	5.0	73	93	68	98	6.07%	12.15%	18.22%	79	87
Borate Fusion XRF											
Al_2O_3, wt.%	9.71	0.146	9.42	10.00	9.27	10.15	1.50%	3.00%	4.50%	9.22	10.20
CaO, wt.%	6.82	0.142	6.54	7.10	6.40	7.25	2.08%	4.16%	6.24%	6.48	7.16
Co, ppm	515	15	485	545	470	560	2.93%	5.87%	8.80%	489	541
Cr_2O_3, ppm	1097	42	1013	1180	972	1222	3.80%	7.60%	11.40%	1042	1152
Cu, wt.%	0.554	0.019	0.516	0.591	0.498	0.610	3.38%	6.77%	10.15%	0.526	0.582
Fe_2O_3, wt.%	23.55	0.279	22.99	24.10	22.71	24.38	1.19%	2.37%	3.56%	22.37	24.72
K_2O, wt.%	0.221	0.007	0.207	0.234	0.200	0.241	3.07%	6.14%	9.21%	0.210	0.232
MgO, wt.%	14.06	0.158	13.75	14.38	13.59	14.54	1.12%	2.24%	3.37%	13.36	14.77
MnO, wt.%	0.153	0.007	0.140	0.166	0.133	0.173	4.36%	8.72%	13.08%	0.145	0.160
Na_2O, wt.%	1.06	0.063	0.93	1.19	0.87	1.25	5.99%	11.99%	17.98%	1.01	1.11
Ni, wt.%	1.26	0.021	1.22	1.30	1.20	1.32	1.65%	3.31%	4.96%	1.19	1.32
P_2O_5, wt.%	0.056	0.007	0.041	0.071	0.034	0.078	13.06%	26.12%	39.18%	0.053	0.059
S, wt.%	7.02	0.111	6.79	7.24	6.68	7.35	1.58%	3.17%	4.75%	6.66	7.37
SiO_2, wt.%	38.63	0.439	37.76	39.51	37.32	39.95	1.14%	2.27%	3.41%	36.70	40.57
TiO_2, wt.%	0.394	0.013	0.368	0.420	0.355	0.433	3.31%	6.63%	9.94%	0.375	0.414
Thermogravimetry											
LOI^{1000}, wt.%	3.01	0.135	2.74	3.28	2.60	3.41	4.49%	8.98%	13.47%	2.86	3.16
Infrared Combustion											
S, wt.%	7.01	0.151	6.71	7.31	6.55	7.46	2.16%	4.32%	6.48%	6.66	7.36
***4-Acid Digestion**											
Ag, ppm	1.03	0.065	0.90	1.16	0.83	1.22	6.31%	12.61%	18.92%	0.98	1.08
Al, wt.%	5.06	0.140	4.78	5.34	4.64	5.48	2.77%	5.53%	8.30%	4.81	5.32
As, ppm	8.42	0.713	6.99	9.84	6.28	10.55	8.47%	16.94%	25.41%	8.00	8.84
Ba, ppm	80	3.2	74	87	71	90	3.97%	7.94%	11.91%	76	84
Be, ppm	0.26	0.04	0.19	0.33	0.16	0.37	13.29%	26.59%	39.88%	0.25	0.28
Bi, ppm	0.73	0.036	0.65	0.80	0.62	0.84	4.98%	9.96%	14.94%	0.69	0.76
Ca, wt.%	4.80	0.179	4.44	5.16	4.26	5.34	3.74%	7.48%	11.22%	4.56	5.04
Cd, ppm	0.40	0.029	0.34	0.46	0.32	0.49	7.12%	14.25%	21.37%	0.38	0.42
Ce, ppm	8.24	0.412	7.42	9.06	7.01	9.48	5.00%	9.99%	14.99%	7.83	8.65
Co, ppm	507	23	460	553	437	576	4.58%	9.15%	13.73%	481	532
Cr, ppm	513	60	392	634	332	694	11.76%	23.53%	35.29%	488	539
Cs, ppm	0.32	0.026	0.27	0.38	0.24	0.40	8.13%	16.27%	24.40%	0.31	0.34
Cu, wt.%	0.562	0.015	0.532	0.593	0.516	0.608	2.72%	5.44%	8.15%	0.534	0.590

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

*Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.

Note 1: intervals may appear asymmetric due to rounding.

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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**											
Dy, ppm	1.65	0.050	1.55	1.75	1.50	1.80	3.05%	6.10%	9.15%	1.57	1.73
Er, ppm	1.00	0.067	0.87	1.14	0.80	1.21	6.72%	13.45%	20.17%	0.95	1.05
Eu, ppm	0.47	0.028	0.41	0.52	0.38	0.55	5.98%	11.96%	17.95%	0.44	0.49
Fe, wt.%	16.24	0.530	15.18	17.30	14.65	17.83	3.27%	6.53%	9.80%	15.43	17.05
Ga, ppm	9.24	0.431	8.38	10.10	7.94	10.53	4.67%	9.34%	14.01%	8.78	9.70
Gd, ppm	1.54	0.132	1.28	1.80	1.14	1.94	8.57%	17.15%	25.72%	1.46	1.62
Hf, ppm	0.64	0.059	0.52	0.76	0.46	0.82	9.20%	18.40%	27.60%	0.61	0.67
Ho, ppm	0.34	0.014	0.31	0.37	0.30	0.39	4.19%	8.38%	12.56%	0.33	0.36
In, ppm	0.056	0.005	0.046	0.066	0.040	0.072	9.28%	18.56%	27.84%	0.053	0.059
K, wt.%	0.185	0.011	0.163	0.207	0.152	0.218	5.98%	11.97%	17.95%	0.176	0.194
La, ppm	3.57	0.334	2.90	4.23	2.56	4.57	9.37%	18.74%	28.12%	3.39	3.74
Li, ppm	5.96	0.251	5.46	6.47	5.21	6.72	4.20%	8.40%	12.61%	5.67	6.26
Lu, ppm	0.15	0.006	0.13	0.16	0.13	0.16	4.26%	8.51%	12.77%	0.14	0.15
Mg, wt.%	8.38	0.195	7.99	8.77	7.80	8.97	2.32%	4.64%	6.96%	7.96	8.80
Mn, wt.%	0.116	0.006	0.104	0.128	0.097	0.134	5.26%	10.53%	15.79%	0.110	0.122
Mo, ppm	2.01	0.113	1.78	2.23	1.67	2.35	5.63%	11.25%	16.88%	1.91	2.11
Na, wt.%	0.783	0.036	0.710	0.856	0.674	0.892	4.65%	9.31%	13.96%	0.744	0.822
Nb, ppm	1.17	0.090	0.99	1.35	0.90	1.44	7.71%	15.41%	23.12%	1.11	1.23
Nd, ppm	5.00	0.256	4.49	5.51	4.23	5.77	5.11%	10.23%	15.34%	4.75	5.25
Ni, wt.%	1.23	0.030	1.17	1.29	1.14	1.32	2.41%	4.82%	7.22%	1.17	1.29
P, wt.%	0.022	0.002	0.019	0.026	0.018	0.027	7.07%	14.14%	21.20%	0.021	0.024
Pb, ppm	6.24	0.515	5.21	7.27	4.69	7.78	8.26%	16.52%	24.78%	5.93	6.55
Pr, ppm	1.11	0.027	1.06	1.17	1.03	1.19	2.42%	4.83%	7.25%	1.06	1.17
Rb, ppm	5.98	0.270	5.44	6.52	5.17	6.79	4.52%	9.04%	13.56%	5.68	6.28
Re, ppm	0.095	0.007	0.082	0.108	0.075	0.115	6.90%	13.81%	20.71%	0.090	0.100
S, wt.%	6.15	0.71	4.74	7.56	4.03	8.26	11.48%	22.95%	34.43%	5.84	6.45
Sb, ppm	0.95	0.081	0.79	1.11	0.71	1.19	8.53%	17.05%	25.58%	0.90	1.00
Sc, ppm	21.7	1.46	18.7	24.6	17.3	26.0	6.74%	13.48%	20.22%	20.6	22.7
Se, ppm	17.0	1.53	13.9	20.0	12.4	21.6	8.99%	17.98%	26.97%	16.1	17.8
Sm, ppm	1.32	0.066	1.18	1.45	1.12	1.52	5.02%	10.04%	15.06%	1.25	1.38
Sn, ppm	0.60	0.047	0.51	0.69	0.46	0.74	7.82%	15.64%	23.46%	0.57	0.63
Sr, ppm	106	4	98	114	94	118	3.71%	7.42%	11.12%	101	111
Ta, ppm	0.076	0.010	0.057	0.095	0.047	0.105	12.70%	25.40%	38.10%	0.072	0.080
Tb, ppm	0.26	0.009	0.24	0.28	0.23	0.28	3.60%	7.19%	10.79%	0.24	0.27
Te, ppm	0.66	0.10	0.47	0.86	0.37	0.96	14.77%	29.55%	44.32%	0.63	0.70
Th, ppm	0.60	0.058	0.49	0.72	0.43	0.78	9.63%	19.26%	28.89%	0.57	0.63
Ti, wt.%	0.226	0.009	0.208	0.244	0.199	0.252	3.93%	7.85%	11.78%	0.215	0.237
Tl, ppm	0.050	0.005	0.041	0.060	0.036	0.064	9.43%	18.86%	28.29%	0.048	0.053
Tm, ppm	0.15	0.008	0.13	0.16	0.13	0.17	5.18%	10.36%	15.54%	0.14	0.16

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

*Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.

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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**											
U, ppm	0.51	0.034	0.44	0.58	0.41	0.61	6.62%	13.25%	19.87%	0.48	0.53
V, ppm	123	7	109	137	102	144	5.68%	11.36%	17.04%	117	129
W, ppm	0.50	0.044	0.41	0.59	0.37	0.63	8.80%	17.61%	26.41%	0.48	0.53
Y, ppm	8.73	0.288	8.16	9.31	7.87	9.60	3.30%	6.60%	9.91%	8.30	9.17
Yb, ppm	0.97	0.042	0.89	1.06	0.85	1.10	4.35%	8.70%	13.04%	0.93	1.02
Zn, ppm	80	5.5	69	91	64	97	6.81%	13.62%	20.43%	76	84
Zr, ppm	20.0	0.93	18.2	21.9	17.3	22.8	4.63%	9.25%	13.88%	19.0	21.0
Aqua Regia Digestion											
Ag, ppm	1.01	0.071	0.86	1.15	0.79	1.22	7.08%	14.16%	21.25%	0.96	1.06
Al, wt.%	3.21	0.228	2.75	3.66	2.52	3.89	7.11%	14.22%	21.33%	3.05	3.37
As, ppm	7.72	0.531	6.66	8.79	6.13	9.32	6.88%	13.76%	20.64%	7.34	8.11
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Be, ppm	0.13	0.03	0.07	0.19	0.03	0.22	24.10%	48.19%	72.29%	0.12	0.13
Bi, ppm	0.65	0.048	0.55	0.74	0.50	0.79	7.41%	14.82%	22.22%	0.62	0.68
Ca, wt.%	2.31	0.37	1.56	3.06	1.19	3.43	16.18%	32.36%	48.54%	2.19	2.43
Cd, ppm	0.26	0.022	0.22	0.31	0.20	0.33	8.30%	16.60%	24.90%	0.25	0.28
Ce, ppm	3.97	0.69	2.58	5.36	1.89	6.05	17.49%	34.97%	52.46%	3.77	4.17
Co, ppm	467	33	401	534	368	567	7.10%	14.21%	21.31%	444	491
Cr, ppm	145	29	87	203	58	232	19.97%	39.95%	59.92%	138	152
Cs, ppm	0.28	0.024	0.23	0.33	0.21	0.35	8.54%	17.08%	25.62%	0.27	0.30
Cu, wt.%	0.532	0.033	0.466	0.597	0.433	0.630	6.18%	12.36%	18.53%	0.505	0.558
Dy, ppm	0.58	0.15	0.29	0.88	0.14	1.03	25.40%	50.81%	76.21%	0.55	0.61
Er, ppm	0.33	0.10	0.14	0.53	0.04	0.63	29.44%	58.89%	88.33%	0.32	0.35
Eu, ppm	0.26	0.05	0.15	0.36	0.10	0.41	20.05%	40.09%	60.14%	0.24	0.27
Fe, wt.%	12.27	0.563	11.14	13.39	10.58	13.96	4.59%	9.18%	13.77%	11.65	12.88
Ga, ppm	4.57	0.47	3.63	5.51	3.17	5.97	10.24%	20.47%	30.71%	4.34	4.80
Gd, ppm	0.61	0.13	0.35	0.87	0.21	1.00	21.60%	43.20%	64.79%	0.58	0.64
Ge, ppm	0.16	0.03	0.10	0.23	0.07	0.26	18.75%	37.49%	56.24%	0.16	0.17
Hf, ppm	0.12	0.04	0.04	0.21	0.00	0.25	32.64%	65.29%	97.93%	0.12	0.13
Ho, ppm	0.12	0.03	0.05	0.19	0.02	0.22	28.08%	56.17%	84.25%	0.11	0.12
In, ppm	0.025	0.004	0.018	0.032	0.015	0.036	13.97%	27.93%	41.90%	0.024	0.027
K, wt.%	0.117	0.008	0.102	0.132	0.094	0.140	6.49%	12.99%	19.48%	0.111	0.123
La, ppm	1.83	0.31	1.22	2.44	0.92	2.75	16.66%	33.32%	49.98%	1.74	1.92
Li, ppm	2.77	0.42	1.93	3.61	1.50	4.03	15.23%	30.46%	45.69%	2.63	2.91
Mg, wt.%	3.46	0.233	3.00	3.93	2.77	4.16	6.72%	13.44%	20.17%	3.29	3.64
Mn, wt.%	0.040	0.004	0.032	0.047	0.028	0.051	9.41%	18.83%	28.24%	0.038	0.042
Mo, ppm	1.78	0.101	1.58	1.98	1.48	2.08	5.67%	11.34%	17.00%	1.69	1.87
Na, wt.%	0.504	0.071	0.363	0.646	0.292	0.717	14.07%	28.13%	42.20%	0.479	0.530
Nd, ppm	2.19	0.54	1.11	3.28	0.56	3.82	24.77%	49.55%	74.32%	2.08	2.30

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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											
Ni, wt.%	1.21	0.066	1.07	1.34	1.01	1.41	5.48%	10.96%	16.44%	1.15	1.27
P, wt.%	0.020	0.001	0.018	0.023	0.017	0.024	6.00%	11.99%	17.99%	0.019	0.021
Pb, ppm	4.21	0.46	3.29	5.14	2.82	5.61	11.01%	22.03%	33.04%	4.00	4.43
Pd, ppb	16.3	2.9	10.4	22.1	7.4	25.1	18.06%	36.13%	54.19%	15.4	17.1
Pr, ppm	0.51	0.10	0.31	0.71	0.20	0.82	19.98%	39.96%	59.94%	0.48	0.54
Rb, ppm	4.49	0.424	3.64	5.34	3.22	5.76	9.45%	18.90%	28.36%	4.26	4.71
Re, ppm	0.089	0.007	0.074	0.103	0.067	0.111	8.23%	16.46%	24.69%	0.084	0.093
S, wt.%	5.66	1.07	3.52	7.80	2.45	8.87	18.92%	37.84%	56.76%	5.37	5.94
Sb, ppm	0.38	0.06	0.26	0.50	0.20	0.56	15.85%	31.71%	47.56%	0.36	0.40
Sc, ppm	4.13	0.68	2.77	5.49	2.09	6.17	16.44%	32.89%	49.33%	3.93	4.34
Se, ppm	16.5	1.53	13.4	19.6	11.9	21.1	9.31%	18.62%	27.93%	15.7	17.3
Sm, ppm	0.52	0.13	0.27	0.78	0.14	0.91	24.53%	49.07%	73.60%	0.50	0.55
Sn, ppm	0.28	0.03	0.22	0.34	0.19	0.37	10.75%	21.49%	32.24%	0.27	0.29
Sr, ppm	76	10	56	96	46	106	13.13%	26.26%	39.39%	72	80
Ta, ppm	< 0.005	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.088	0.027	0.034	0.141	0.007	0.168	30.49%	60.97%	91.46%	0.083	0.092
Te, ppm	0.64	0.08	0.48	0.80	0.40	0.89	12.78%	25.56%	38.33%	0.61	0.67
Th, ppm	0.33	0.06	0.21	0.45	0.15	0.51	18.18%	36.37%	54.55%	0.31	0.34
Tl, ppm	0.036	0.005	0.026	0.046	0.021	0.051	14.05%	28.10%	42.16%	0.034	0.038
U, ppm	0.42	0.024	0.37	0.47	0.34	0.49	5.86%	11.72%	17.58%	0.40	0.44
V, ppm	39.8	7.4	24.9	54.6	17.5	62.0	18.66%	37.32%	55.98%	37.8	41.8
W, ppm	0.19	0.013	0.17	0.22	0.16	0.23	6.52%	13.05%	19.57%	0.18	0.20
Y, ppm	3.29	0.78	1.73	4.85	0.95	5.64	23.74%	47.48%	71.22%	3.13	3.46
Zn, ppm	22.1	2.5	17.0	27.2	14.5	29.7	11.46%	22.91%	34.37%	21.0	23.2
Zr, ppm	4.45	0.66	3.13	5.76	2.48	6.42	14.76%	29.53%	44.29%	4.23	4.67

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).
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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. In evaluating laboratory performance with this CRM, the section headed 'Intended Use' should be read carefully.

Table 1 provides performance gate intervals for the 136 certified values. Table 2 shows 42 indicative values, Table 3 provides some indicative physical properties and Table 4 presents the 95% confidence and tolerance limits for all certified values. Table 5 presents gold homogeneity (via INAA) and is also demonstrated by a nested ANOVA program using both fire assay and aqua regia digestion data (see 'Homogeneity Evaluation' section).

Tabulated results of all elements (including Au INAA analyses) 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 86-DataPack.1.0.210212_155552.xlsx**).

Results for Ni, Cu and Co by borate fusion with XRF are also presented in scatter plots (Figures 1 to 3, respectively) together with ±3SD (magenta) and ±5% (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

SOURCE MATERIAL

OREAS 86 was prepared from Ni-Cu-Co ore grade drill core samples sourced from the Nova Mine in Western Australia. The Nova Mine, owned and operated by Independence Group (IGO), is located in the Fraser Range, approximately 160km east-northeast of Norseman, 360km southeast of Kalgoorlie and 380km from the Port of Esperance in Western Australia. OREAS 86 is one of two Ni-Cu-Co ore CRMs prepared (the other is the lower grade 'OREAS 85').

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).

Table 2. Indicative Values for OREAS 86.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate Fusion XRF								
As	ppm	*< 100*	Hg	ppm	*< 100*	Sn	ppm	*< 50*
Ba	ppm	*104*	In	ppm	*< 100*	Sr	ppm	*85*
Bi	ppm	*< 100*	La	ppm	*< 90*	Ta	ppm	*< 100*
Cd	ppm	*< 100*	Mo	ppm	*< 50*	Te	ppm	*< 100*
Ce	ppm	*< 80*	Nb	ppm	*68*	Tl	ppm	*< 100*
Cl	ppm	*200*	Pb	ppm	*< 50*	V_2O_5	ppm	*206*
Cs	ppm	*< 100*	Rb	ppm	*< 50*	W	ppm	*< 10*
Ga	ppm	*< 100*	Sb	ppm	*< 50*	Y	ppm	*< 39*
Ge	ppm	*< 100*	Sc	ppm	*< 40*	Zn	ppm	*80*
Hf	ppm	*< 80*	Se	ppm	*< 100*	Zr	ppm	*362*
Infrared Combustion								
C	wt.%	*0.186*						
***4-Acid Digestion**								
Ge	ppm	*0.61*	Hg	ppm	*0.18*			
Aqua Regia Digestion								
Ba	ppm	*32.9*	Nb	ppm	*0.035*	Ti	wt.%	*0.074*
Hg	ppm	*0.009*	Pt	ppb	*3.40*	Tm	ppm	*0.052*
Lu	ppm	*0.047*	Si	wt.%	*0.089*	Yb	ppm	*0.32*

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).
*Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.
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.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 86 was prepared in the following manner:

- Drying to constant mass at 85°C;
- Multi-stage milling to 100% passing 30 microns;
- Homogenisation;
- Packaging into 60g units sealed under nitrogen in laminated foil pouches.

PHYSICAL PROPERTIES

OREAS 86 was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 3 presents these findings that should be used for informational purposes only.

Table 3. Physical properties of OREAS 86.

Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
854.5	0.60	N4	Medium Dark Gray

‡The Munsell Rock Color 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.

ANALYTICAL PROGRAM

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

- Au, Pd and Pt by 25-50g Pb collection fire assay with ICP-MS (11 laboratories), ICP-OES (5 laboratories) or AAS finish (2 laboratories);
- Gold via 15-50g aqua regia digestion with ICP OES/MS finish (10 laboratories) or AAS (1 laboratory) finish;
- Al_2O_3, CaO, Co, Cu, Fe_2O_3, K_2O, MgO, Na_2O, Ni, P_2O_5, S, SiO_2 and TiO_2 by lithium borate fusion with XRF finish (up to 17 laboratories depending on the analyte except for 2 laboratories who used pressed powder pellet with XRF);
- Loss on ignition at 1000° Celsius (17 laboratories);
- Total Sulphur by infrared combustion furnace (17 laboratories);
- 4-Acid digestion for full elemental suite ICP-OES/MS finish (up to 19 laboratories depending on the element);
- Aqua regia digestion for full elemental suite ICP-OES/MS and AAS finish (up to 18 laboratories depending on the element);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (ANSTO, Lucas Heights, Australia).

For the round robin program ten 1.5kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 120g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 120g samples from each of three separate 1.5kg 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.

STATISTICAL ANALYSIS

Standard Deviation intervals (see 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.***

Certified Values, Confidence Limits and Tolerance Limits (Table 4) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration).

For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. In certain instances, statistician's prerogative has been employed in discriminating outliers.

Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status.

Certified Values are the means of accepted laboratory means after outlier filtering. The INAA data (see Table 5) is omitted from determination of the certified value for Au and is used solely for the calculation of Tolerance Limits and homogeneity evaluation of OREAS 86 (see 'Homogeneity Evaluation' section below).

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 present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

Homogeneity Evaluation

For analytes other than gold the tolerance limits (ISO 16269:2014) shown in Table 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 ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 0.0.548 and 0.577 wt.%. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35). ***Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.***

Table 4. 95% Confidence & Tolerance Limits for OREAS 86.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Fire Assay					
Au, Gold (ppb)	87	85	88	85*	88*
Pd, Palladium (ppb)	18.3	17.5	19.1	17.2	19.4
Pt, Platinum (ppb)	7.4	7.0	7.9	6.8	8.0
Aqua Regia Digestion (sample weights 10-50g)					
Au, Gold (ppb)	83	80	86	81*	85*
Borate Fusion XRF					
Al_2O_3, Aluminium(III) oxide (wt.%)	9.71	9.63	9.79	9.64	9.78
CaO, Calcium oxide (wt.%)	6.82	6.74	6.90	6.78	6.86
Co, Cobalt (ppm)	515	506	525	501	529
Cr_2O_3, Chromium(III) oxide (ppm)	1097	1073	1120	1054	1140
Cu, Copper (wt.%)	0.554	0.544	0.564	0.547	0.561
Fe_2O_3, Iron(III) oxide (wt.%)	23.55	23.39	23.70	23.41	23.68
K_2O, Potassium oxide (wt.%)	0.221	0.217	0.224	0.217	0.225
MgO, Magnesium oxide (wt.%)	14.06	13.98	14.15	13.99	14.14
MnO, Manganese oxide (wt.%)	0.153	0.146	0.159	IND	IND
Na_2O, Sodium oxide (wt.%)	1.06	1.01	1.11	1.04	1.08
Ni, Nickel (wt.%)	1.26	1.25	1.27	1.24	1.27
P_2O_5, Phosphorus(V) oxide (wt.%)	0.056	0.052	0.060	0.053	0.059
S, Sulphur (wt.%)	7.02	6.94	7.09	6.94	7.09
SiO_2, Silicon dioxide (wt.%)	38.63	38.41	38.86	38.41	38.86
TiO_2, Titanium dioxide (wt.%)	0.394	0.387	0.402	0.387	0.402
Thermogravimetry					
LOI^{1000}, Loss on ignition @1000°C (wt.%)	3.01	2.93	3.09	2.94	3.07
Infrared Combustion					
S, Sulphur (wt.%)	7.01	6.93	7.09	6.94	7.07
†4-Acid Digestion					
Ag, Silver (ppm)	1.03	1.00	1.06	1.00	1.05
Al, Aluminium (wt.%)	5.06	5.00	5.12	4.96	5.17
As, Arsenic (ppm)	8.42	7.92	8.91	8.06	8.78
Ba, Barium (ppm)	80	79	82	78	83
Be, Beryllium (ppm)	0.26	0.25	0.28	0.22	0.31
Bi, Bismuth (ppm)	0.73	0.71	0.75	0.70	0.76
Ca, Calcium (wt.%)	4.80	4.71	4.89	4.68	4.91
Cd, Cadmium (ppm)	0.40	0.39	0.41	0.37	0.43
Ce, Cerium (ppm)	8.24	8.03	8.45	7.93	8.55

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

*Gold Tolerance Limits for typical 30g fire assay, 25g aqua regia digestion and 200g cyanide leach methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

†Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.

Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
†4-Acid Digestion continued					
Co, Cobalt (ppm)	507	496	518	493	520
Cr, Chromium (ppm)	513	483	544	483	543
Cs, Caesium (ppm)	0.32	0.31	0.34	0.30	0.34
Cu, Copper (wt.%)	0.562	0.556	0.568	0.548	0.577
Dy, Dysprosium (ppm)	1.65	1.61	1.69	1.60	1.70
Er, Erbium (ppm)	1.00	0.95	1.06	0.96	1.04
Eu, Europium (ppm)	0.47	0.44	0.49	0.45	0.49
Fe, Iron (wt.%)	16.24	15.99	16.49	15.76	16.71
Ga, Gallium (ppm)	9.24	9.01	9.47	8.95	9.53
Gd, Gadolinium (ppm)	1.54	1.45	1.63	1.48	1.60
Hf, Hafnium (ppm)	0.64	0.61	0.67	0.61	0.67
Ho, Holmium (ppm)	0.34	0.34	0.35	0.33	0.36
In, Indium (ppm)	0.056	0.054	0.058	0.049	0.063
K, Potassium (wt.%)	0.185	0.180	0.190	0.179	0.191
La, Lanthanum (ppm)	3.57	3.40	3.73	3.46	3.67
Li, Lithium (ppm)	5.96	5.84	6.09	5.67	6.26
Lu, Lutetium (ppm)	0.15	0.14	0.15	IND	IND
Mg, Magnesium (wt.%)	8.38	8.31	8.45	8.23	8.53
Mn, Manganese (wt.%)	0.116	0.113	0.119	0.114	0.118
Mo, Molybdenum (ppm)	2.01	1.94	2.07	1.92	2.09
Na, Sodium (wt.%)	0.783	0.765	0.801	0.767	0.799
Nb, Niobium (ppm)	1.17	1.12	1.21	1.13	1.21
Nd, Neodymium (ppm)	5.00	4.80	5.20	4.85	5.15
Ni, Nickel (wt.%)	1.23	1.21	1.24	1.20	1.26
P, Phosphorus (wt.%)	0.022	0.022	0.023	0.021	0.023
Pb, Lead (ppm)	6.24	5.92	6.56	5.93	6.55
Pr, Praseodymium (ppm)	1.11	1.09	1.13	1.08	1.14
Rb, Rubidium (ppm)	5.98	5.85	6.11	5.80	6.15
Re, Rhenium (ppm)	0.095	0.092	0.098	0.089	0.101
S, Sulphur (wt.%)	6.15	5.79	6.50	5.97	6.33
Sb, Antimony (ppm)	0.95	0.90	1.00	0.88	1.02
Sc, Scandium (ppm)	21.7	21.0	22.3	20.8	22.5
Se, Selenium (ppm)	17.0	16.4	17.6	15.9	18.1
Sm, Samarium (ppm)	1.32	1.28	1.35	1.26	1.37
Sn, Tin (ppm)	0.60	0.58	0.62	IND	IND
Sr, Strontium (ppm)	106	104	108	102	110

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

†Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.

Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
†4-Acid Digestion continued					
Ta, Tantalum (ppm)	0.076	0.069	0.083	IND	IND
Tb, Terbium (ppm)	0.26	0.25	0.26	0.24	0.27
Te, Tellurium (ppm)	0.66	0.62	0.70	0.59	0.74
Th, Thorium (ppm)	0.60	0.57	0.63	0.57	0.63
Ti, Titanium (wt.%)	0.226	0.222	0.230	0.219	0.232
Tl, Thallium (ppm)	0.050	0.049	0.052	IND	IND
Tm, Thulium (ppm)	0.15	0.14	0.15	IND	IND
U, Uranium (ppm)	0.51	0.50	0.52	0.47	0.55
V, Vanadium (ppm)	123	119	126	120	126
W, Tungsten (ppm)	0.50	0.49	0.51	IND	IND
Y, Yttrium (ppm)	8.73	8.59	8.87	8.41	9.05
Yb, Ytterbium (ppm)	0.97	0.95	1.00	0.93	1.02
Zn, Zinc (ppm)	80	78	83	78	83
Zr, Zirconium (ppm)	20.0	19.6	20.5	19.3	20.8
Aqua Regia Digestion					
Ag, Silver (ppm)	1.01	0.97	1.05	0.97	1.05
Al, Aluminium (wt.%)	3.21	3.10	3.32	3.10	3.32
As, Arsenic (ppm)	7.72	7.40	8.05	7.36	8.09
B, Boron (ppm)	< 10	IND	IND	IND	IND
Be, Beryllium (ppm)	0.13	0.10	0.15	IND	IND
Bi, Bismuth (ppm)	0.65	0.62	0.68	0.62	0.68
Ca, Calcium (wt.%)	2.31	2.13	2.49	2.24	2.38
Cd, Cadmium (ppm)	0.26	0.25	0.27	0.24	0.28
Ce, Cerium (ppm)	3.97	3.60	4.34	3.75	4.19
Co, Cobalt (ppm)	467	451	484	454	481
Cr, Chromium (ppm)	145	129	161	139	151
Cs, Caesium (ppm)	0.28	0.27	0.30	0.27	0.30
Cu, Copper (wt.%)	0.532	0.515	0.548	0.519	0.544
Dy, Dysprosium (ppm)	0.58	0.42	0.74	0.54	0.63
Er, Erbium (ppm)	0.33	0.24	0.43	0.31	0.36
Eu, Europium (ppm)	0.26	0.20	0.31	0.24	0.27
Fe, Iron (wt.%)	12.27	11.99	12.54	11.95	12.59
Ga, Gallium (ppm)	4.57	4.34	4.80	4.31	4.83
Gd, Gadolinium (ppm)	0.61	0.46	0.76	0.58	0.64
Ge, Germanium (ppm)	0.16	0.12	0.21	0.15	0.18
Hf, Hafnium (ppm)	0.12	0.10	0.15	0.11	0.14

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

†Four acid digestion quantitatively dissolves nearly all minerals in the majority of geological samples however, some refractory minerals may only be partially digested.

Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Ho, Holmium (ppm)	0.12	0.09	0.15	0.11	0.13
In, Indium (ppm)	0.025	0.023	0.027	0.022	0.028
K, Potassium (wt.%)	0.117	0.114	0.120	0.111	0.123
La, Lanthanum (ppm)	1.83	1.68	1.99	1.75	1.91
Li, Lithium (ppm)	2.77	2.54	3.00	2.59	2.95
Mg, Magnesium (wt.%)	3.46	3.34	3.58	3.35	3.57
Mn, Manganese (wt.%)	0.040	0.038	0.042	0.038	0.041
Mo, Molybdenum (ppm)	1.78	1.72	1.84	1.71	1.85
Na, Sodium (wt.%)	0.504	0.468	0.541	0.482	0.527
Nd, Neodymium (ppm)	2.19	1.72	2.66	2.10	2.28
Ni, Nickel (wt.%)	1.21	1.17	1.25	1.18	1.24
P, Phosphorus (wt.%)	0.020	0.020	0.021	0.019	0.022
Pb, Lead (ppm)	4.21	3.94	4.49	4.01	4.42
Pd, Palladium (ppb)	16.3	14.4	18.1	IND	IND
Pr, Praseodymium (ppm)	0.51	0.40	0.62	0.48	0.54
Rb, Rubidium (ppm)	4.49	4.24	4.74	4.29	4.69
Re, Rhenium (ppm)	0.089	0.084	0.093	0.084	0.094
S, Sulphur (wt.%)	5.66	5.02	6.30	5.46	5.85
Sb, Antimony (ppm)	0.38	0.35	0.41	0.35	0.41
Sc, Scandium (ppm)	4.13	3.69	4.58	3.95	4.32
Se, Selenium (ppm)	16.5	15.6	17.3	15.6	17.4
Sm, Samarium (ppm)	0.52	0.38	0.66	0.48	0.57
Sn, Tin (ppm)	0.28	0.26	0.30	0.25	0.31
Sr, Strontium (ppm)	76	71	81	74	78
Ta, Tantalum (ppm)	< 0.005	IND	IND	IND	IND
Tb, Terbium (ppm)	0.088	0.062	0.114	0.078	0.098
Te, Tellurium (ppm)	0.64	0.60	0.68	0.58	0.70
Th, Thorium (ppm)	0.33	0.28	0.37	0.32	0.34
Tl, Thallium (ppm)	0.036	0.034	0.039	0.033	0.039
U, Uranium (ppm)	0.42	0.40	0.43	0.40	0.44
V, Vanadium (ppm)	39.8	35.9	43.7	37.6	42.0
W, Tungsten (ppm)	0.19	0.18	0.20	0.18	0.21
Y, Yttrium (ppm)	3.29	2.86	3.72	3.13	3.45
Zn, Zinc (ppm)	22.1	20.7	23.5	20.9	23.3
Zr, Zirconium (ppm)	4.45	4.04	4.86	4.12	4.77

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 5 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 86. An equivalent scaled version of the results is also provided to demonstrate the level of repeatability that would be achieved if 30g fire assay determinations were undertaken without the normal measurement error associated with this methodology. The homogeneity of gold has been determined by INAA using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material (i.e., sampling error) and measurement error becomes negligible. In this instance a subsample weight of 85 milligrams was employed and the 1RSD of 0.55% was calculated for a 30g fire assay sample (10.38% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 86.

Table 5. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples and showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.

Replicate No	Au 85mg actual	Au 30g equivalent*
1	0.090	0.089
2	0.079	0.089
3	0.102	0.090
4	0.111	0.091
5	0.085	0.089
6	0.082	0.089
7	0.081	0.089
8	0.088	0.089
9	0.086	0.089
10	0.096	0.090
11	0.100	0.090
12	0.100	0.090
13	0.083	0.089
14	0.085	0.089
15	0.074	0.089
16	0.090	0.089
17	0.095	0.090
18	0.086	0.089
19	0.080	0.089
20	0.094	0.090
Mean	0.089	0.089
Median	0.087	0.089
Std Dev.	0.009	0.000
Rel.Std.Dev.	**10.38%**	**0.55%**

*Results calculated for a 30g equivalent sample mass using the formula: $x^{30g\ Eq} = \frac{(x^{INAA} - \bar{X}) \times RSD@30g}{RSD@85mg} + \bar{X}$

where $x^{30g\ Eq}$ = equivalent result calculated for a 30g sample mass
(x^{INAA}) = raw INAA result at 85mg
$\bar{X}$ = mean of 85mg INAA results

The homogeneity of OREAS 86 has also been evaluated in a **nested ANOVA** of the round robin program. Each of the forty-two round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation is to test that no statistically significant difference exists in the variance between units to that of the variance within units. This allows an assessment of homogeneity across the entire prepared batch of OREAS 86. The test was performed using the following parameters:

- Gold fire assay – 108 samples (18 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 66 samples (11 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, H_0: Between-unit variance is no greater than within-unit variance (reject H_0 if p-value < 0.05);
- Alternative Hypothesis, H_1: Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of the *p*-value. This process derived *p*-values of 0.71 for Au by fire assay, 0.96 for Au by aqua regia digestion. Both *p*-values are insignificant and the Null Hypothesis is retained. Additionally, none of the other certified values showed significant *p*-values.

Please note that 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 86 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 86 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, Brisbane, QLD, Australia
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Vancouver, BC, Canada
7. American Assay Laboratories, Sparks, Nevada, USA

8. ANSTO, Lucas Heights, NSW, Australia
9. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
12. Bureau Veritas Geoanalytical, Cardiff, NSW, Australia
13. Bureau Veritas Geoanalytical, Perth, WA, Australia
14. Intertek Genalysis, Adelaide, SA, Australia
15. Intertek Genalysis, Perth, WA, Australia
16. Intertek Testing Services, Townsville, QLD, Australia
17. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
18. Labtium Oy, Sodankyla, Finland
19. MinAnalytical Services, Perth, WA, Australia
20. Nagrom, Perth, WA, Australia
21. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
22. SGS Australia Mineral Services, Perth, WA, Australia

Please note: To preserve anonymity, the above numbered alphabetical list of participating laboratories does not correspond with the Lab ID numbering on the scatter plots below.

PREPARER AND SUPPLIER

Certified reference material OREAS 85 was prepared, certified and supplied by:

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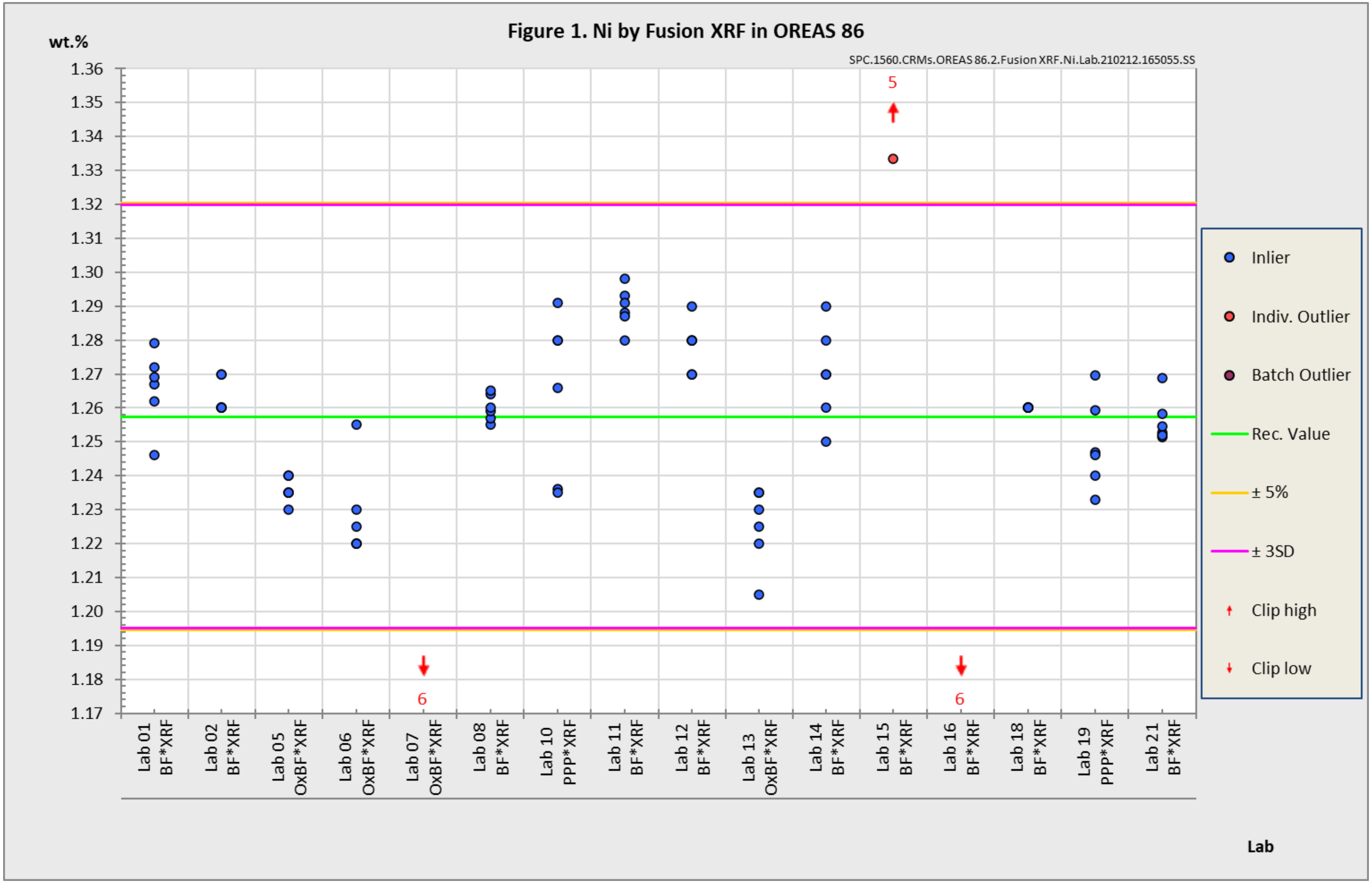
Figure 1. Ni by Fusion XRF in OREAS 86
wt.%
SPC.1560.CRMs.OREAS 86.2.Fusion XRF.Ni.Lab.210212.165055.SS
1.36
1.35
1.34
1.33
1.32
1.31
1.30
1.29
1.28
1.27
1.26
1.25
1.24
1.23
1.22
1.21
1.20
1.19
1.18
1.17
5
6
6
Lab 01 BF*XRF
Lab 02 BF*XRF
Lab 05 OxBF*XRF
Lab 06 OxBF*XRF
Lab 07 OxBF*XRF
Lab 08 BF*XRF
Lab 10 PPP*XRF
Lab 11 BF*XRF
Lab 12 BF*XRF
Lab 13 OxBF*XRF
Lab 14 BF*XRF
Lab 15 BF*XRF
Lab 16 BF*XRF
Lab 18 BF*XRF
Lab 19 PPP*XRF
Lab 21 BF*XRF
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Clip high
Clip low
Lab

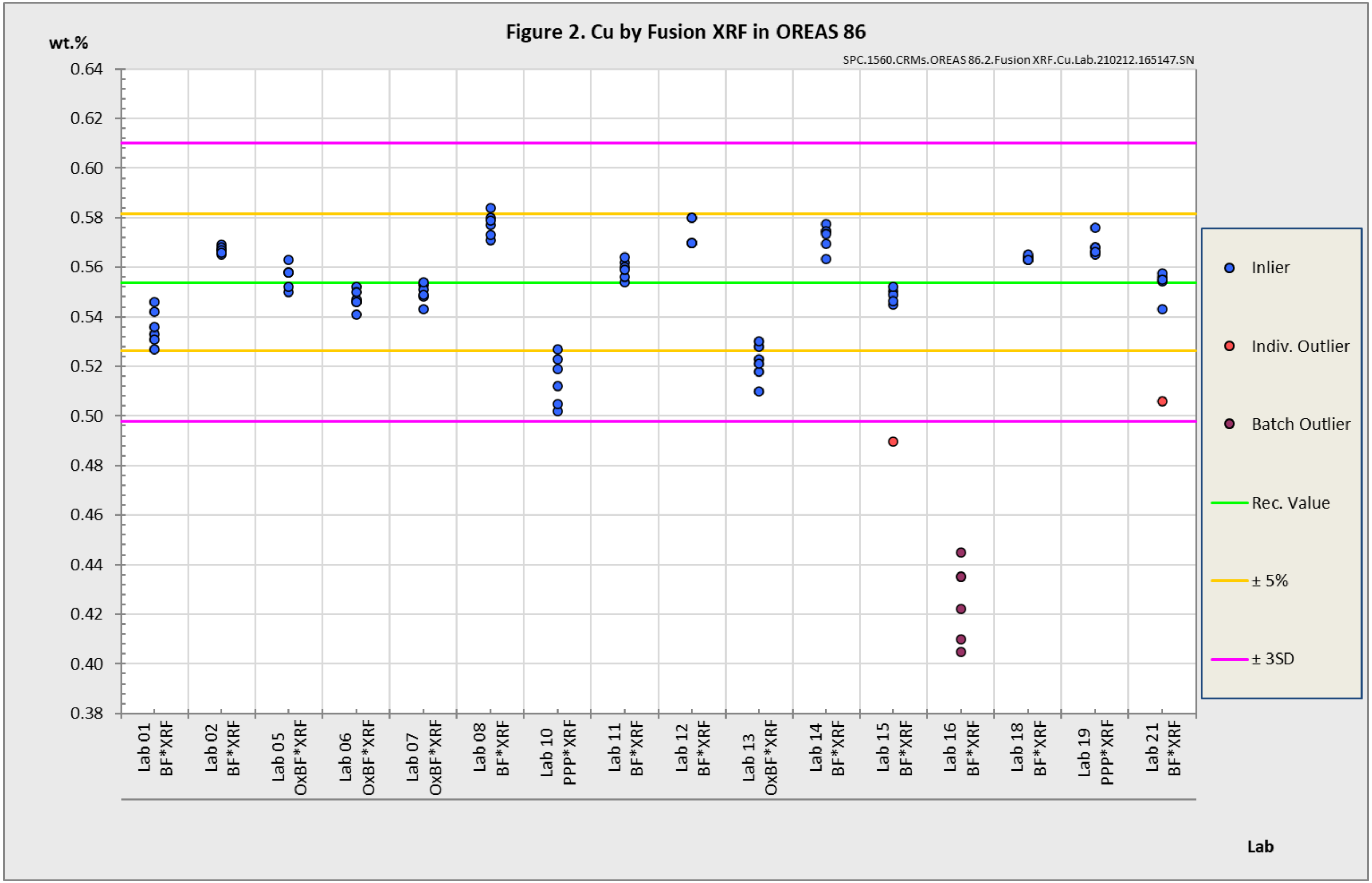
Figure 2. Cu by Fusion XRF in OREAS 86
wt.%
SPC.1560.CRMs.OREAS 86.2.Fusion XRF.Cu.Lab.210212.165147.SN
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
Lab 01 BF*XRF
Lab 02 BF*XRF
Lab 05 OxBF*XRF
Lab 06 OxBF*XRF
Lab 07 OxBF*XRF
Lab 08 BF*XRF
Lab 10 PPP*XRF
Lab 11 BF*XRF
Lab 12 BF*XRF
Lab 13 OxBF*XRF
Lab 14 BF*XRF
Lab 15 BF*XRF
Lab 16 BF*XRF
Lab 18 BF*XRF
Lab 19 PPP*XRF
Lab 21 BF*XRF
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Lab

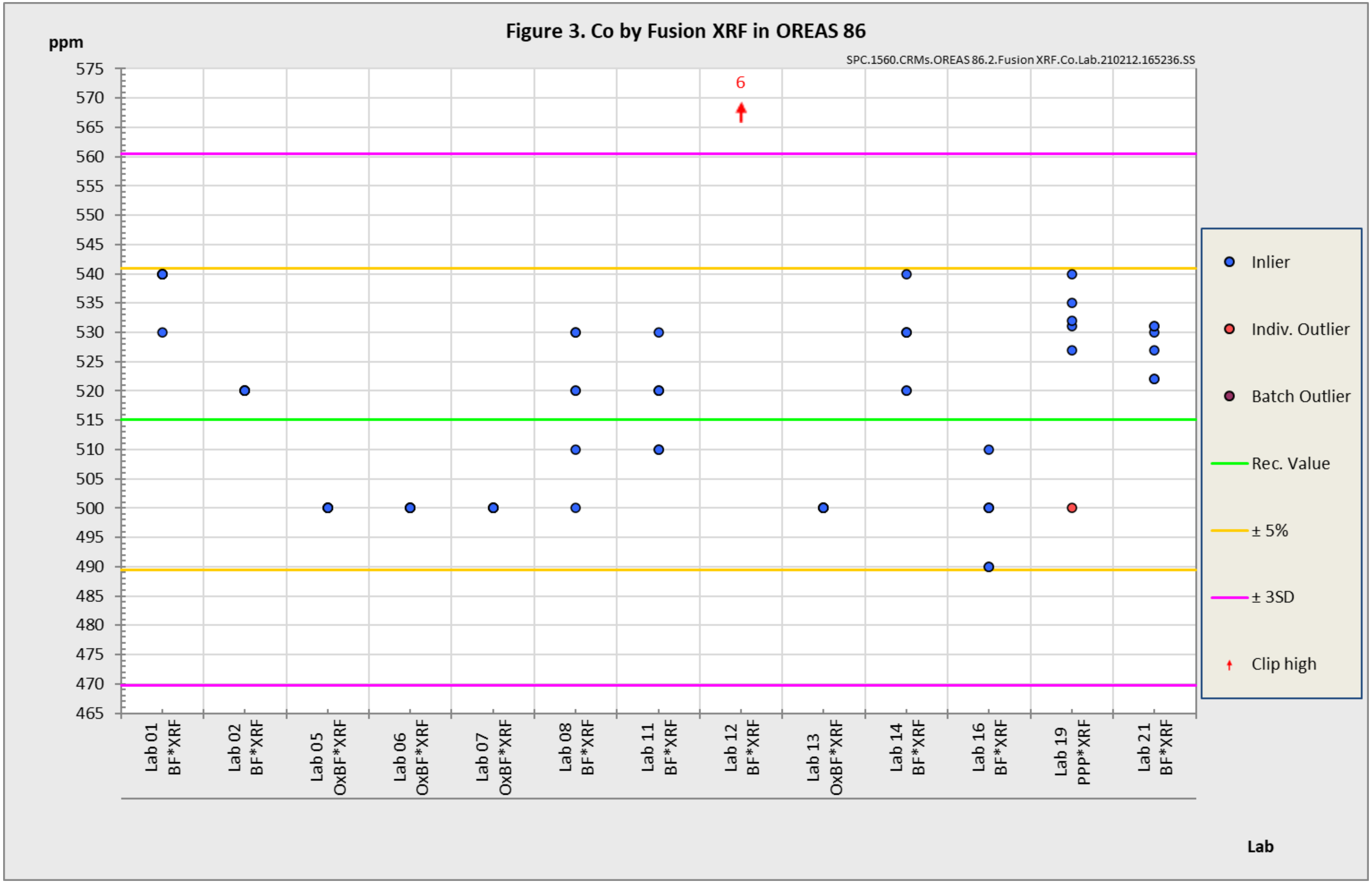

Figure 3. Co by Fusion XRF in OREAS 86
ppm
SPC.1560.CRMs.OREAS 86.2.Fusion XRF.Co.Lab.210212.165236.SS
575
570
565
560
555
550
545
540
535
530
525
520
515
510
505
500
495
490
485
480
475
470
465
6
Lab 01 BF*XRF
Lab 02 BF*XRF
Lab 05 OxBF*XRF
Lab 06 OxBF*XRF
Lab 07 OxBF*XRF
Lab 08 BF*XRF
Lab 11 BF*XRF
Lab 12 BF*XRF
Lab 13 OxBF*XRF
Lab 14 BF*XRF
Lab 16 BF*XRF
Lab 19 PPP*XRF
Lab 21 BF*XRF
Lab
Inlier
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Clip high

METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner representative of the entire batch of the 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 86 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 86 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 86 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 86 contains an elevated level of reactive sulphide (~7.01% S) and has been packaged under nitrogen in single use laminated foil pouches. 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 are on a dry sample basis. This requires the removal of hygroscopic moisture by drying in air to constant mass at 105°C. If the reference material is not dried prior to analysis, the XRF results should be corrected to dry sample basis via a moisture determination (weighed at the same time as the XRF analyses).

The certified values for fire assay, LOI at 1000° C and aqua regia digestion are reported on a 'sample as received' basis. I.e., drying the CRM prior to these types of analyses is not necessary.

The CRM does not require homogenisation prior to analysis.

Minimum sample size

As a practical guide, 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 sample masses should be used depending on the operationally defined methodology.

- Au by fire assay: ≥25g;
- Au by aqua regia digestion: ≥10g;
- Majors by lithium borate fusion with X-ray fluorescence finish: ≥0.2g;
- Loss on Ignition (LOI) at 1000°C: ≥1g;
- S by infrared combustion furnace/CS analyser: ≥0.1g;
- Full elemental suites by 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Full elemental suites by aqua regia digestion with ICP-OES and/or MS finish: ≥0.5g.

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 inter-laboratory 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.

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.

HANDLING INSTRUCTIONS

Fine powders pose a risk to eyes and lungs and therefore standard precautions including 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	3rd April, 2021	First publication.

QMS CERTIFICATION

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

3rd April, 2021

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

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