oreas
an analytichem company

Ore Research & Exploration P/L **ABN** 28 006 859 856
37A Hosie Street, Bayswater North, VIC 3153, Australia
P +61 3 9729 0333 | **E** info@ore.com.au | **oreas.com**

CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 929b

Copper Ore (CSA Mine, Cobar, NSW, Australia)

Table 1. Certified Values, Uncertainty & Tolerance Intervals in OREAS 929b.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Borate Fusion XRF					
Al_2O_3, Aluminium(III) oxide (wt.%)	10.34	10.21	10.47	10.23	10.46
BaO, Barium oxide (wt.%)	0.176	0.164	0.188	0.165	0.187
CaO, Calcium oxide (wt.%)	0.062	0.053	0.071	0.058	0.066
Cu, Copper (wt.%)	2.14	2.07	2.22	2.12	2.17
Fe_2O_3, Iron(III) oxide (wt.%)	8.01	7.91	8.12	7.94	8.09
K_2O, Potassium oxide (wt.%)	2.73	2.69	2.78	2.70	2.76
MgO, Magnesium oxide (wt.%)	0.588	0.564	0.612	0.572	0.605
MnO_2, Manganese dioxide (wt.%)	0.018	0.015	0.020	IND	IND
P_2O_5, Phosphorus(V) oxide (wt.%)	0.055	0.041	0.070	IND	IND
S, Sulphur (wt.%)	2.37	2.29	2.46	2.34	2.41
SiO_2, Silicon dioxide (wt.%)	70.35	69.43	71.27	69.96	70.74
TiO_2, Titanium dioxide (wt.%)	0.454	0.434	0.473	0.440	0.467
Zn, Zinc (ppm)	180	163	197	161	199
Thermogravimetry					
LOI^{1000}, Loss on ignition @1000 °C (wt.%)	3.93	3.74	4.12	3.86	3.99
Infrared Combustion					
C, Carbon (wt.%)	0.749	0.727	0.770	0.735	0.762
S, Sulphur (wt.%)	2.41	2.35	2.47	2.36	2.46
Borate / Peroxide Fusion ICP					
Al, Aluminium (wt.%)	5.49	5.36	5.61	5.39	5.58
As, Arsenic (ppm)	101	95	107	97	105
B, Boron (ppm)	131	106	155	118	143
Ba, Barium (wt.%)	0.161	0.155	0.168	0.158	0.165
Be, Beryllium (ppm)	1.94	1.73	2.15	IND	IND
Bi, Bismuth (ppm)	120	112	128	118	123
Ca, Calcium (wt.%)	0.050	0.044	0.057	IND	IND
Cd, Cadmium (ppm)	< 10	IND	IND	IND	IND
Ce, Cerium (ppm)	65	61	69	63	67
Co, Cobalt (ppm)	16.8	15.5	18.2	16.0	17.7
Cr, Chromium (ppm)	79	69	90	71	88
Cs, Caesium (ppm)	4.52	4.15	4.89	4.28	4.76
Cu, Copper (wt.%)	2.11	2.05	2.17	2.06	2.15
Dy, Dysprosium (ppm)	3.75	3.29	4.20	3.54	3.96
Er, Erbium (ppm)	2.29	2.09	2.49	2.13	2.45
Eu, Europium (ppm)	1.08	0.97	1.19	0.98	1.19
Fe, Iron (wt.%)	5.59	5.38	5.81	5.51	5.68
Ga, Gallium (ppm)	16.3	15.3	17.3	15.9	16.8

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

Note: intervals may appear asymmetric due to rounding.

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 the upper bound/non-detect limit value).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Borate / Peroxide Fusion ICP continued					
Gd, Gadolinium (ppm)	4.54	4.05	5.02	4.27	4.80
Ge, Germanium (ppm)	2.12	1.82	2.42	IND	IND
Ho, Holmium (ppm)	0.80	0.72	0.88	0.74	0.86
In, Indium (ppm)	1.86	1.70	2.03	IND	IND
K, Potassium (wt.%)	2.33	2.26	2.39	2.27	2.39
La, Lanthanum (ppm)	34.0	30.9	37.1	32.6	35.4
Li, Lithium (ppm)	23.0	19.9	26.2	21.3	24.7
Lu, Lutetium (ppm)	0.33	0.27	0.39	0.30	0.36
Mg, Magnesium (wt.%)	0.345	0.331	0.359	0.335	0.355
Mn, Manganese (wt.%)	0.011	0.010	0.012	0.010	0.011
Mo, Molybdenum (ppm)	4.89	4.69	5.08	IND	IND
Nb, Niobium (ppm)	9.68	8.34	11.02	7.50	11.85
Nd, Neodymium (ppm)	28.3	25.8	30.9	27.0	29.6
P, Phosphorus (wt.%)	0.030	0.028	0.031	IND	IND
Pb, Lead (ppm)	88	81	95	85	91
Pr, Praseodymium (ppm)	7.51	7.02	7.99	7.19	7.83
Rb, Rubidium (ppm)	131	126	137	128	135
S, Sulphur (wt.%)	2.39	2.32	2.47	2.34	2.45
Sb, Antimony (ppm)	5.37	4.67	6.06	4.98	5.76
Si, Silicon (wt.%)	33.65	32.59	34.70	33.26	34.04
Sm, Samarium (ppm)	5.40	4.97	5.83	5.18	5.61
Sn, Tin (ppm)	25.5	23.1	28.0	IND	IND
Sr, Strontium (ppm)	42.6	38.7	46.5	40.2	45.0
Tb, Terbium (ppm)	0.66	0.59	0.73	0.63	0.70
Th, Thorium (ppm)	12.1	11.3	12.8	11.6	12.5
Ti, Titanium (wt.%)	0.266	0.255	0.278	0.256	0.277
Tl, Thallium (ppm)	0.94	0.83	1.05	IND	IND
Tm, Thulium (ppm)	0.34	0.31	0.37	0.32	0.36
U, Uranium (ppm)	4.02	3.87	4.18	3.88	4.17
V, Vanadium (ppm)	167	161	174	163	172
W, Tungsten (ppm)	11.9	9.8	13.9	IND	IND
Y, Yttrium (ppm)	22.1	21.1	23.1	21.1	23.1
Yb, Ytterbium (ppm)	2.19	2.02	2.35	2.04	2.34
Zn, Zinc (ppm)	184	171	197	178	190
4-Acid Digestion					
Ag, Silver (ppm)	9.15	8.71	9.58	8.88	9.42
Al, Aluminium (wt.%)	5.34	5.14	5.54	5.23	5.45

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

Note: intervals may appear asymmetric due to rounding.

IND = indeterminate (due to limited reading resolution of the methods employed).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
As, Arsenic (ppm)	99	94	104	96	102
Ba, Barium (ppm)	1366	1157	1576	1337	1395
Be, Beryllium (ppm)	1.94	1.84	2.03	1.85	2.03
Bi, Bismuth (ppm)	119	111	126	116	122
Ca, Calcium (wt.%)	0.049	0.046	0.052	0.048	0.050
Cd, Cadmium (ppm)	0.37	0.32	0.42	0.33	0.41
Ce, Cerium (ppm)	64	61	68	63	66
Co, Cobalt (ppm)	16.1	15.1	17.0	15.2	16.9
Cr, Chromium (ppm)	68	64	73	66	71
Cs, Caesium (ppm)	4.32	4.08	4.57	4.09	4.55
Cu, Copper (wt.%)	2.11	2.07	2.16	2.08	2.15
Dy, Dysprosium (ppm)	2.85	2.51	3.20	2.64	3.07
Er, Erbium (ppm)	1.51	1.26	1.75	1.40	1.61
Eu, Europium (ppm)	1.03	0.95	1.12	0.96	1.11
Fe, Iron (wt.%)	5.62	5.48	5.75	5.51	5.72
Ga, Gallium (ppm)	15.8	15.1	16.5	15.2	16.4
Gd, Gadolinium (ppm)	4.09	3.81	4.38	3.87	4.32
Ge, Germanium (ppm)	0.20	0.15	0.24	0.16	0.24
Hf, Hafnium (ppm)	2.29	2.14	2.44	2.17	2.42
Ho, Holmium (ppm)	0.54	0.45	0.62	0.50	0.57
In, Indium (ppm)	1.81	1.73	1.90	1.74	1.89
K, Potassium (wt.%)	2.28	2.21	2.35	2.23	2.32
La, Lanthanum (ppm)	32.6	30.9	34.3	31.5	33.6
Li, Lithium (ppm)	20.4	19.4	21.4	19.7	21.1
Lu, Lutetium (ppm)	0.22	0.18	0.26	0.18	0.27
Mg, Magnesium (wt.%)	0.340	0.327	0.354	0.331	0.349
Mn, Manganese (wt.%)	0.011	0.010	0.011	0.011	0.011
Mo, Molybdenum (ppm)	5.04	4.79	5.29	4.79	5.29
Na, Sodium (wt.%)	0.066	0.059	0.073	0.064	0.069
Nb, Niobium (ppm)	3.94	3.47	4.42	3.72	4.17
Nd, Neodymium (ppm)	28.0	26.5	29.5	27.0	29.0
Ni, Nickel (ppm)	9.25	8.54	9.96	8.64	9.86
P, Phosphorus (wt.%)	0.026	0.024	0.028	0.025	0.027
Pb, Lead (ppm)	79	75	84	76	83
Pr, Praseodymium (ppm)	7.63	7.03	8.23	7.22	8.04
Rb, Rubidium (ppm)	132	125	138	128	135
S, Sulphur (wt.%)	2.43	2.35	2.51	2.38	2.48
Sb, Antimony (ppm)	4.65	4.34	4.97	4.35	4.96

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
Note: intervals may appear asymmetric due to rounding.

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Sc, Scandium (ppm)	9.24	8.82	9.65	8.84	9.63
Sm, Samarium (ppm)	5.32	4.94	5.70	5.04	5.60
Sn, Tin (ppm)	21.4	20.6	22.3	20.4	22.4
Sr, Strontium (ppm)	36.9	35.4	38.5	35.8	38.0
Tb, Terbium (ppm)	0.54	0.48	0.61	0.51	0.58
Te, Tellurium (ppm)	0.11	0.09	0.13	0.10	0.12
Th, Thorium (ppm)	11.5	11.0	12.1	11.2	11.9
Ti, Titanium (wt.%)	0.190	0.176	0.203	0.184	0.196
Tl, Thallium (ppm)	0.92	0.86	0.97	0.85	0.98
U, Uranium (ppm)	3.87	3.71	4.04	3.72	4.03
V, Vanadium (ppm)	161	155	167	157	165
W, Tungsten (ppm)	11.8	11.1	12.5	11.2	12.5
Y, Yttrium (ppm)	13.5	12.2	14.8	12.9	14.1
Yb, Ytterbium (ppm)	1.53	1.30	1.77	1.31	1.76
Zn, Zinc (ppm)	180	171	190	173	187
Zr, Zirconium (ppm)	78	74	83	76	81
Aqua Regia Digestion					
Ag, Silver (ppm)	9.07	8.77	9.37	8.84	9.30
Al, Aluminium (wt.%)	0.502	0.466	0.538	0.484	0.520
As, Arsenic (ppm)	96	94	98	93	98
B, Boron (ppm)	< 10	IND	IND	IND	IND
Be, Beryllium (ppm)	0.31	0.29	0.33	0.29	0.33
Bi, Bismuth (ppm)	120	111	128	115	124
Ca, Calcium (wt.%)	0.041	0.038	0.044	IND	IND
Cd, Cadmium (ppm)	0.31	0.26	0.36	0.29	0.34
Ce, Cerium (ppm)	46.4	42.3	50.5	44.0	48.8
Co, Cobalt (ppm)	15.6	15.0	16.2	15.1	16.1
Cr, Chromium (ppm)	18.3	17.2	19.4	17.2	19.4
Cs, Caesium (ppm)	1.38	1.23	1.52	1.29	1.46
Cu, Copper (wt.%)	2.15	2.07	2.23	2.11	2.19
Dy, Dysprosium (ppm)	1.44	1.04	1.85	1.30	1.58
Fe, Iron (wt.%)	5.36	5.20	5.52	5.23	5.49
Ga, Gallium (ppm)	1.91	1.74	2.07	1.81	2.00
Gd, Gadolinium (ppm)	2.51	1.60	3.43	2.28	2.74
Ge, Germanium (ppm)	0.12	0.09	0.14	IND	IND
Hf, Hafnium (ppm)	0.29	0.26	0.32	0.27	0.31
Hg, Mercury (ppm)	0.067	0.050	0.084	IND	IND

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

Note: intervals may appear asymmetric due to rounding.

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 the upper bound/non-detect limit value).

Table 1 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Aqua Regia Digestion continued					
In, Indium (ppm)	1.73	1.63	1.83	1.66	1.80
K, Potassium (wt.%)	0.158	0.141	0.175	0.148	0.168
La, Lanthanum (ppm)	20.5	18.1	22.9	19.5	21.6
Li, Lithium (ppm)	1.56	1.26	1.85	IND	IND
Mg, Magnesium (wt.%)	0.077	0.070	0.083	IND	IND
Mn, Manganese (wt.%)	0.009	0.008	0.009	0.008	0.009
Mo, Molybdenum (ppm)	4.85	4.65	5.04	4.69	5.00
Ni, Nickel (ppm)	6.84	6.50	7.17	6.49	7.18
P, Phosphorus (wt.%)	0.020	0.018	0.021	0.019	0.021
Pb, Lead (ppm)	70	66	73	67	72
Rb, Rubidium (ppm)	9.69	8.76	10.61	9.21	10.17
Re, Rhenium (ppb)	0.995	0.962	1.029	IND	IND
S, Sulphur (wt.%)	2.38	2.30	2.45	2.31	2.44
Sb, Antimony (ppm)	3.10	2.73	3.47	2.93	3.28
Sc, Scandium (ppm)	1.26	1.14	1.37	1.12	1.39
Se, Selenium (ppm)	24.9	23.3	26.5	23.5	26.3
Sm, Samarium (ppm)	3.17	2.11	4.23	2.98	3.36
Sn, Tin (ppm)	18.9	17.6	20.2	17.9	19.9
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Te, Tellurium (ppm)	0.091	0.073	0.108	IND	IND
Th, Thorium (ppm)	7.41	6.76	8.07	7.06	7.77
Tl, Thallium (ppm)	0.090	0.076	0.104	IND	IND
U, Uranium (ppm)	1.87	1.74	2.01	1.80	1.95
V, Vanadium (ppm)	13.4	11.7	15.1	12.8	14.0
W, Tungsten (ppm)	8.38	7.74	9.01	8.07	8.68
Y, Yttrium (ppm)	4.79	4.24	5.33	4.58	5.00
Zn, Zinc (ppm)	167	160	175	163	172
Zr, Zirconium (ppm)	8.72	7.99	9.45	8.34	9.10

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

Note: intervals may appear asymmetric due to rounding.

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 the upper bound/non-detect limit value).

Table 2. Indicative Values for OREAS 929b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Borate Fusion XRF								
As	ppm	*133*	Na_2O	wt.%	*0.138*	Sn	ppm	*< 50*
Bi	ppm	*119*	Nb	ppm	*< 50*	Sr	ppm	*100*
CeO_2	ppm	*< 100*	Nd	ppm	*< 90*	Ta	ppm	*150*
Co	ppm	*67*	Ni	ppm	*< 50*	Th	ppm	*< 44*
Cr	ppm	*70*	Pb	ppm	*115*	TOT_XRF	wt.%	*105.68*
Gd	ppm	*< 90*	Pr	ppm	*< 80*	V	ppm	*191*
HfO_2	ppm	*< 100*	Rb	ppm	*108*	W	ppm	*16.7*
La_2O_3	ppm	*92*	Sb	ppm	*235*	Y_2O_3	ppm	*73*
Mo	ppm	*< 50*	Sm	ppm	*57*	Zr	ppm	*150*
Borate / Peroxide Fusion ICP								
Ag	ppm	*8.89*	Re	ppm	*< 0.1*	Te	ppm	*< 5*
Hf	ppm	*3.99*	Sc	ppm	*8.62*	Zr	ppm	*148*
Na	wt.%	*0.059*	Se	ppm	*27.0*			
Ni	ppm	*16.1*	Ta	ppm	*0.72*			
4-Acid Digestion								
B	ppm	*36.5*	Re	ppb	*3.24*	Tm	ppm	*0.20*
Hg	ppm	*0.038*	Ta	ppm	*0.28*			
Aqua Regia Digestion								
Au	ppm	*0.019*	Na	wt.%	*0.010*	Sr	ppm	*8.67*
Ba	ppm	*84*	Nb	ppm	*0.077*	Tb	ppm	*0.25*
Er	ppm	*0.53*	Nd	ppm	*17.9*	Ti	ppm	*43.5*
Eu	ppm	*0.54*	Pd	ppb	*68.5*	Tm	ppm	*0.072*
Ho	ppm	*0.22*	Pr	ppm	*4.44*	Yb	ppm	*0.45*
Lu	ppm	*0.064*	Pt	ppb	*1.83*			

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.

TABLE OF CONTENTS

INTRODUCTION 9
SOURCE MATERIAL 9
COMMINUTION AND HOMOGENISATION PROCEDURES 9
PHYSICAL PROPERTIES 10
MINERALOGY 10
ANALYTICAL PROGRAM 11
STATISTICAL ANALYSIS 11
Certified Values and their uncertainty intervals 11
Indicative (uncertified) values 11
Homogeneity Evaluation 12
PERFORMANCE GATES 13
PREPARER AND SUPPLIER 17
PARTICIPATING LABORATORIES 18
METROLOGICAL TRACEABILITY 23
COMMUTABILITY 23
INTENDED USE 24
MINIMUM SAMPLE SIZE 24
PERIOD OF VALIDITY & STORAGE INSTRUCTIONS 25
INSTRUCTIONS FOR HANDLING & CORRECT USE 25
LEGAL NOTICE 26
DOCUMENT HISTORY 27
CERTIFYING OFFICER 27
QMS CERTIFICATION 27
REFERENCES 27

LIST OF TABLES

Table 1. Certified Values, Uncertainty & Tolerance Intervals in OREAS 929b. 2
Table 2. Indicative Values for OREAS 929b. 7
Table 3. Physical properties of OREAS 929b. 10
Table 4. Indicative mineralogy of OREAS 929b by semi-quantitative XRD analysis. 10
Table 5. Performance Gates for OREAS 929b. 13

LIST OF FIGURES

Figure 1. Cu by borate fusion XRF in OREAS 929b 19
Figure 2. Ag by 4-acid digestion in OREAS 929b 20
Figure 3. Cu by 4-acid digestion in OREAS 929b 21
Figure 4. Cu by aqua regia digestion in OREAS 929b 22

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 'Instructions for handling and correct use' should be read carefully.

Table 1 provides the certified values and their associated 95 % expanded uncertainty and tolerance intervals, Table 2 shows indicative values including major and trace element characterisation, Table 3 provides some indicative physical properties, Table 4 shows indicative mineralogy by semi-quantitative XRD analysis and Table 5 presents the performance gate intervals for all certified values.

Tabulated results of all analytes 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 929b-DataPack.1.0.260213_110441.xlsx**). The certified values and uncertainties in this Certificate are the sole authoritative figures. Any additional significant figures in the DataPack are provided for reference only and do not affect the certified results.

Results are also presented in scatter plots for Cu by fusion XRF, Ag and Cu by 4-acid digestion and Cu by aqua regia digestion in Figures 1 to 4 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 929b is a certified reference material (CRM) prepared from a blend of barren black slate and primary copper ore sourced from the CSA Mine near Cobar in central western New South Wales, Australia. The barren black slate was obtained from a quarry in Victoria, Australia. The copper ore is hosted within the Early Devonian CSA Siltstone of the Cobar Supergroup, comprising thinly bedded turbiditic carbonaceous siltstones and mudstones. Mineralisation is structurally controlled within steeply dipping bodies along a major shear zone on the eastern margin of the Cobar Basin and comprises epigenetic sulphide assemblages dominated by chalcopyrite, pyrrhotite, pyrite, sphalerite, galena, bornite, and cubanite, with associated low-grade greenschist-facies alteration characterised by iron-rich chlorite and silica.

COMMINUTION AND HOMOGENISATION PROCEDURES

The materials constituting OREAS 929b was prepared in the following manner:

- Drying the black slate to constant mass at 105 °C;

- Drying the copper ore to constant mass at 85 °C;
- Crushing and multi-stage milling of the black slate to 98 % minus 75 microns;
- Crushing and multi-stage milling of the copper ore to 100 % minus 30 microns;
- Preliminary homogenisation, sampling and check assaying of the copper ore;
- Blending the barren black slate and copper ore in appropriate proportions to achieve target grades;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 10 g units under nitrogen in laminated foil pouches.

PHYSICAL PROPERTIES

OREAS 929b 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 929b.

Bulk Density (kg/m^3)	Moisture (wt.%)	Munsell Notation‡	Munsell Color‡
790	0.45	N3	Dark Gray

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

MINERALOGY

The semi-quantitative XRD results shown in Table 4 below were undertaken by ALS Metallurgy in Balcatta, Western Australia. The results have been normalised to 100 % and represent the relative proportion of crystalline material. Totals greater or less than 100 % are due to rounding errors.

Some amorphous material may be present. 'Kandite group' appears to be mainly kaolinite. A trace of apatite, tourmaline group, serpentine and troilite may be present.

Table 4. Indicative mineralogy of OREAS 929b by semi-quantitative XRD analysis.

Mineral / Mineral Group	% (mass ratio)
Chalcopyrite	6
Magnetite	1
Goethite	2
Stilpnomelane and/or sepiolite	< 1
Kandite group	1
Chlorite	2
Annite - biotite - phlogopite	1
Muscovite - illite	24
K-feldspar and/or rutile	< 1
Quartz	63

ANALYTICAL PROGRAM

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

- Lithium borate fusion whole rock analysis package by X-ray fluorescence (up to 17 laboratories depending on the element);
- Thermogravimetry: Loss on Ignition (LOI) at 1000 °C (5 laboratories used a thermogravimetric analyser, 4 laboratories included LOI with their fusion package and 6 laboratories used a conventional muffle furnace);
- Total C and S by IR combustion furnace (up to 21 laboratories depending on the element);
- Lithium borate or sodium peroxide fusion with full suite ICP-OES and ICP-MS elemental packages (up to 18 laboratories depending on the element);
- 4-acid (HNO_3-HF-$HClO_4$-HCl) digestion with full suite ICP-OES and ICP-MS elemental packages (up to 22 laboratories depending on the element);
- Full ICP-OES and ICP-MS elemental suites by aqua regia digestion (up to 21 laboratories depending on the element).

For the round robin program, six 2 kg test units were collected at predetermined intervals during the bagging stage, immediately after homogenisation. These units are considered representative of the entire prepared batch. Each participating laboratory received six test portions, obtained by subsampling 15 g from each of the six distinct 2 kg units.

Homogeneity was assessed by submitting 12 pulp samples to a single laboratory for analysis. Paired 10 g samples were drawn from each of the six test units, enabling an Analysis of Variance (ANOVA) to compare within-unit and between-unit variances. This statistical method provides a relative measure of homogeneity and tests the null hypothesis that all units derive from the same population distribution (refer to the 'Homogeneity Evaluation' section below).

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Table 1) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). Outlier evaluation was conducted in accordance with ISO 17034:2017 and ISO 33405:2024. While formal statistical tests were applied, professional statistical judgment was also exercised in determining the validity of potential outliers. Assessment of systematic bias and performance using independent control materials (CRMs) was incorporated to ensure compliance with the referenced standards and to establish metrological traceability of the certified values.

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 outlined in [5] and [14]. 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 or where interlaboratory consensus is poor. This data is intended for 'informational purposes' only.

Standard Deviation intervals (see Table 5, 'Performance Gates') provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e., after removal of all individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e., the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. ***The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.***

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Table 1 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 Cu by fusion XRF, where 99 % of the time (1-α=0.99) at least 95 % of subsamples (ρ=0.95) will have concentrations lying between 2.12 and 2.17 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. ***Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.***

Analysis of Variance (ANOVA) Study

Homogeneity of OREAS 929b was evaluated using an ANOVA study in addition to the precision error method. Twelve 10 g pulp samples (paired from six sampling units) were analysed for Cu and Zn by oxidising fusion with X-ray fluorescence finish (ME-XRF15b). The ANOVA compares within- and between-unit variances to test the null hypothesis that all units are drawn from the same population. A *p*-value < 0.05 indicates statistically significant heterogeneity between units.

Both *p*-values for Cu and Zn were statistically insignificant, and the null hypothesis is retained. ANOVA provides a relative measure of homogeneity, and poor absolute homogeneity could theoretically pass if within-unit variance is consistent across units. Cu and Zn are minor constituents in OREAS 929b, and achieving homogeneity for minor constituents is generally more challenging than for major constituents. Therefore, the successful demonstration of homogeneity for Cu and Zn provides strong evidence that the material is also homogeneous for all certified analytes. This approach is consistent with ISO Guide 35:2017, which allows the use of representative analytes to infer homogeneity of the full suite of certified properties.

Based on this statistical analysis and the results of the interlaboratory certification program, OREAS 929b is concluded to be fit-for-purpose as a certified reference material (see 'Intended Use' below).

PERFORMANCE GATES

Table 5 below 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 [1].

Table 5. Performance Gates for OREAS 929b.

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 Fusion XRF											
Al_2O_3, wt.%	10.34	0.191	9.96	10.72	9.77	10.91	1.85%	3.69%	5.54%	9.83	10.86
BaO, wt.%	0.176	0.013	0.150	0.202	0.138	0.215	7.32%	14.64%	21.97%	0.167	0.185
CaO, wt.%	0.062	0.012	0.039	0.086	0.027	0.098	18.97%	37.93%	56.90%	0.059	0.065
Cu, wt.%	2.14	0.097	1.95	2.34	1.85	2.44	4.53%	9.06%	13.60%	2.04	2.25
Fe_2O_3, wt.%	8.01	0.118	7.78	8.25	7.66	8.37	1.47%	2.94%	4.41%	7.61	8.42
K_2O, wt.%	2.73	0.052	2.63	2.84	2.58	2.89	1.89%	3.79%	5.68%	2.60	2.87
MgO, wt.%	0.588	0.031	0.526	0.651	0.494	0.683	5.34%	10.68%	16.02%	0.559	0.618
MnO_2, wt.%	0.018	0.004	0.010	0.026	0.006	0.030	22.50%	44.99%	67.49%	0.017	0.019
P_2O_5, wt.%	0.055	0.011	0.034	0.077	0.023	0.088	19.66%	39.32%	58.97%	0.053	0.058
S, wt.%	2.37	0.113	2.15	2.60	2.03	2.71	4.76%	9.52%	14.28%	2.25	2.49
SiO_2, wt.%	70.35	1.033	68.28	72.42	67.25	73.45	1.47%	2.94%	4.41%	66.83	73.87
TiO_2, wt.%	0.454	0.016	0.422	0.485	0.407	0.501	3.46%	6.92%	10.39%	0.431	0.476
Zn, ppm	180	18	144	216	126	234	10.06%	20.12%	30.18%	171	189
Thermogravimetry											
LOI^{1000}, wt.%	3.93	0.265	3.40	4.46	3.13	4.72	6.75%	13.50%	20.25%	3.73	4.12
Infrared Combustion											
C, wt.%	0.749	0.033	0.683	0.814	0.650	0.847	4.39%	8.79%	13.18%	0.711	0.786
S, wt.%	2.41	0.052	2.30	2.51	2.25	2.57	2.17%	4.34%	6.51%	2.29	2.53
Borate / Peroxide Fusion ICP											
Al, wt.%	5.49	0.104	5.28	5.69	5.18	5.80	1.89%	3.78%	5.67%	5.21	5.76
As, ppm	101	3	95	107	93	109	2.75%	5.49%	8.24%	96	106
B, ppm	131	18	94	167	76	185	13.97%	27.94%	41.91%	124	137
Ba, wt.%	0.161	0.009	0.143	0.180	0.133	0.189	5.78%	11.57%	17.35%	0.153	0.170
Be, ppm	1.94	0.145	1.65	2.23	1.50	2.38	7.48%	14.96%	22.44%	1.84	2.04

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

Notes: intervals may appear asymmetric due to rounding; 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 5 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											
Bi, ppm	120	7	107	134	100	141	5.71%	11.42%	17.14%	114	126
Ca, wt.%	0.050	0.011	0.029	0.071	0.019	0.082	20.95%	41.90%	62.84%	0.048	0.053
Cd, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Ce, ppm	65	5.5	54	76	48	81	8.45%	16.91%	25.36%	62	68
Co, ppm	16.8	1.7	13.4	20.3	11.7	22.0	10.23%	20.46%	30.69%	16.0	17.7
Cr, ppm	79	13	54	105	41	118	16.22%	32.45%	48.67%	75	83
Cs, ppm	4.52	0.195	4.13	4.91	3.94	5.11	4.31%	8.62%	12.92%	4.29	4.75
Cu, wt.%	2.11	0.070	1.97	2.25	1.90	2.32	3.31%	6.61%	9.92%	2.00	2.21
Dy, ppm	3.75	0.304	3.14	4.36	2.84	4.66	8.10%	16.21%	24.31%	3.56	3.94
Er, ppm	2.29	0.143	2.01	2.58	1.86	2.72	6.25%	12.49%	18.74%	2.18	2.41
Eu, ppm	1.08	0.076	0.93	1.23	0.85	1.31	7.06%	14.13%	21.19%	1.03	1.14
Fe, wt.%	5.59	0.180	5.23	5.95	5.05	6.13	3.21%	6.43%	9.64%	5.31	5.87
Ga, ppm	16.3	0.75	14.8	17.8	14.1	18.6	4.60%	9.19%	13.79%	15.5	17.1
Gd, ppm	4.54	0.232	4.07	5.00	3.84	5.23	5.11%	10.21%	15.32%	4.31	4.76
Ge, ppm	2.12	0.192	1.73	2.50	1.54	2.69	9.05%	18.11%	27.16%	2.01	2.22
Ho, ppm	0.80	0.052	0.69	0.90	0.64	0.95	6.52%	13.04%	19.56%	0.76	0.84
In, ppm	1.86	0.099	1.66	2.06	1.57	2.16	5.29%	10.59%	15.88%	1.77	1.95
K, wt.%	2.33	0.070	2.19	2.47	2.12	2.54	3.00%	6.00%	8.99%	2.21	2.45
La, ppm	34.0	1.90	30.2	37.8	28.3	39.7	5.59%	11.18%	16.76%	32.3	35.7
Li, ppm	23.0	4.4	14.2	31.9	9.7	36.3	19.27%	38.53%	57.80%	21.9	24.2
Lu, ppm	0.33	0.022	0.29	0.37	0.26	0.40	6.62%	13.24%	19.86%	0.31	0.35
Mg, wt.%	0.345	0.015	0.314	0.376	0.299	0.391	4.43%	8.86%	13.29%	0.328	0.362
Mn, wt.%	0.011	0.002	0.007	0.015	0.005	0.017	19.12%	38.24%	57.36%	0.010	0.011
Mo, ppm	4.89	0.430	4.03	5.75	3.60	6.18	8.80%	17.60%	26.41%	4.64	5.13
Nb, ppm	9.68	0.859	7.96	11.39	7.10	12.25	8.88%	17.75%	26.63%	9.19	10.16
Nd, ppm	28.3	2.13	24.1	32.6	22.0	34.7	7.50%	15.01%	22.51%	26.9	29.7
P, wt.%	0.030	0.002	0.027	0.033	0.025	0.034	5.24%	10.47%	15.71%	0.028	0.031
Pb, ppm	88	11	67	109	56	120	12.17%	24.34%	36.50%	84	92
Pr, ppm	7.51	0.539	6.43	8.59	5.89	9.13	7.18%	14.36%	21.55%	7.13	7.89
Rb, ppm	131	5	121	142	116	147	3.94%	7.89%	11.83%	125	138
S, wt.%	2.39	0.097	2.20	2.59	2.10	2.69	4.04%	8.09%	12.13%	2.27	2.51
Sb, ppm	5.37	0.70	3.96	6.77	3.26	7.48	13.11%	26.21%	39.32%	5.10	5.63
Si, wt.%	33.65	0.958	31.73	35.56	30.77	36.52	2.85%	5.69%	8.54%	31.96	35.33
Sm, ppm	5.40	0.476	4.44	6.35	3.97	6.82	8.83%	17.66%	26.48%	5.13	5.67
Sn, ppm	25.5	2.46	20.6	30.5	18.2	32.9	9.63%	19.25%	28.88%	24.3	26.8
Sr, ppm	42.6	5.2	32.2	53.0	27.1	58.1	12.17%	24.33%	36.50%	40.5	44.7
Tb, ppm	0.66	0.031	0.60	0.72	0.57	0.76	4.65%	9.30%	13.95%	0.63	0.70
Th, ppm	12.1	0.66	10.7	13.4	10.1	14.0	5.49%	10.99%	16.48%	11.4	12.7
Ti, wt.%	0.266	0.011	0.244	0.289	0.233	0.300	4.24%	8.47%	12.71%	0.253	0.280
Tl, ppm	0.94	0.059	0.82	1.06	0.76	1.12	6.26%	12.52%	18.78%	0.89	0.99
Tm, ppm	0.34	0.016	0.31	0.37	0.29	0.39	4.61%	9.22%	13.84%	0.32	0.36
U, ppm	4.02	0.124	3.78	4.27	3.65	4.40	3.09%	6.18%	9.27%	3.82	4.23
V, ppm	167	9	149	185	140	194	5.37%	10.74%	16.11%	159	176

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

Table 5 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											
W, ppm	11.9	1.8	8.3	15.4	6.5	17.2	15.05%	30.10%	45.15%	11.3	12.5
Y, ppm	22.1	1.10	19.9	24.3	18.8	25.4	4.98%	9.96%	14.94%	21.0	23.2
Yb, ppm	2.19	0.107	1.97	2.40	1.87	2.51	4.88%	9.76%	14.64%	2.08	2.30
Zn, ppm	184	16	152	216	136	232	8.64%	17.29%	25.93%	175	193
4-Acid Digestion											
Ag, ppm	9.15	0.538	8.07	10.22	7.53	10.76	5.89%	11.77%	17.66%	8.69	9.60
Al, wt.%	5.34	0.195	4.95	5.73	4.76	5.92	3.64%	7.29%	10.93%	5.07	5.61
As, ppm	99	5.2	89	109	83	114	5.25%	10.50%	15.74%	94	104
Ba, ppm	1366	362	642	2090	281	2452	26.49%	52.97%	79.46%	1298	1434
Be, ppm	1.94	0.120	1.70	2.18	1.58	2.30	6.22%	12.44%	18.66%	1.84	2.03
Bi, ppm	119	11	97	140	87	151	8.99%	17.97%	26.96%	113	125
Ca, wt.%	0.049	0.006	0.037	0.061	0.030	0.067	12.65%	25.29%	37.94%	0.046	0.051
Cd, ppm	0.37	0.07	0.23	0.51	0.16	0.58	18.99%	37.97%	56.96%	0.35	0.39
Ce, ppm	64	4.9	55	74	50	79	7.57%	15.14%	22.72%	61	68
Co, ppm	16.1	0.82	14.4	17.7	13.6	18.5	5.10%	10.19%	15.29%	15.3	16.9
Cr, ppm	68	4.0	60	77	56	81	5.91%	11.82%	17.74%	65	72
Cs, ppm	4.32	0.279	3.76	4.88	3.49	5.16	6.45%	12.90%	19.35%	4.11	4.54
Cu, wt.%	2.11	0.049	2.02	2.21	1.97	2.26	2.31%	4.62%	6.94%	2.01	2.22
Dy, ppm	2.85	0.34	2.18	3.53	1.85	3.86	11.75%	23.50%	35.25%	2.71	3.00
Er, ppm	1.51	0.26	0.99	2.02	0.73	2.28	17.07%	34.14%	51.21%	1.43	1.58
Eu, ppm	1.03	0.049	0.94	1.13	0.89	1.18	4.76%	9.51%	14.27%	0.98	1.09
Fe, wt.%	5.62	0.143	5.33	5.90	5.19	6.05	2.54%	5.08%	7.63%	5.34	5.90
Ga, ppm	15.8	0.75	14.3	17.3	13.6	18.0	4.72%	9.43%	14.15%	15.0	16.6
Gd, ppm	4.09	0.206	3.68	4.51	3.48	4.71	5.04%	10.09%	15.13%	3.89	4.30
Ge, ppm	0.20	0.04	0.11	0.28	0.07	0.32	21.08%	42.15%	63.23%	0.19	0.21
Hf, ppm	2.29	0.149	1.99	2.59	1.85	2.74	6.50%	13.00%	19.50%	2.18	2.41
Ho, ppm	0.54	0.10	0.34	0.73	0.25	0.83	18.07%	36.14%	54.21%	0.51	0.56
In, ppm	1.81	0.102	1.61	2.02	1.50	2.12	5.65%	11.30%	16.95%	1.72	1.90
K, wt.%	2.28	0.057	2.16	2.39	2.11	2.45	2.52%	5.05%	7.57%	2.16	2.39
La, ppm	32.6	1.25	30.1	35.1	28.8	36.3	3.84%	7.68%	11.51%	30.9	34.2
Li, ppm	20.4	0.81	18.8	22.0	18.0	22.8	3.97%	7.94%	11.91%	19.4	21.4
Lu, ppm	0.22	0.022	0.18	0.27	0.16	0.29	9.97%	19.94%	29.91%	0.21	0.23
Mg, wt.%	0.340	0.014	0.313	0.367	0.299	0.381	3.99%	7.99%	11.98%	0.323	0.357
Mn, wt.%	0.011	0.001	0.010	0.012	0.009	0.013	5.42%	10.84%	16.27%	0.010	0.012
Mo, ppm	5.04	0.231	4.58	5.50	4.35	5.73	4.58%	9.15%	13.73%	4.79	5.29
Na, wt.%	0.066	0.006	0.054	0.078	0.049	0.084	8.87%	17.73%	26.60%	0.063	0.070
Nb, ppm	3.94	0.74	2.47	5.41	1.74	6.15	18.64%	37.29%	55.93%	3.75	4.14
Nd, ppm	28.0	1.04	25.9	30.1	24.9	31.1	3.71%	7.43%	11.14%	26.6	29.4
Ni, ppm	9.25	0.649	7.95	10.55	7.30	11.20	7.01%	14.02%	21.03%	8.79	9.71
P, wt.%	0.026	0.002	0.021	0.031	0.019	0.033	9.27%	18.55%	27.82%	0.025	0.027
Pb, ppm	79	6.7	66	93	59	99	8.38%	16.75%	25.13%	75	83
Pr, ppm	7.63	0.319	6.99	8.27	6.67	8.59	4.19%	8.37%	12.56%	7.25	8.01
Rb, ppm	132	6	120	144	113	150	4.63%	9.26%	13.89%	125	138
S, wt.%	2.43	0.066	2.30	2.56	2.23	2.63	2.70%	5.41%	8.11%	2.31	2.55

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

Notes: intervals may appear asymmetric due to rounding; 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 5 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											
Sb, ppm	4.65	0.411	3.83	5.47	3.42	5.89	8.83%	17.65%	26.48%	4.42	4.89
Sc, ppm	9.24	0.325	8.59	9.89	8.26	10.21	3.52%	7.04%	10.56%	8.77	9.70
Se, ppm	25.9	1.46	22.9	28.8	21.5	30.2	5.63%	11.26%	16.89%	24.6	27.1
Sm, ppm	5.32	0.354	4.61	6.03	4.26	6.39	6.66%	13.31%	19.97%	5.06	5.59
Sn, ppm	21.4	1.13	19.2	23.7	18.0	24.8	5.28%	10.57%	15.85%	20.3	22.5
Sr, ppm	36.9	1.45	34.0	39.8	32.6	41.3	3.93%	7.86%	11.79%	35.1	38.8
Tb, ppm	0.54	0.046	0.45	0.63	0.40	0.68	8.50%	17.00%	25.50%	0.51	0.57
Te, ppm	0.11	0.02	0.07	0.14	0.06	0.16	15.40%	30.79%	46.19%	0.10	0.11
Th, ppm	11.5	0.67	10.2	12.9	9.5	13.5	5.78%	11.56%	17.34%	11.0	12.1
Ti, wt.%	0.190	0.022	0.147	0.233	0.125	0.254	11.33%	22.67%	34.00%	0.180	0.199
Tl, ppm	0.92	0.071	0.77	1.06	0.70	1.13	7.81%	15.62%	23.43%	0.87	0.96
U, ppm	3.87	0.145	3.58	4.16	3.44	4.31	3.75%	7.50%	11.25%	3.68	4.07
V, ppm	161	7	148	174	141	181	4.11%	8.23%	12.34%	153	169
W, ppm	11.8	0.74	10.4	13.3	9.6	14.0	6.24%	12.48%	18.72%	11.2	12.4
Y, ppm	13.5	2.0	9.5	17.5	7.5	19.5	14.75%	29.49%	44.24%	12.8	14.2
Yb, ppm	1.53	0.25	1.03	2.03	0.78	2.28	16.26%	32.52%	48.78%	1.46	1.61
Zn, ppm	180	8	163	197	155	206	4.68%	9.36%	14.04%	171	189
Zr, ppm	78	6.5	65	91	59	98	8.29%	16.58%	24.87%	74	82
Aqua Regia Digestion											
Ag, ppm	9.07	0.398	8.28	9.87	7.88	10.27	4.38%	8.77%	13.15%	8.62	9.53
Al, wt.%	0.502	0.043	0.415	0.588	0.372	0.632	8.63%	17.26%	25.89%	0.477	0.527
As, ppm	96	2.3	91	100	89	103	2.40%	4.80%	7.20%	91	101
B, ppm	< 10	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Be, ppm	0.31	0.022	0.26	0.35	0.24	0.37	7.23%	14.46%	21.69%	0.29	0.32
Bi, ppm	120	9	102	137	94	145	7.21%	14.43%	21.64%	114	125
Ca, wt.%	0.041	0.002	0.036	0.046	0.034	0.048	5.83%	11.65%	17.48%	0.039	0.043
Cd, ppm	0.31	0.06	0.19	0.44	0.13	0.50	19.77%	39.54%	59.31%	0.30	0.33
Ce, ppm	46.4	6.4	33.7	59.1	27.3	65.4	13.70%	27.39%	41.09%	44.1	48.7
Co, ppm	15.6	0.76	14.1	17.1	13.3	17.8	4.85%	9.70%	14.55%	14.8	16.4
Cr, ppm	18.3	1.73	14.9	21.8	13.1	23.5	9.43%	18.86%	28.28%	17.4	19.2
Cs, ppm	1.38	0.23	0.91	1.84	0.68	2.07	16.82%	33.64%	50.45%	1.31	1.44
Cu, wt.%	2.15	0.094	1.96	2.34	1.87	2.43	4.37%	8.74%	13.10%	2.04	2.26
Dy, ppm	1.44	0.28	0.88	2.00	0.60	2.29	19.50%	39.00%	58.50%	1.37	1.51
Fe, wt.%	5.36	0.140	5.08	5.64	4.94	5.78	2.62%	5.23%	7.85%	5.09	5.63
Ga, ppm	1.91	0.23	1.44	2.37	1.21	2.60	12.22%	24.44%	36.66%	1.81	2.00
Gd, ppm	2.51	0.70	1.12	3.90	0.43	4.60	27.68%	55.37%	83.05%	2.39	2.64
Ge, ppm	0.12	0.02	0.08	0.15	0.07	0.17	14.95%	29.91%	44.86%	0.11	0.12
Hf, ppm	0.29	0.016	0.26	0.32	0.24	0.34	5.46%	10.91%	16.37%	0.28	0.31
Hg, ppm	0.067	0.013	0.042	0.093	0.029	0.105	18.95%	37.91%	56.86%	0.064	0.071
In, ppm	1.73	0.074	1.58	1.88	1.51	1.95	4.30%	8.59%	12.89%	1.64	1.82
K, wt.%	0.158	0.026	0.106	0.210	0.080	0.236	16.40%	32.80%	49.20%	0.150	0.166
La, ppm	20.5	3.9	12.6	28.4	8.7	32.4	19.24%	38.48%	57.73%	19.5	21.5
Li, ppm	1.56	0.41	0.74	2.37	0.34	2.77	26.07%	52.15%	78.22%	1.48	1.63

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

Table 5 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											
Mg, wt.%	0.077	0.010	0.058	0.096	0.048	0.105	12.45%	24.89%	37.34%	0.073	0.080
Mn, wt.%	0.009	0.001	0.007	0.010	0.007	0.010	7.02%	14.05%	21.07%	0.008	0.009
Mo, ppm	4.85	0.287	4.27	5.42	3.98	5.71	5.92%	11.84%	17.77%	4.60	5.09
Ni, ppm	6.84	0.308	6.22	7.45	5.91	7.76	4.50%	9.01%	13.51%	6.50	7.18
P, wt.%	0.020	0.002	0.016	0.023	0.015	0.025	8.66%	17.32%	25.98%	0.019	0.021
Pb, ppm	70	4.4	61	79	57	83	6.22%	12.45%	18.67%	66	73
Rb, ppm	9.69	1.13	7.42	11.95	6.29	13.08	11.69%	23.38%	35.07%	9.20	10.17
Re, ppb	0.995	0.045	0.905	1.085	0.860	1.130	4.52%	9.04%	13.57%	0.945	1.045
S, wt.%	2.38	0.080	2.22	2.54	2.14	2.62	3.38%	6.76%	10.13%	2.26	2.50
Sb, ppm	3.10	0.63	1.84	4.37	1.20	5.00	20.38%	40.76%	61.15%	2.95	3.26
Sc, ppm	1.26	0.15	0.96	1.55	0.82	1.69	11.63%	23.26%	34.89%	1.19	1.32
Se, ppm	24.9	1.85	21.2	28.6	19.3	30.5	7.45%	14.89%	22.34%	23.7	26.1
Sm, ppm	3.17	0.81	1.56	4.78	0.75	5.59	25.40%	50.80%	76.20%	3.01	3.33
Sn, ppm	18.9	1.46	16.0	21.8	14.5	23.3	7.73%	15.45%	23.18%	18.0	19.9
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Te, ppm	0.091	0.020	0.051	0.131	0.031	0.151	22.07%	44.13%	66.20%	0.086	0.095
Th, ppm	7.41	1.01	5.39	9.44	4.38	10.45	13.65%	27.31%	40.96%	7.04	7.79
Tl, ppm	0.090	0.015	0.059	0.121	0.043	0.136	17.24%	34.47%	51.71%	0.085	0.094
U, ppm	1.87	0.127	1.62	2.13	1.49	2.26	6.78%	13.56%	20.34%	1.78	1.97
V, ppm	13.4	2.9	7.6	19.2	4.7	22.1	21.58%	43.15%	64.73%	12.7	14.1
W, ppm	8.38	0.97	6.44	10.32	5.47	11.29	11.58%	23.16%	34.74%	7.96	8.80
Y, ppm	4.79	0.88	3.03	6.54	2.16	7.42	18.30%	36.60%	54.91%	4.55	5.03
Zn, ppm	167	9	150	185	141	194	5.30%	10.60%	15.90%	159	176
Zr, ppm	8.72	0.745	7.23	10.21	6.49	10.96	8.54%	17.08%	25.63%	8.28	9.16

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

Notes: intervals may appear asymmetric due to rounding; 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.

IND = indeterminate.

PREPARER AND SUPPLIER

Certified reference material OREAS 929b is prepared, certified and supplied by:

ORE Research & Exploration Pty Ltd
37A Hosie Street
Bayswater North VIC 3153
AUSTRALIA

Tel: +613-9729 0333
Web: www.oreas.com
Email: info@ore.com.au

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, Malaga, WA, Australia
7. ALS, Vancouver, BC, Canada
8. American Assay Laboratories, Sparks, Nevada, USA
9. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
10. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
11. ESAN Istanbul, Istanbul, Turkey
12. Inspectorate (BV), Lima, Peru
13. Inspectorate Griffith India, Gandhidham, Gujarat, India
14. Inspectorate Griffith India Pvt. Ltd., Zawar, Rajasthan, India
15. Intertek, Perth, WA, Australia
16. Paragon Geochemical Laboratories, Sparks, Nevada, USA
17. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
18. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
19. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
20. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
21. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
22. UIS Analytical Services, Centurion, South Africa

Please note: To maintain anonymity of participating laboratories, the alphabetical list above does not correspond to the Lab ID numbers shown in the scatter plots below.

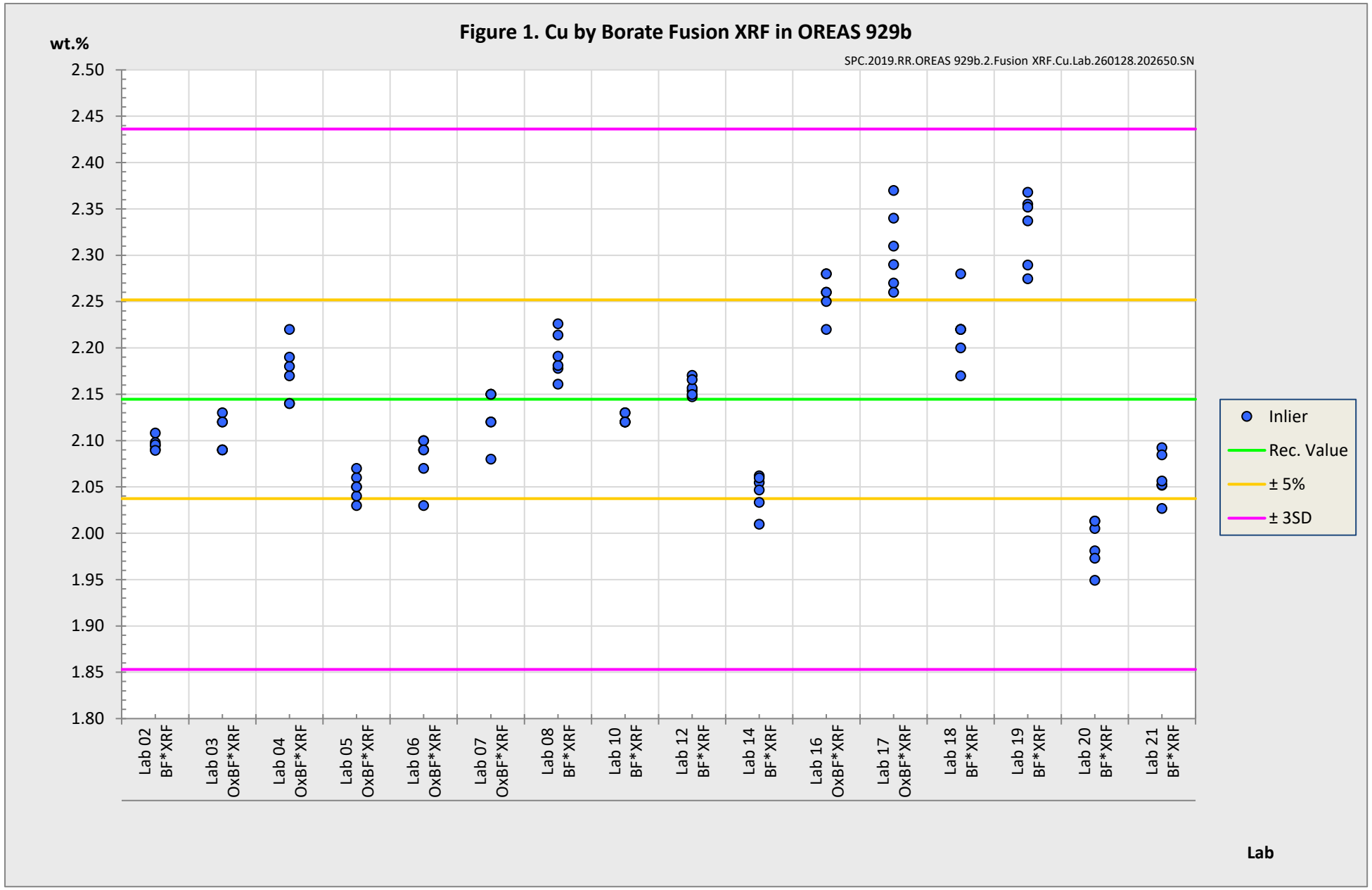

Figure 1. Cu by Borate Fusion XRF in OREAS 929b
wt.%
SPC.2019.RR.OREAS 929b.2.Fusion XRF.Cu.Lab.260128.202650.SN
2.50
2.45
2.40
2.35
2.30
2.25
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
Lab 02 BF*XRF
Lab 03 OxBF*XRF
Lab 04 OxBF*XRF
Lab 05 OxBF*XRF
Lab 06 OxBF*XRF
Lab 07 OxBF*XRF
Lab 08 BF*XRF
Lab 10 BF*XRF
Lab 12 BF*XRF
Lab 14 BF*XRF
Lab 16 OxBF*XRF
Lab 17 OxBF*XRF
Lab 18 BF*XRF
Lab 19 BF*XRF
Lab 20 BF*XRF
Lab 21 BF*XRF
Lab
Inlier
Rec. Value
± 5%
± 3SD

Figure 2. Ag by 4-Acid Digestion in OREAS 929b

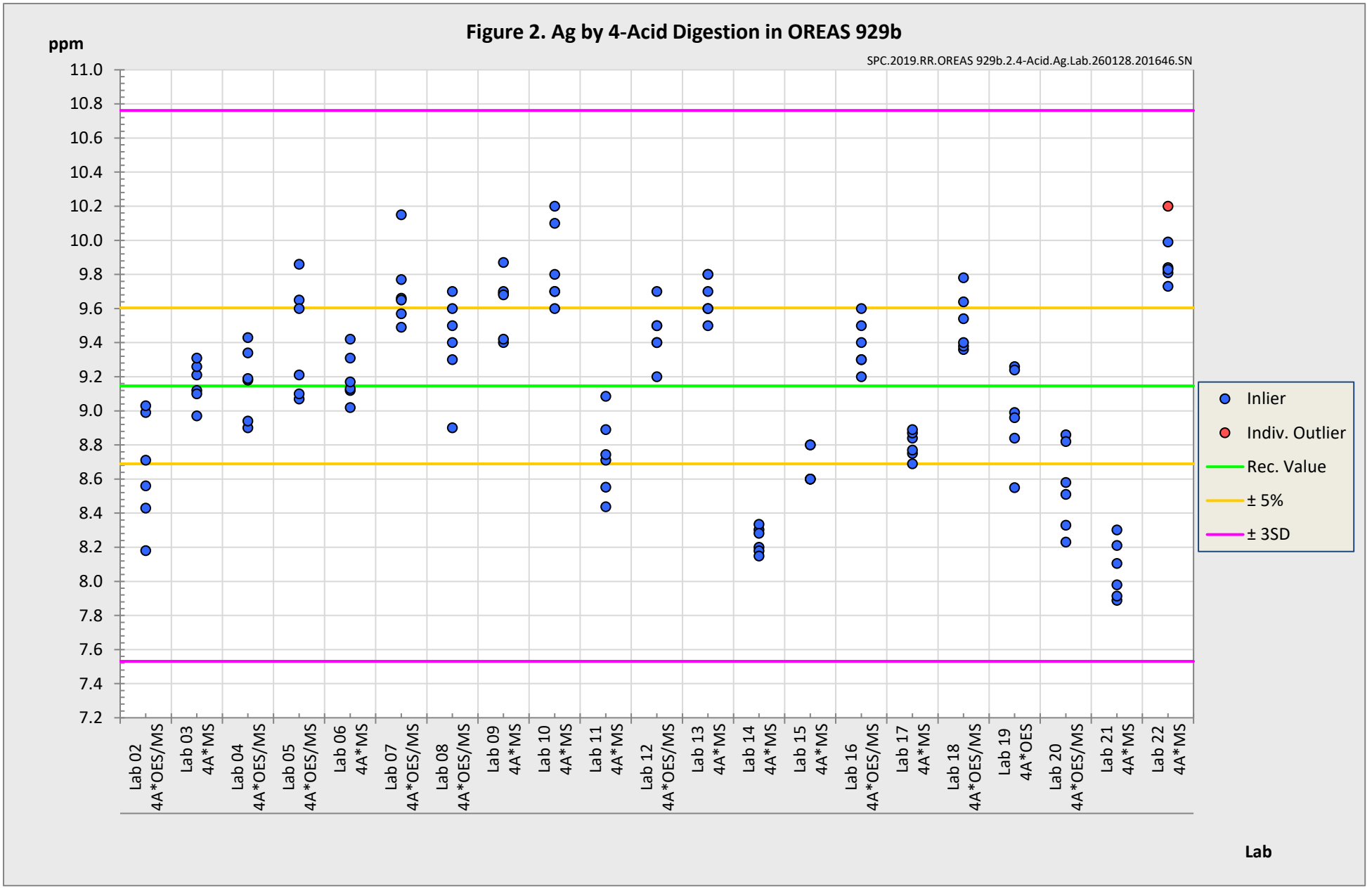
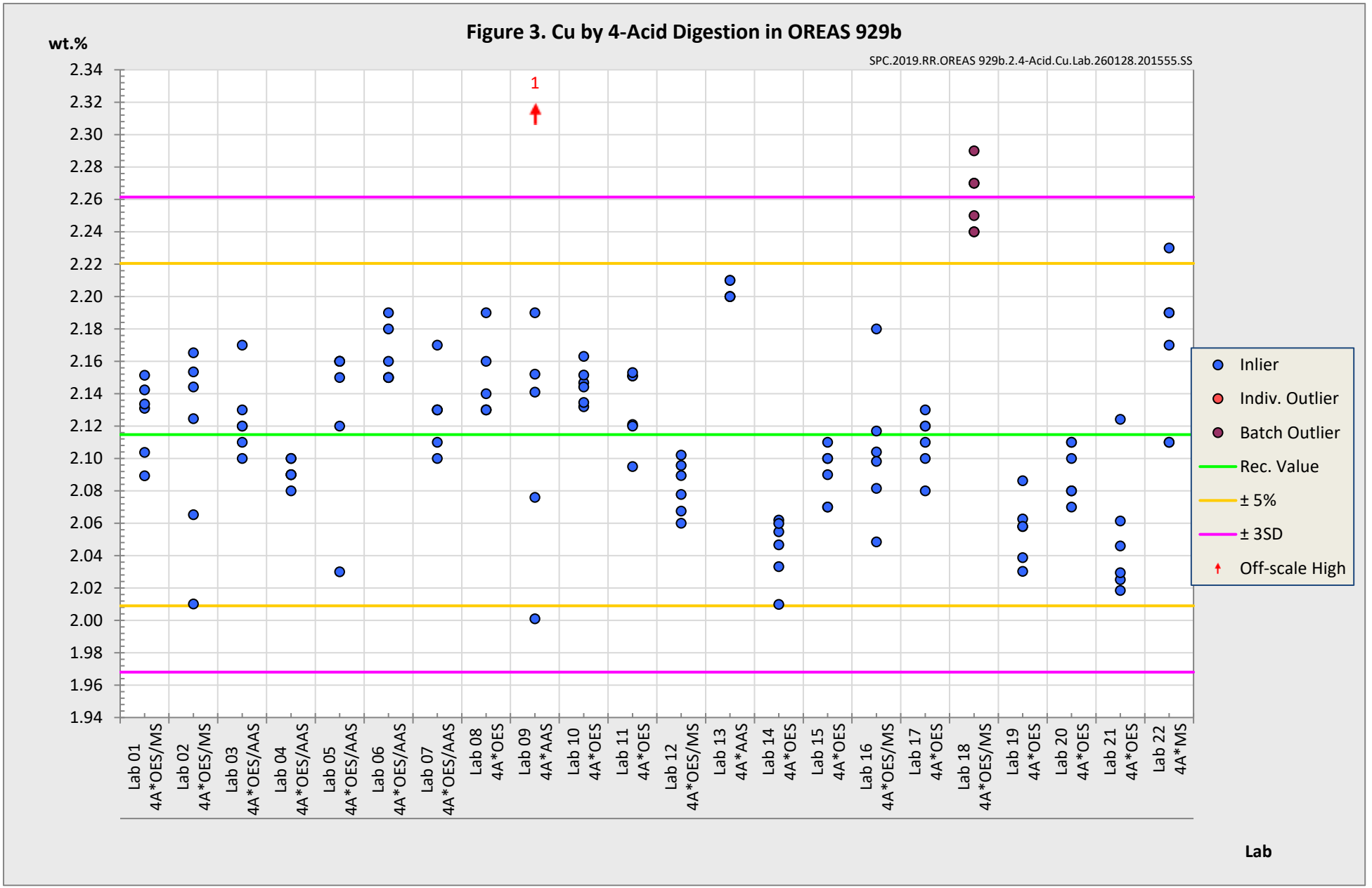
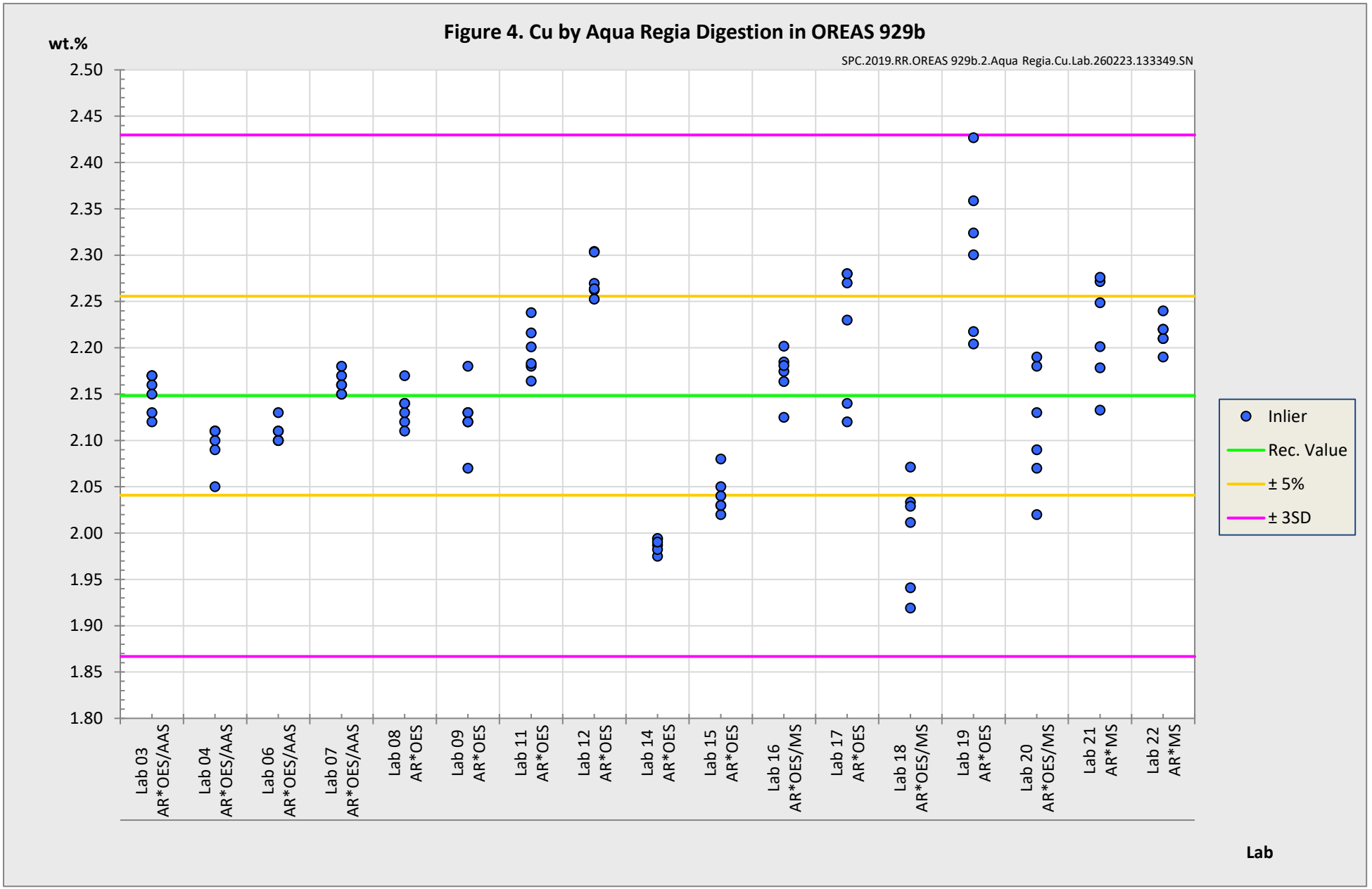


Figure 3. Cu by 4-Acid Digestion in OREAS 929b




Figure 4. Cu by Aqua Regia Digestion in OREAS 929b
wt.%
SPC.2019.RR.OREAS 929b.2.Aqua Regia.Cu.Lab.260223.133349.SN
2.50
2.45
2.40
2.35
2.30
2.25
2.20
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
Lab 03 AR*OES/AAS
Lab 04 AR*OES/AAS
Lab 06 AR*OES/AAS
Lab 07 AR*OES/AAS
Lab 08 AR*OES
Lab 09 AR*OES
Lab 11 AR*OES
Lab 12 AR*OES
Lab 14 AR*OES
Lab 15 AR*OES
Lab 16 AR*OES/MS
Lab 17 AR*OES
Lab 18 AR*OES/MS
Lab 19 AR*OES
Lab 20 AR*OES/MS
Lab 21 AR*MS
Lab 22 AR*MS
Lab
Inlier
Rec. Value
± 5%
± 3SD

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 or as milligrams per kilogram (mg/kg)) [14]. In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%) or parts per million (ppm).

The analytical samples sent to participating laboratories were selected in a manner to be representative of the entire prepared batch of CRM. This representativeness 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. The systematic sampling method was chosen due to the low risk of overlooking repetitive effects or trends in the batch due to the way the CRM was processed. In line with ISO 17025 [7], each analytical data set received from the participating laboratories has been validated by its assayer through the inclusion of internal reference materials and QC checks during and post analysis.

Participating laboratories were selected based on demonstrated analytical competence, including prior performance in interlaboratory comparison programs conducted by ORE Pty Ltd, with consideration given to their expertise in relevant analytical methods, measurands, and sample matrices. For the measurands reported in this certificate (Table 1), data were sourced from laboratories accredited to ISO/IEC 17025. Where formal accreditation was not held for specific operationally defined measurands, metrological traceability was verified through the use of well-characterised, independently certified reference materials (CRMs) included as control samples in the round robin study.

In accordance with ISO 33405:2024-05 [4], clause 9.2.5, and ISO 17034:2016 [8], clause 7.12.4 b), the use of such control samples provides an acceptable means of demonstrating traceability in the absence of formal accreditation. In this certification program, traceability was further supported by the agreement of measured values for control samples with their known certified values, thereby offering additional confidence in the calibration and validity of measurement results across participating laboratories.

Operationally Defined Measurands

In accordance with ISO 33405:2024-05, Clause 9.2.4, measurands (analytes) may be certified as operationally defined. For these measurands, traceability to the SI may not be achievable because the analytical procedure involves sample transformations (e.g., leaching or extraction). While instrument calibration can be traceable to appropriate units, the transformation steps themselves are not directly traceable and can only be evaluated through reference comparisons or harmonized procedures.

Accordingly, characterisation of these measurands has been based on the concordance of results obtained from multiple laboratories using a common, well-defined procedure. This approach ensures fitness-for-purpose and fulfils the requirements for metrological traceability as specified in ISO 17034 and ISO 33405 for operationally defined measurands.

COMMUTABILITY

The certified values reported herein are derived from measurements performed using analytical methods involving sample pre-treatment steps, such as fusion or acid digestion. These processes convert the sample matrix into a chemically simplified and stable form,

facilitating calibration traceable to primary standards via solution-based calibration protocols. Due to the established robustness and effectiveness of these pre-treatment methods, issues related to commutability are not expected to impact the suitability of this Certified Reference Material (CRM) for its intended use.

OREAS CRMs are prepared from natural ore materials, ensuring the presence of matrix and mineralogical characteristics representative of typical exploration and process samples. Consistent with ISO 17034:2016 and ISO Guide 30, users are advised to select CRMs with matrix and mineralisation styles closely matching those of their routine 'field' samples to minimize matrix effects and enhance analytical comparability. Detailed descriptions of the CRM's source material and mineralogical characteristics are provided in the 'Source Material' section to guide appropriate CRM selection.

INTENDED USE

OREAS 929b 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 929b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 929b 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/ validation 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. When a value provided in this certificate is used to calibrate a measurement process, the uncertainty associated with that value should be appropriately propagated into the user's uncertainty calculation. Users can determine an approximation of the standard uncertainty by calculating one fourth of the width of the Expanded Uncertainty interval given in this certificate (Expanded Uncertainty intervals are provided 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:

- Borate fusion with X-ray fluorescence finish: ≥0.2 g;
- Loss on Ignition (LOI) at 1000 °C: ≥1 g;
- C and S by infrared combustion furnace/CS analyser: ≥ 0.1 g;
- Borate fusion /Sodium peroxide with ICP-OES and/or MS finish: ≥0.2 g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥ 0.25 g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥ 0.5 g.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 929b remains valid, within the specified measurement uncertainties, until at least June 2040, 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.

Single-use sachets

OREAS 929b contains sulphides (2.4 wt.% Total Sulphur) and is packaged in single-use, 10 g laminated foil sachets. Following analysis, it is the manufacturer's expectation that any remaining material is discarded. It is the user's responsibility to prevent contamination and avoid prolonged exposure of the sample to the atmosphere prior to analysis.

INSTRUCTIONS FOR HANDLING & CORRECT USE

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

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [11].

As per routine analysis at commercial laboratories, the certified values derived by borate fusion with XRF finish are on a dry sample basis. Analytes by all other methods refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis for these methods.

Authoritative Source of Information

This Certificate of Analysis constitutes the primary and authoritative document for the certified values, associated expanded uncertainties, and their correct use. While the accompanying DataPack provides supporting information, including raw data and uncertainty estimates with additional significant figures, these extended figures are provided solely for transparency, convenience and statistical reference. Users must rely exclusively on the values stated in this Certificate, rounded to an appropriate number of significant figures, for all metrological and analytical purposes. Any discrepancy between values presented in the DataPack and those in this Certificate shall be resolved in favour of the information provided herein.

Notice on Certificate Updates

The version of the Certificate of Analysis (COA) available on the OREAS website is considered the official and most current version. As COAs may be revised following periodic reviews, re-evaluation of data, or the availability of new information, users are strongly advised to refer to the latest online version prior to each use. It is the user's responsibility to ensure that the most recent and applicable certificate is used to support the traceability,

validity, and fitness-for-purpose of the certified reference material (CRM). Any significant changes to the sections of this certificate will be clearly documented in the revised certificate.

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 5 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 95 % 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.

© COPYRIGHT Ore Research & Exploration Pty Ltd.
Unauthorised copying, reproduction, storage or dissemination is prohibited.

DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	16th February 2026	First publication.

CERTIFYING OFFICER

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

QMS CERTIFICATION

ORE Pty Ltd is accredited for compliance with ISO 17034:2016 (Accreditation number 20483).

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.

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 33401:2024-01. Reference materials – Contents of certificates, labels and accompanying documentation.

[4] ISO 33405:2024-05. Reference materials – Approaches for characterization and assessment of homogeneity and stability.

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

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

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

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

[9] Munsell Rock Color Book (2014). Rock-Color Chart Committee, Geological Society of America (GSA), Minnesota (USA).
[10] OREAS-BUP-70-09-11: Statistical Analysis - OREAS Evaluation Method.
[11] OREAS-TN-04-1498: Stability under transport; an experimental study of OREAS CRMs.
[12] OREAS-TN-05-1674: Long-term storage stability; an experimental study of OREAS CRMs.
[13] Thompson, A.; Taylor, B.N. (2008); Guide for the Use of the International System of Units (SI); NIST Special Publication 811; U.S. Government Printing Office: Washington, DC; available at: https://physics.nist.gov/cuu/pdf/sp811.pdf (accessed Nov 2021).
[14] Van der Veen A.M.H. et al. (2001). Uncertainty calculations in the certification of reference materials, Accred Qual Assur 6: 290-294.