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CERTIFICATE OF ANALYSIS FOR

FERRUGINOUS SOIL REFERENCE MATERIAL OREAS 45b

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June, 2010

REPORT 02/471A

Summary Statistics

Table 1. Precious and base metals by fire assay and 4 acid digest ICPOES/MS

Constituent	Recommended value	1 standard deviation
Antimony, Sb (ppm)	0.90	0.22
Arsenic, As (ppm)	12.6	1.4
Bismuth, Bi (ppm)	0.22	0.02
Cadmium, Cd (ppm)	0.12	0.04
Chromium, Cr (ppm)	861	27
Cobalt, Co (ppm)	85	5
Copper, Cu (ppm)	522	6
Gold, Au (ppb)	36	3
Lead, Pb (ppm)	26.0	1.0
Nickel, Ni (ppm)	280	10
Palladium, Pd (ppb)	38	1
Platinum, Pt (ppb)	52	5
Silver, Ag (ppm)	0.23	0.03
Zinc, Zn (ppm)	196	7

IND - indeterminate

Table 2. Precious and base metals by aqua regia ICPOES/MS

Constituent	Recommended value	1 standard deviation
Antimony, Sb (ppm)	0.31	0.05
Arsenic, As (ppm)	3.0	0.9
Bismuth, Bi (ppm)	0.18	0.01
Cadmium, Cd (ppm)	0.10	0.01
Chromium, Cr (ppm)	667	53
Cobalt, Co (ppm)	73.8	2.3
Copper, Cu (ppm)	449	35
Gold, Au (ppb)	31	3
Lead, Pb (ppm)	21	1
Nickel, Ni (ppm)	197	11
Palladium, Pd (ppb)	35	7
Platinum, Pt (ppb)	48	8
Silver, Ag (ppm)	0.20	0.01
Zinc, Zn (ppm)	173	8

IND - indeterminate

Table 3. Major elements, LOI, C & S by fusion XRF/ICPOES & Leco

Constituent	Recommended value	1 standard deviation
Si (wt.%)	20.11	0.37
Al (wt.%)	7.63	0.12
Fe (wt.%)	17.40	0.12
Ca (wt.%)	0.355	0.005
Mg (wt.%)	0.254	0.012
Na (wt.%)	0.076	0.009
K (wt.%)	0.307	0.016
Mn (wt.%)	0.101	0.001
Ti (wt.%)	1.53	0.04
P (wt.%)	0.059	0.002
Cr (wt.%)	0.088	0.003
LOI (wt.%)	12.68	0.23
Carbon, C (wt.%)	3.15	0.18
Sulphur, S (wt.%)	0.034	0.005

IND - indeterminate

Table 4. Lithophile trace elements by fusion ICPMS

Constituent	Recommended value	1 standard deviation
Barium, Ba (ppm)	232	8
Cerium, Ce (ppm)	54.1	1.1
Dysprosium, Dy (ppm)	4.3	0.2
Erbium, Er (ppm)	2.2	0.1
Europium, Eu (ppm)	1.28	0.03
Gadolinium, Gd (ppm)	4.4	0.32
Holmium, Ho (ppm)	0.79	0.03
Lanthanium, La (ppm)	29.8	0.89
Lutetium, Lu (ppm)	0.31	0.03
Neodymium, Nd (ppm)	23.8	0.82
Niobium, Nb (ppm)	32	0.89
Praseodymium, Pr (ppm)	6.15	0.19
Rubidium, Rb (ppm)	22.1	1.12
Samarium, Sm (ppm)	5.0	0.19
Strontium, Sr (ppm)	35.9	1.41
Terbium, Tb (ppm)	0.71	0.02
Thorium, Th (ppm)	10.8	1.07
Thulium, Tm (ppm)	0.31	0.02
Tin, Sn (ppm)	3.9	0.33
Uranium, U (ppm)	2.7	0.26
Ytterbium, Yb (ppm)	2.1	0.14
Yttrium, Y (ppm)	19.0	1.72
Zirconium, Zr (ppm)	324	18.26

IND – indeterminate

SOURCE MATERIALS

Multi-element soil standard OREAS 45b is one of a pigeon pair prepared from a 40:60 blend of soil characterised by anomalous levels of precious and base metals and barren soil. The anomalous sample was obtained from soil developed over a Ni-Cu-PGE mineralised contact between gabbro and pyroxenite from the Southern Murchison region of Western Australia while the barren sample was taken from an in situ layer of mature soil developed over early Tertiary olivine basalt in outer eastern Melbourne, Victoria, Australia.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material was prepared in the following manner:

a) drying each sample to constant mass at 105^0 C;
b) crushing and screening each sample;
c) milling anomalous soil to minus 25 microns;
d) milling barren soil to minus 75 microns;
e) thorough homogenisation of a 40:60 blend of the PGE anomalous and barren soils;
f) packaging into 10g and 60g units in laminated foil pouches and also in 1kg units in plastic jars.

ANALYSIS OF OREAS 45b

Seven commercial laboratories participated in the analytical program to characterise elements listed in Tables 1 - 4. Their results together with uncorrected means, medians, one sigma standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM^3) are presented in Appendices A, B, C and D. The parameter PDM^3 (percent deviation of lab mean from the corrected mean of means) is a measure of laboratory accuracy while RSD (the relative standard deviation) is an effective measure of analytical precision where homogeneity of the test material has been confirmed. The analytical methods employed by each laboratory are given in column headings and explained in Table 1 of each appendix.
With the exception of Lab G, five 60g were submitted to each laboratory for analysis and were taken at spaced intervals during packaging of the standard in order to maximise their representation. Each laboratory was instructed to determine: Au, Pt and Pd by fire assay ICPMS; Ag, As, Bi, Cd, Co, Cr, Cu, Na, Ni, P, Pb, Sb, Zn by four-acid digest and ICPOES or ICPMS; Ag, As, Au, Bi, Cd, Co, Cr, Cu, Ni, Pb, Pd, Pt, Sb, Zn by aqua regia and ICPOES or ICPMS; major elements by fusion XRF or fusion ICPOES; C and S by Leco furnace; lithophile trace elements by fusion ICPMS. Lab G determined As, Au, Ce, La, Lu, Na, Sb, Sm and Yb in twenty replicates via instrumental neutron activation analysis (INAA) using reduced analytical subsample weights of 4g.

STATISTICAL EVALUATION OF ANALYTICAL DATA FOR OREAS 45b

Recommended Value and Confidence Limits

The certified value is the mean of means of accepted replicate values of accepted participating laboratories computed according to the formulae

$$\bar{x}_i = \frac{1}{n_i} \sum_{j=1}^{n_i} x_{ij}$$

$$\ddot{x} = \frac{1}{p} \sum_{i=1}^{p} \bar{x}_i$$

where

x_{ij} *is the jth result reported by laboratory i;*

p is the number of participating laboratories;

n_i *is the number of results reported by laboratory i;*

$\bar{x}_i$ *is the mean for laboratory i;*

$\ddot{x}$ *is the mean of means.*

The confidence limits were obtained by calculation of the variance of the consensus value (mean of means) and reference to Student's-*t* distribution with degrees of freedom (*p*-1).

$$\hat{V}(\ddot{x}) = \frac{1}{p(p-1)} \sum_{i=1}^{p} (\bar{x}_i - \ddot{x})^2$$

$$\text{Confidence limits} = \ddot{x} \pm t_{1-x/2}(p-1)(\hat{V}(\ddot{x}))^{1/2}$$

where $t_{1-x/2}(p-1)$ *is the 1-x/2 fractile of the t-distribution with (p-1) degrees of freedom.*

The distribution of the values are assumed to be symmetrical about the mean in the calculation of the confidence limits.

The test for rejection of individual outliers from each laboratory data set was based on *z* scores (rejected if $|z_i| > 2.5$) computed from the robust estimators of location and scale, *T* and *S*, respectively, according to the formulae

$$S = 1.483 \underset{j=1.....n}{\text{median}} / x_j - \underset{i=1.....n}{\text{median}} (x_i) /$$

$$z_i = \frac{x_i - T}{S}$$

where

T is the median value in a data set;

S is the median of all absolute deviations from the sample median multiplied by 1.483, a correction factor to make the estimator consistent with the usual parameter of a normal distribution.

Table 5. Recommended values and 95% confidence intervals for precious and base metals by fire assay and four-acid digest ICPOES/MS in OREAS 45b.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Antimony, Sb (ppm)	0.90	0.70	1.10
Arsenic, As (ppm)	12.6	10.9	14.4
Bismuth, Bi (ppm)	0.22	0.20	0.24
Cadmium, Cd (ppm)	0.12	0.05	0.19
Chromium, Cr (ppm)	861	829	892
Cobalt, Co (ppm)	85	80	90
Copper, Cu (ppm)	522	517	526
Gold, Au (ppb)	36	33	40
Lead, Pb (ppm)	26.0	25.1	26.9
Nickel, Ni (ppm)	280	270	289
Palladium, Pd (ppb)	38	37	39
Platinum, Pt (ppb)	52	47	57
Silver, Ag (ppm)	0.23	0.21	0.26
Zinc, Zn (ppm)	196	191	200

Table 6. Recommended values and 95% confidence intervals for precious and base metals by aqua regia digest ICPOES/MS in OREAS 45b.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Antimony, Sb (ppm)	0.31	0.28	0.35
Arsenic, As (ppm)	3.0	2.1	3.9
Bismuth, Bi (ppm)	0.18	0.15	0.20
Cadmium, Cd (ppm)	0.10	0.10	0.11
Chromium, Cr (ppm)	667	609	724
Cobalt, Co (ppm)	73.8	72.5	75.1
Copper, Cu (ppm)	449	411	487
Gold, Au (ppb)	31	26	37
Lead, Pb (ppm)	21	19	23
Nickel, Ni (ppm)	197	184	211
Palladium, Pd (ppb)	35	19	52
Platinum, Pt (ppb)	48	34	61
Silver, Ag (ppm)	0.20	0.19	0.21
Zinc, Zn (ppm)	173	165	182

Table 7. Recommended values and 95% confidence intervals for major elements, LOI, C & S by fusion XRF/ICPOES and Leco in OREAS 45b.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Si (wt.%)	20.11	19.71	20.51
Al (wt.%)	7.63	7.48	7.79
Fe (wt.%)	17.40	17.30	17.51
Ca (wt.%)	0.355	0.351	0.358
Mg (wt.%)	0.254	0.243	0.266
Na (wt.%)	0.076	0.066	0.085
K (wt.%)	0.307	0.291	0.322
Mn (wt.%)	0.101	0.099	0.103
Ti (wt.%)	1.53	1.47	1.58
P (wt.%)	0.059	0.057	0.061
Cr (wt.%)	0.088	0.085	0.091
LOI (wt.%)	12.68	12.38	12.98
Carbon, C (wt.%)	3.15	2.95	3.34
Sulphur, S (wt.%)	0.034	0.028	0.039

Table 8. Recommended values and 95% confidence intervals for lithophile trace elements by fusion ICPMS in OREAS 45b.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Barium, Ba (ppm)	232	223	240
Cerium, Ce (ppm)	55.3	54.0	56.5
Dysprosium, Dy (ppm)	4.3	4.0	4.6
Erbium, Er (ppm)	2.2	2.1	2.4
Europium, Eu (ppm)	1.28	1.23	1.33
Gadolinium, Gd (ppm)	4.4	3.9	4.9
Holmium, Ho (ppm)	0.79	0.77	0.82
Lanthanium, La (ppm)	29.1	27.7	30.6
Lutetium, Lu (ppm)	0.31	0.30	0.32
Neodymium, Nd (ppm)	23.8	22.2	25.4
Niobium, Nb (ppm)	32	31	32
Praseodymium, Pr (ppm)	6.15	5.90	6.41
Rubidium, Rb (ppm)	22.1	20.9	23.3
Samarium, Sm (ppm)	5.0	4.8	5.3
Strontium, Sr (ppm)	35.9	34.5	37.3
Terbium, Tb (ppm)	0.71	0.69	0.72
Thorium, Th (ppm)	10.8	9.6	12.0
Thulium, Tm (ppm)	0.31	0.29	0.33
Tin, Sn (ppm)	3.9	3.6	4.3
Uranium, U (ppm)	2.7	2.4	2.9
Ytterbium, Yb (ppm)	2.1	2.0	2.3
Yttrium, Y (ppm)	19.0	17.1	20.9
Zirconium, Zr (ppm)	324	300	347

In certain instances statistician's prerogative has been employed in discriminating outliers. Individual outliers and, more rarely, laboratory means deemed to be outlying are shown in bold (Appendices A, B, C, & D) and have been omitted in the determination of recommended values.
The magnitude of the confidence interval is inversely proportional to the number of participating laboratories and interlaboratory agreement. It is a measure of the reliability of the recommended value, i.e. the narrower the confidence interval the greater the certainty in the recommended value.

Statement of Homogeneity
The standard deviation of each laboratory data set includes error due to both the imprecision of the analytical method employed and to possible inhomogeneity of the material analysed. The standard deviation of the pooled individual analyses of all participating laboratories includes error due to the imprecision of each analytical method, to possible inhomogeneity of the material analysed and, in particular, to deficiencies in accuracy of each analytical method. In determining tolerance intervals for elements other than gold that component of error attributable to measurement inaccuracy was eliminated by transformation of the individual results of each data set to a common mean (the uncorrected grand mean) according to the formula

$$x'_{ij} = x_{ij} - \bar{x}_i + \frac{\sum_{i=1}^{p} \sum_{j=1}^{n_i} x_{ij}}{\sum_{i=1}^{p} n_i}$$

where

x_{ij} *is the jth raw result reported by laboratory i*;
x'_{ij} *is the jth transformed result reported by laboratory i*;
n_i *is the number of results reported by laboratory i*;
p *is the number of participating laboratories*;
$\bar{x}_i$ *is the raw mean for laboratory i.*

The homogeneity of each constituent was determined from tables of factors for two-sided tolerance limits for normal distributions (ISO 3207) in which

$$\text{Lower limit is } \ddot{x} - k'_2(n, p, 1-\alpha)s''_g$$
$$\text{Upper limit is } \ddot{x} + k'_2(n, p, 1-\alpha)s''_g$$

where

n is the number of results
1-α is the confidence level;
p is the proportion of results expected within tolerance limits;
k'_2 is the factor for two-sided tolerance limits (m, α unknown);
s''_g is the corrected grand standard deviation.

The meaning of these tolerance limits may be illustrated for 4-acid copper where 99% of the time at least 95% of subsamples will have concentrations lying between 511 and 532 ppm. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (IS0 Guide 35).
The corrected grand standard deviation, s_g'', used to compute the tolerance intervals is the weighted means of standard deviations of all data sets for a particular constituent according to the formula

$$s_g'' = \frac{\sum_{i=1}^{p} (s_i (1 - \frac{s_i}{s_g'}))}{\sum_{i=1}^{p} (1 - \frac{s_i}{s_g'})}$$

where

$$1 - (\frac{s_i}{2 s_g'}) \text{ is the weighting factor for laboratory } i ;$$

$$s_g' \text{ is the grand standard deviation computed from the transformed (i.e. means - adjusted) results}$$

according to the formula

$$s_g' = \left[\frac{\sum_{i=j}^{p} \sum_{j=i}^{n_i} (x_{ij}' - \bar{x}_i')^2}{\sum_{i=1}^{p} n_i - 1} \right]^{1/2}$$

$$\text{where } \bar{x}_i' \text{ is the transformed mean for laboratorty } i$$

The weighting factors were applied to compensate for the considerable variation in analytical precision amongst participating laboratories. Hence, weighting factors for each data set have been constructed so as to be inversely proportional to the standard deviation of that data set. Outliers were removed prior to the calculation of s_g' and a weighting factor of zero was applied to those data sets where $s_i / 2s_g' > 1$ (i.e. where the weighting factor $1 - s_i / 2s_g' < 0$).
It should be noted that estimates of tolerance by this method are considered conservative as a significant proportion of the observed variance, even in those laboratories exhibiting the best analytical precision, can presumably be attributed to measurement error.
For gold a more simplified procedure was used in the determination of homogeneity. This entailed using the high precision INAA data alone, obtained on an analytical subsample weight of 4g (compared to 30-50g for the fire assay method). By employing a sufficiently reduced subsample weight in a series of determinations by the same method, analytical

error becomes negligible in comparison to subsampling error. The corresponding standard deviation at a 50g subsample weight can then be determined from the observed standard deviation of the 4g data using the known relationship between the two parameters (Kleeman, 1967). The homogeneity of gold was then determined from tables of factors for two-sided tolerance limits for normal distributions.

Table 9. Recommended values and tolerance limits for precious and base metals by fire assay and four-acid digest ICPOES/MS.

Constituent	Recommended value	Tolerance limits 1-a=0.99, r=0.95	
		Low	High
Antimony, Sb (ppm)	0.90	0.82	0.98
Arsenic, As (ppm)	12.6	11.7	13.5
Bismuth, Bi (ppm)	0.22	0.21	0.24
Cadmium, Cd (ppm)	0.12	0.11	0.14
Chromium, Cr (ppm)	861	837	884
Cobalt, Co (ppm)	85	81	90
Copper, Cu (ppm)	522	511	532
Gold, Au (ppb)	36	33	40
Lead, Pb (ppm)	26.0	25.6	26.4
Nickel, Ni (ppm)	280	271	289
Palladium, Pd (ppb)	38	36	40
Platinum, Pt (ppb)	52	49	56
Silver, Ag (ppm)	0.23	0.22	0.25
Zinc, Zn (ppm)	196	188	204

Table 10. Recommended values and tolerance limits for precious and base metals by aqua regia digest ICPOES/MS.

Constituent	Recommended value	Tolerance limits 1-a=0.99, r=0.95	
		Low	High
Antimony, Sb (ppm)	0.31	0.28	0.34
Arsenic, As (ppm)	3.0	2.7	3.3
Bismuth, Bi (ppm)	0.18	0.17	0.18
Cadmium, Cd (ppm)	0.10	0.10	0.11
Chromium, Cr (ppm)	667	641	692
Cobalt, Co (ppm)	73.8	69.3	78.3
Copper, Cu (ppm)	449	430	468
Gold, Au (ppb)	31	28	34
Lead, Pb (ppm)	21	20	22
Nickel, Ni (ppm)	197	192	202
Palladium, Pd (ppb)	35	33	38
Platinum, Pt (ppb)	48	47	48
Silver, Ag (ppm)	0.20	0.19	0.21
Zinc, Zn (ppm)	173	164	183

Table 11. Recommended values and tolerance limits for major elements, LOI, C & S by fusion XRF/ICPOES and Leco.

Constituent	Recommended value	Tolerance limits 1-a=0.99, r=0.95	
		Low	High
Si (wt.%)	20.11	19.93	20.29
Al (wt.%)	7.63	7.38	7.89
Fe (wt.%)	17.40	17.18	17.63
Ca (wt.%)	0.355	IND	IND
Mg (wt.%)	0.254	0.236	0.273
Na (wt.%)	0.076	0.074	0.078
K (wt.%)	0.307	0.301	0.312
Mn (wt.%)	0.101	IND	IND
Ti (wt.%)	1.53	1.51	1.54
P (wt.%)	0.059	0.056	0.061
Cr (wt.%)	0.088	0.087	0.088
LOI (wt.%)	12.68	12.42	12.94
Carbon, C (wt.%)	3.15	3.08	3.22
Sulphur, S (wt.%)	0.034	0.020	0.048

Table 12. Recommended values and tolerance limits for lithophile trace elements by fusion ICPMS.

Constituent	Recommended value	Tolerance limits 1-a=0.99, r=0.95	
		Low	High
Barium, Ba (ppm)	232	221	242
Cerium, Ce (ppm)	55.3	53.3	57.2
Dysprosium, Dy (ppm)	4.3	3.9	4.6
Erbium, Er (ppm)	2.2	2.1	2.3
Europium, Eu (ppm)	1.28	1.26	1.30
Gadolinium, Gd (ppm)	4.4	4.0	4.8
Holmium, Ho (ppm)	0.79	0.77	0.81
Lanthanium, La (ppm)	29.1	28.3	30.0
Lutetium, Lu (ppm)	0.31	0.29	0.32
Neodymium, Nd (ppm)	23.8	22.4	25.3
Niobium, Nb (ppm)	32	30	33
Praseodymium, Pr (ppm)	6.15	5.86	6.45
Rubidium, Rb (ppm)	22.1	21.9	22.3
Samarium, Sm (ppm)	5.0	4.9	5.2
Strontium, Sr (ppm)	35.9	34.0	37.9
Terbium, Tb (ppm)	0.71	0.69	0.72
Thorium, Th (ppm)	10.8	10.1	11.6
Thulium, Tm (ppm)	0.31	0.30	0.32
Tin, Sn (ppm)	3.9	3.9	3.9
Uranium, U (ppm)	2.7	2.6	2.7
Ytterbium, Yb (ppm)	2.1	2.0	2.3
Yttrium, Y (ppm)	19.0	18.4	19.6
Zirconium, Zr (ppm)	324	309	338

Performance Gates

Performance gates provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this standard in a QA/QC program. They take into account errors attributable to measurement (analytical bias and precision) and standard variability. For an effective standard the contribution of the latter should be negligible in comparison to measurement errors.

The first method uses the standard deviation of the pooled individual analyses generated from the certification program. All individual and lab dataset (batch) outliers are removed prior to determination of the standard deviation. These outliers can only be removed if they can be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM.

Table 13. Performance gates for precious and base metals by fire assay and four-acid digest ICPOES/MS.

Constituent	1 σ		2 σ		3 σ		5%	
	Low	High	Low	High	Low	High	Low	High
Antimony, Sb (ppm)	0.68	1.12	0.47	1.34	0.25	1.55	0.86	0.95
Arsenic, As (ppm)	11.2	14.0	9.8	15.4	8.4	16.8	12.0	13.3
Bismuth, Bi (ppm)	0.20	0.25	0.18	0.27	0.15	0.29	0.21	0.23
Cadmium, Cd (ppm)	0.08	0.17	0.04	0.21	IND	IND	0.12	0.13
Chromium, Cr (ppm)	834	888	807	914	780	941	818	904
Cobalt, Co (ppm)	80	90	75	95	71	100	81	90
Copper, Cu (ppm)	516	527	510	533	504	539	496	548
Gold, Au (ppb)	33	40	30	43	27	46	35	38
Lead, Pb (ppm)	25.0	27.0	24.0	28.0	23.0	29.0	24.7	27.3
Nickel, Ni (ppm)	270	289	260	299	251	309	266	294
Palladium, Pd (ppb)	37	39	35	41	34	42	36	40
Platinum, Pt (ppb)	48	57	43	61	39	66	50	55
Silver, Ag (ppm)	0.20	0.26	0.18	0.29	0.15	0.32	0.22	0.24
Zinc, Zn (ppm)	189	203	182	209	175	216	186	205

Table 14. Performance gates for precious and base metals by aqua regia digest ICPOES/MS.

Constituent	1 σ		2 σ		3 σ		5%	
	Low	High	Low	High	Low	High	Low	High
Antimony, Sb (ppm)	0.27	0.36	0.22	0.41	0.17	0.45	0.30	0.33
Arsenic, As (ppm)	2.1	3.8	1.3	4.7	0.4	5.6	2.8	3.1
Bismuth, Bi (ppm)	0.16	0.19	0.15	0.20	0.14	0.22	0.17	0.19
Cadmium, Cd (ppm)	0.10	0.11	0.09	0.12	0.08	0.13	0.10	0.11
Chromium, Cr (ppm)	614	719	561	772	509	825	633	700
Cobalt, Co (ppm)	71.5	76.1	69.3	78.3	67.0	80.6	70.1	77.5
Copper, Cu (ppm)	414	484	378	519	343	554	426	471
Gold, Au (ppb)	28	35	24	38	21	41	30	33
Lead, Pb (ppm)	20	23	18	24	17	25	20	22
Nickel, Ni (ppm)	187	208	176	218	166	229	187	207
Palladium, Pd (ppb)	28	42	22	49	15	55	33	37
Platinum, Pt (ppb)	40	55	32	63	24	71	45	50
Silver, Ag (ppm)	0.19	0.21	0.17	0.23	0.16	0.24	0.19	0.21
Zinc, Zn (ppm)	165	181	157	190	149	198	165	182

Table 15. Performance gates for major elements, LOI, C & S by fusion XRF/ICPOES and Leco.

Constituent	1 σ		2 σ		3 σ		5%	
	Low	High	Low	High	Low	High	Low	High
Si (wt.%)	19.74	20.49	19.36	20.86	18.99	21.24	19.11	21.12
Al (wt.%)	7.51	7.75	7.39	7.87	7.27	7.99	7.25	8.01
Fe (wt.%)	17.28	17.52	17.16	17.64	17.04	17.76	16.53	18.27
Ca (wt.%)	0.350	0.359	0.345	0.364	0.341	0.369	0.337	0.372
Mg (wt.%)	0.243	0.266	0.231	0.278	0.220	0.289	0.242	0.267
Na (wt.%)	0.066	0.085	0.057	0.095	0.047	0.104	0.072	0.080
K (wt.%)	0.291	0.322	0.275	0.338	0.259	0.354	0.291	0.322
Mn (wt.%)	0.100	0.102	0.099	0.103	0.098	0.104	0.096	0.106
Ti (wt.%)	1.49	1.57	1.45	1.61	1.40	1.65	1.45	1.60
P (wt.%)	0.056	0.061	0.054	0.063	0.052	0.066	0.056	0.062
Cr (wt.%)	0.085	0.090	0.083	0.093	0.080	0.096	0.083	0.092
LOI (wt.%)	12.45	12.91	12.22	13.15	11.99	13.38	12.05	13.32
Carbon, C (wt.%)	2.97	3.33	2.79	3.50	2.61	3.68	2.99	3.30
Sulphur, S (wt.%)	0.03	0.04	0.02	0.04	0.02	0.05	0.032	0.035

Table 16. Performance gates for lithophile elements by fusion ICPMS.

Constituent	1 σ		2 σ		3 σ		5%	
	Low	High	Low	High	Low	High	Low	High
Barium, Ba (ppm)	224	239	216	247	208	255	220	243
Cerium, Ce (ppm)	53.0	55.2	51.9	56.2	50.9	57.3	51.4	56.8
Dysprosium, Dy (ppm)	4.0	4.5	3.8	4.7	3.6	4.9	4.0	4.5
Erbium, Er (ppm)	2.1	2.3	2.0	2.4	1.9	2.5	2.1	2.3
Europium, Eu (ppm)	1.24	1.31	1.21	1.35	1.17	1.38	1.21	1.34
Gadolinium, Gd (ppm)	4.1	4.7	3.8	5.0	3.4	5.3	4.2	4.6
Holmium, Ho (ppm)	0.76	0.82	0.74	0.85	0.71	0.87	0.75	0.83
Lanthanium, La (ppm)	28.9	30.7	28.0	31.6	27.1	32.5	28.3	31.3
Lutetium, Lu (ppm)	0.28	0.34	0.26	0.36	0.23	0.39	0.29	0.33
Neodymium, Nd (ppm)	23.0	24.6	22.2	25.4	21.4	26.3	22.6	25.0
Niobium, Nb (ppm)	31	33	30	34	29	34	30	33
Praseodymium, Pr (ppm)	5.97	6.34	5.78	6.52	5.60	6.71	5.85	6.46
Rubidium, Rb (ppm)	21.0	23.2	19.9	24.4	18.7	25.5	21.0	23.2
Samarium, Sm (ppm)	4.8	5.2	4.6	5.4	4.4	5.5	4.7	5.2
Strontium, Sr (ppm)	34.5	37.3	33.1	38.8	31.7	40.2	34.1	37.7
Terbium, Tb (ppm)	0.68	0.73	0.66	0.75	0.63	0.78	0.67	0.74
Thorium, Th (ppm)	9.7	11.9	8.7	13.0	7.6	14.0	10.3	11.3
Thulium, Tm (ppm)	0.29	0.34	0.26	0.36	0.24	0.39	0.30	0.33
Tin, Sn (ppm)	3.6	4.2	3.3	4.6	2.9	4.9	3.7	4.1
Uranium, U (ppm)	2.4	2.9	2.1	3.2	1.9	3.4	2.5	2.8
Ytterbium, Yb (ppm)	2.0	2.3	1.8	2.4	1.7	2.5	2.0	2.2
Yttrium, Y (ppm)	17.3	20.7	15.6	22.4	13.8	24.1	18.0	19.9
Zirconium, Zr (ppm)	306	342	287	360	269	379	308	340

Performance gates have been calculated for one, two and three standard deviations of the accepted pool of certification data and are presented in Tables 13-16. As a guide these intervals may be regarded as informational (1σ), warning or rejection for multiple outliers (2σ), or rejection for individual outliers (3σ) in QC monitoring although their precise application should be at the discretion of the QC manager concerned.

For the second method a ±5% error bar on the recommended value is used as the window of acceptability (refer Tables 13-16).
Both methods should be used with caution 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.

PARTICIPATING LABORATORIES

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PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

The reference material OREAS 45b has been prepared and certified and is supplied by:

Ore Research & Exploration Pty Ltd
6-8 Gatwick Road
Bayswater North VIC 3153
AUSTRALIA

Telephone (03) 9729 0333 *International +613-9729 0333*
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It has been packaged in unit sizes of 10g and 60g units in laminated foil pouches and is also available in 1kg unit in plastic jars.

INTENDED USE

OREAS 45b is a multi-element reference material intended for the QC monitoring of analytical data.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 45b has been prepared from a blend of ferruginous soils. It is therefore considered to have long-term stability under normal storage conditions.

INSTRUCTIONS FOR THE CORRECT USE OF THE REFERENCE MATERIAL

The recommended values for OREAS 45b refer to the concentration levels of elements after removal of hygroscopic moisture at 105° C. It is therefore recommended that the reference material be dried at this temperature prior to analysis.

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.

CERTIFYING OFFICER: Dr Paul Hamlyn

REFERENCES

ISO Guide 35 (1985), Certification of reference materials - General and statistical principals.

ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.

Kleeman, A. W. (1967), *J. Geol. Soc. Australia*, **14**, 43.

APPENDIX A

Analytical Results for precious and base metals by fire assay and four-acid digest ICPOES/MS in OREAS 45b

Table A1. Key to abbreviations used in Tables A2 – A15.

Abbreviation	Explanation
Std.Dev.	one sigma standard deviation
Rel.Std.Dev.	one sigma relative standard deviation
PDM[3]	percent deviation of lab mean from corrected mean of means
FA	Fire assay (lead collection with HCl leach)
4A	four acid (HF-HNO_3–$HClO_4$–HCl) digestion
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry

Table A2. Analytical results for silver in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*MS	Lab E 4A*MS	Lab F 4A*MS
1	0.10	0.24	0.25	0.60	< 0.5	0.20
2	< 0.1	0.23	0.25	0.50	< 0.5	0.20
3	0.10	0.24	0.25	0.50	< 0.5	0.20
4	< 0.1	0.23	0.25	0.50	< 0.5	0.20
5	< 0.1	0.24	0.20	0.50	< 0.5	0.30
Mean	**0.10**	0.24	0.24	**0.52**	< 0.5	0.22
Median	0.10	0.24	0.25	0.50	< 0.5	0.20
Std.Dev.	0.00	0.01	0.02	0.04	-	0.04
Rel.Std.Dev.	0.00%	2.32%	9.32%	8.60%	-	20.3%
PDM[3]	-56.9%	1.72%	3.45%	124%	-	-5.17%

Table A3. Analytical results for arsenic in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G INAA (4.0g)	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*MS	Lab E 4A*MS	Lab F 4A*MS
1	11.16	11.0	3.3	14.0	13.0	14.0	11.4
2	12.24	11.0	3.2	14.5	13.0	16.0	11.4
3	11.65	11.0	3.0	13.5	13.0	16.0	11.1
4	11.02	10.0	2.9	13.5	12.0	14.0	11.5
5	11.53	11.0	2.6	13.5	13.0	16.0	11.7
6	11.90						
7	12.12						
8	10.79						
9	11.81						
10	11.70						
11	11.73						
12	11.54						
13	11.70						
14	11.94						
15	11.85						
16	12.02						
17	11.76						
18	12.07						
19	11.47						
20	12.73						
Mean	11.7	10.8	**3.0**	13.8	12.8	15.2	11.4
Median	11.7	11.0	3.0	13.5	13.0	16.0	11.4
Std.Dev.	0.4	0.4	0.3	0.4	0.4	1.1	0.2
Rel.Std.Dev.	3.69%	4.14%	9.13%	3.24%	3.49%	7.21%	1.90%
PDM[3]	-7.05%	-14.5%	-76.2%	9.30%	1.38%	20.4%	-9.55%

Table A4. Analytical results for gold in standard OREAS 45b (refer Table A1 for abbreviations; values in ppb).

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	FA*MS	FA*MS	FA*MS	FA*MS	FA*MS	FA*MS
1	33.5	36	33	31	20	38	52
2	43.5	38	38	30	23	39	50
3	34.9	40	36	32	**19**	38	49
4	37.0	38	37	33	23	37	47
5	31.6	37	36	30	24	41	46
6	36.8						
7	38.1						
8	45.1						
9	40.2						
10	31.1						
11	37.6						
12	45.8						
13	40.4						
14	33.4						
15	40.2						
16	42.9						
17	34.7						
18	41.6						
19	41.6						
20	39.4						
Mean	38	38	36	31	**22**	39	**49**
Median	39	38	36	31	23	38	49
Std.Dev.	4	1	2	1	2	2	2
Rel.Std.Dev.	11.3%	3.92%	5.20%	4.18%	9.94%	3.93%	4.89%
PDM[3]	5.65%	3.81%	-1.1%	-14.3%	-40.1%	6.00%	34.0%

Table A5. Analytical results for bismuth in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*MS	4A*MS	4A*MS	4A*MS	4A*MS	4A*MS
1	0.21	0.24	0.30	0.30	0.20	0.23
2	0.22	0.22	0.30	0.20	0.20	0.23
3	0.22	0.24	0.25	0.20	0.20	0.24
4	0.22	0.24	0.25	0.20	0.20	0.24
5	0.22	0.25	0.25	0.20	0.20	0.24
Mean	0.22	0.24	**0.27**	0.22	0.20	0.24
Median	0.22	0.24	0.25	0.20	0.20	0.24
Std.Dev.	0.00	0.01	0.03	0.04	0.00	0.01
Rel.Std.Dev.	2.05%	4.60%	10.1%	20.3%	0.00%	2.32%
PDM[3]	-1.98%	7.01%	21.4%	-1.08%	-10.1%	6.12%

Table A6. Analytical results for cadmium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*MS	4A*MS	4A*MS	4A*MS	4A*MS	4A*MS
1	< 0.1	0.10	0.20	< 0.1	< 0.5	0.1
2	0.10	0.10	0.15	< 0.1	< 0.5	0.1
3	0.10	0.10	0.20	< 0.1	< 0.5	<0.1
4	0.10	0.11	0.20	< 0.1	< 0.5	0.1
5	< 0.1	0.11	0.20	< 0.1	< 0.5	0.1
Mean	0.10	0.10	0.19	< 0.1	< 0.5	0.10
Median	0.10	0.10	0.20	< 0.1	< 0.5	0.10
Std.Dev.	0.00	0.01	0.02	-	-	0.00
Rel.Std.Dev.	0.00%	5.27%	11.77%	-	-	0.00%
PDM[3]	-23.9%	-20.8%	44.7%	-	-	-23.9%

Table A7. Analytical results for cobalt in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*MS	4A*MS	4A*MS	4A*OES	4A*OES	4A*OES
1	79.5	85.5	81.0	93.0	85.0	79.0
2	81.6	82.2	85.0	92.0	95.0	83.0
3	83.1	85.5	84.5	92.0	90.0	80.0
4	78.7	85.4	82.5	90.0	90.0	81.0
5	77.8	89.1	85.5	92.0	90.0	80.0
Mean	80.1	85.5	83.7	91.8	90.0	80.6
Median	79.5	85.5	84.5	92.0	90.0	80.0
Std.Dev.	2.2	2.4	1.9	1.1	3.5	1.5
Rel.Std.Dev.	2.71%	2.85%	2.26%	1.19%	3.93%	1.88%
PDM[3]	-6.05%	0.29%	-1.87%	7.62%	5.51%	-5.51%

Table A8. Analytical results for chromium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*OES	4A*MS	4A*MS	4A*OES	4A*OES	4A*OES
1	829	685	823	885	890	829
2	837	657	858	880	910	844
3	841	676	888	875	890	842
4	**736**	669	882	**825**	890	834
5	839	687	858	850	900	836
Mean	816	**675**	862	863	896	837
Median	837	676	858	875	890	836
Std.Dev.	45	12	26	25	9	6
Rel.Std.Dev.	5.53%	1.82%	2.96%	2.91%	1.00%	0.73%
PDM[3]	-5.15%	-21.6%	0.11%	0.26%	4.10%	-2.76%

Table A9. Analytical results for copper in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*OES	4A*MS	4A*MS	4A*OES	4A*OES	4A*OES
1	511	581	508	534	520	520
2	519	556	501	526	525	525
3	523	573	519	523	520	526
4	523	570	481	508	520	524
5	513	589	497	522	525	525
Mean	518	**574**	**501**	523	522	524
Median	519	573	501	523	520	525
Std.Dev.	6	12	14	9	3	2
Rel.Std.Dev.	1.08%	2.16%	2.78%	1.80%	0.52%	0.45%
PDM[3]	-0.73%	10.0%	-3.90%	0.19%	0.08%	0.46%

Table A10. Analytical results for nickel in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	4A*OES	4A*MS	4A*MS	4A*OES	4A*OES	4A*OES
1	271	294	**265**	295	275	263
2	274	283	275	291	285	269
3	272	286	275	290	280	268
4	274	290	272	283	**265**	272
5	278	301	276	290	285	268
Mean	274	291	273	290	278	268
Median	274	290	275	290	280	268
Std.Dev.	2.7	7.0	4.4	4.3	8.4	3.2
Rel.Std.Dev.	0.98%	2.42%	1.61%	1.49%	3.01%	1.21%
PDM[3]	-2.10%	3.98%	-2.54%	3.62%	-0.60%	-4.17%

Table A11. Analytical results for lead in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*MS	Lab E 4A*OES	Lab F 4A*MS
1	26	25	26	27	26	26
2	26	24	24	27	26	27
3	25	25	25	27	26	27
4	26	25	25	27	28	27
5	27	26	**28**	27	26	26
Mean	26.0	24.9	25.6	27.0	26.4	26.6
Median	26.0	25.2	25.4	27.0	26.0	26.6
Std.Dev.	0.7	0.8	1.5	0.0	0.9	0.4
Rel.Std.Dev.	2.72%	3.03%	5.95%	0.00%	3.39%	1.53%
PDM[3]	0.08%	-4.07%	-1.57%	3.93%	1.62%	2.39%

Table A12. Analytical results for palladium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppb).

Replicate No.	Lab A FA*MS	Lab B FA*MS	Lab C FA*MS	Lab D FA*MS	Lab E FA*MS	Lab F FA*MS
1	38	37	30	37	38	40
2	39	41	30	37	39	39
3	38	40	31	37	38	38
4	38	39	32	37	36	36
5	37	39	30	38	38	37
Mean	38	39	**31**	37	38	38
Median	38	39	30	37	38	38
Std.Dev.	0.7	1.5	0.9	0.4	1.1	1.6
Rel.Std.Dev.	1.86%	3.78%	3.05%	1.22%	2.90%	4.16%
PDM[3]	0.11%	3.27%	-19.3%	-3.06%	-0.42%	0.11%

Table A13. Analytical results for platinum in standard OREAS 45b (refer Table A1 for abbreviations; values in ppb).

Replicate No.	Lab A FA*MS	Lab B FA*MS	Lab C FA*MS	Lab D FA*MS	Lab E FA*MS	Lab F FA*MS
1	54	**46**	46	50	55	62
2	55	50	44	48	56	60
3	57	48	47	47	55	59
4	53	48	49	49	55	56
5	53	49	47	49	58	57
Mean	54.4	48.3	46.7	48.3	55.8	58.6
Median	54.0	48.4	46.7	48.5	55.0	59.0
Std.Dev.	1.7	1.4	1.9	0.9	1.3	2.4
Rel.Std.Dev.	3.08%	2.84%	4.11%	1.88%	2.34%	4.13%
PDM[3]	4.42%	-7.36%	-10.4%	-7.29%	7.11%	12.4%

Table A14. Analytical results for antimony in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G INAA (4.0g)	Lab A 4A*MS	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*MS	Lab E 4A*OES	Lab F 4A*MS
1	0.68	0.70	0.26	0.70	1.30	1.20	0.90
2	0.73	0.62	0.27	0.65	1.10	1.00	0.90
3	1.12	0.69	0.28	0.75	1.00	1.00	0.90
4	0.77	0.53	0.27	0.80	1.00	1.80	0.90
5	0.73	0.75	0.27	0.70	1.00	1.40	0.90
6	0.80						
7	1.09						
8	0.85						
9	0.83						
10	1.01						
11	0.85						
12	0.91						
13	0.99						
14	0.86						
15	1.01						
16	1.07						
17	1.12						
18	0.72						
19	0.84						
20	0.97						
Mean	0.90	0.66	**0.27**	0.72	1.08	1.28	0.90
Median	0.86	0.69	0.27	0.70	1.00	1.20	0.90
Std.Dev.	0.14	0.09	0.01	0.06	0.13	0.33	0.00
Rel.Std.Dev.	15.7%	13.0%	2.62%	7.92%	12.1%	26.2%	0.00%
PDM[3]	-2.72%	-28.7%	-70.7%	-22.0%	17.1%	38.7%	-2.45%

Table A15. Analytical results for zinc in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A 4A*OES	Lab B 4A*MS	Lab C 4A*MS	Lab D 4A*OES	Lab E 4A*OES	Lab F 4A*OES
1	192	200	195	189	210	**204**
2	191	197	187	190	190	195
3	196	**208**	198	198	205	194
4	196	198	190	177	195	192
5	208	202	199	191	205	197
Mean	197	201	194	189	201	196
Median	196	200	195	190	205	195
Std.Dev.	6.8	4.4	5.4	7.6	8.2	4.6
Rel.Std.Dev.	3.44%	2.17%	2.79%	4.01%	4.09%	2.35%
PDM[3]	0.49%	2.74%	-1.09%	-3.39%	2.74%	0.39%

APPENDIX B

Analytical Results for precious and base metals by aqua regia digest ICPOES/MS in OREAS 45b

Table B1. Key to abbreviations used in Tables B2 – B15.

Abbreviation	Explanation
Std.Dev.	one sigma standard deviation
Rel.Std.Dev.	one sigma relative standard deviation
PDM[3]	percent deviation of lab mean from corrected mean of means
AR	aqua regia digestion
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry

Table B2. Analytical results for silver in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*MS	AR*MS	AR*MS
1	0.20	0.20	0.19	< 0.2	0.15	0.22
2	0.20	0.21	0.20	0.20	0.20	0.25
3	0.21	0.22	0.19	< 0.2	0.20	0.25
4	0.19	0.21	0.20	0.20	0.20	0.25
5	0.22	0.22	0.21	0.20	0.20	0.25
Mean	0.20	0.21	0.20	0.20	0.19	**0.24**
Median	0.20	0.21	0.20	0.20	0.20	0.25
Std.Dev.	0.0	0.0	0.0	0.0	0.0	0.0
Rel.Std.Dev.	5.59%	3.95%	3.52%	0.00%	11.8%	5.50%
PDM[3]	1.74%	5.73%	-1.95%	-0.26%	-5.25%	21.7%

Table B3. Analytical results for arsenic in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*MS	AR*MS
1	2.8	2.9	3.2	< 3	4.6	2.1
2	1.8	2.9	3.4	3.0	4.4	2.0
3	2.4	2.9	3.3	3.0	4.4	2.0
4	1.9	2.8	3.3	3.0	4.6	1.9
5	2.5	2.9	3.4	< 3	4.4	2.0
Mean	2.3	2.9	3.3	3.0	4.5	2.0
Median	2.4	2.9	3.3	3.0	4.4	2.0
Std.Dev.	0.4	0.0	0.1	0.0	0.1	0.1
Rel.Std.Dev.	18.5%	1.55%	3.21%	0.00%	2.45%	3.54%
PDM[3]	-23.8%	-3.68%	10.37%	0.33%	49.8%	-33.1%

Table B4. Analytical results for gold in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	-	AR*MS	-	AR*MS	AR*MS
1	28	N/A	27	N/A	35	31
2	31	N/A	27	N/A	36	32
3	28	N/A	27	N/A	36	31
4	30	N/A	28	N/A	36	30
5	33	N/A	29	N/A	37	**35**
Mean	30.0	-	27.8	-	36.0	32
Median	30.0	-	27.4	-	36.0	31
Std.Dev.	2.1	-	1.0	-	0.7	1.924
Rel.Std.Dev.	7.07%	-	3.67%	-	1.96%	6.05%
PDM[3]	-4.44%	-	-11.5%	-	14.7%	1.29%

Table B5. Analytical results for bismuth in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*MS	AR*MS
1	0.17	0.19	0.19	< 20	0.16	0.23
2	0.17	0.18	0.20	< 20	0.16	0.23
3	0.16	0.17	0.19	< 20	0.16	0.24
4	0.18	0.18	0.19	< 20	0.16	0.24
5	0.18	0.19	0.20	< 20	0.16	0.24
Mean	0.17	0.18	0.19	< 20	0.16	**0.24**
Median	0.17	0.18	0.19	< 20	0.16	0.24
Std.Dev.	0.01	0.01	0.00	-	0.00	0.01
Rel.Std.Dev.	4.86%	4.60%	1.43%	-	0.00%	2.32%
PDM[3]	-2.55%	3.12%	8.78%	-	-9.35%	33.7%

Table B6. Analytical results for cadmium in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*MS	AR*MS
1	0.09	0.10	0.12	0.10	0.10	0.12
2	0.10	0.10	0.11	0.10	0.10	0.12
3	0.08	0.10	0.11	0.10	0.10	0.12
4	0.10	0.11	0.11	0.10	0.10	0.12
5	0.10	0.11	0.12	0.10	0.10	0.12
Mean	0.09	0.10	0.11	0.10	0.10	0.12
Median	0.10	0.10	0.11	0.10	0.10	0.12
Std.Dev.	0.01	0.01	0.00	0.00	0.00	0.00
Rel.Std.Dev.	9.52%	5.27%	3.77%	0.00%	0.00%	0.00%
PDM[3]	-10.3%	-0.79%	5.88%	-4.61%	-4.61%	14.5%

Table B7. Analytical results for cobalt in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*OES	AR*MS
1	72.6	68.0	70.6	72.0	74.0	64.0
2	75.6	68.5	73.7	73.0	74.0	64.0
3	69.8	69.2	73.2	73.0	74.0	65.0
4	72.5	**65.5**	75.8	73.0	74.0	64.0
5	79.0	70.7	78.2	72.0	76.0	66.0
Mean	73.9	**68.4**	74.3	72.6	74.4	**64.6**
Median	72.6	68.5	73.7	73.0	74.0	64.0
Std.Dev.	3.5	1.9	2.9	0.5	0.9	0.9
Rel.Std.Dev.	4.75%	2.79%	3.87%	0.75%	1.20%	1.38%
PDM[3]	0.15%	-7.33%	0.65%	-1.62%	0.82%	-12.5%

Table B8. Analytical results for chromium in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*OES	AR*MS
1	756	634	688	705	595	630
2	743	637	688	**755**	595	631
3	716	644	676	705	585	649
4	730	630	663	715	585	636
5	753	643	689	730	600	**659**
Mean	740	638	681	722	592	641
Median	743	637	688	715	595	636
Std.Dev.	16.7	5.9	11.5	21.1	6.7	12.6
Rel.Std.Dev.	2.25%	0.93%	1.68%	2.92%	1.13%	1.96%
PDM[3]	10.9%	-4.36%	2.11%	8.29%	-11.2%	-3.85%

Table B9. Analytical results for copper in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*OES	AR*MS	AR*MS	AR*OES	AR*OES	AR*MS
1	476	**510**	**417**	433	389	470
2	469	490	434	433	400	470
3	452	491	431	429	380	487
4	461	487	431	432	394	475
5	475	500	442	**426**	397	**493**
Mean	467	496	431	431	392	479
Median	469	491	431	432	394	475
Std.Dev.	10.1	9.4	8.8	3.0	7.8	10.5
Rel.Std.Dev.	2.17%	1.90%	2.04%	0.71%	2.00%	2.18%
PDM[3]	3.98%	10.4%	-3.91%	-4.04%	-12.6%	6.74%

Table B10. Analytical results for nickel in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*OES	AR*MS	AR*MS	AR*OES	AR*OES	AR*MS
1	247	**216**	197	199	187	185
2	246	211	204	198	185	186
3	234	211	201	197	183	190
4	242	208	215	198	183	186
5	257	210	213	195	184	195
Mean	245	211	206	197	184	188
Median	246	211	204	198	184	186
Std.Dev.	8.3	2.9	7.7	1.5	1.7	4.2
Rel.Std.Dev.	3.40%	1.40%	3.73%	0.77%	0.91%	2.21%
PDM[3]	24.4%	7.11%	4.32%	0.11%	-6.48%	-4.45%

Table B11. Analytical results for lead in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*MS	AR*MS
1	20	24	20	20	20	20
2	20	23	21	30	20	22
3	19	23	21	30	20	21
4	20	24	22	30	20	21
5	21	24	22	30	20	21
Mean	20	23	21	**28**	20	21
Median	20	24	21	30	20	21
Std.Dev.	0.7	0.5	0.7	4.5	0.0	0.7
Rel.Std.Dev.	3.54%	2.03%	3.21%	15.97%	0.00%	3.37%
PDM[3]	-5.37%	10.81%	0.56%	32.5%	-5.37%	-0.64%

Table B12. Analytical results for palladium in standard OREAS 45b (refer Table B1 for abbreviations; values in ppb).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	-	AR*MS	-	AR*MS	AR*MS
1	44	N/A	33	N/A	40	40
2	57	N/A	26	N/A	40	39
3	60	N/A	17	N/A	40	38
4	65	N/A	34	N/A	40	36
5	75	N/A	28	N/A	40	37
Mean	**60.2**	-	27.6	-	40.0	38.0
Median	60.0	-	28.0	-	40.0	38.0
Std.Dev.	11.3	-	6.8	-	0.0	1.6
Rel.Std.Dev.	18.84%	-	24.65%	-	0.00%	4.16%
PDM[3]	71.0%	-	-21.6%	-	13.6%	7.95%

Table B13. Analytical results for platinum in standard OREAS 45b (refer Table B1 for abbreviations; values in ppb).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	-	AR*MS	AR*OES	AR*MS	AR*MS
1	38	N/A	40	N/A	50	62
2	41	N/A	45	N/A	50	60
3	39	N/A	37	N/A	50	59
4	43	N/A	43	N/A	50	56
5	42	N/A	42	N/A	50	57
Mean	40.6	-	41.4	-	50.0	58.6
Median	41.0	-	42.0	-	50.0	59.0
Std.Dev.	2.1	-	3.0	-	0.0	2.4
Rel.Std.Dev.	5.11%	-	7.37%	-	0.00%	4.13%
PDM[3]	-14.8%	-	-13.1%	-	4.94%	23.0%

Table B14. Analytical results for antimony in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*MS	AR*MS	AR*MS	AR*OES	AR*MS	AR*MS
1	0.30	0.26	0.31	0.30	0.06	0.40
2	0.35	0.27	0.30	0.40	0.06	0.40
3	0.29	0.28	0.31	0.30	0.04	0.30
4	0.23	0.27	0.32	0.30	0.04	0.30
5	0.36	0.27	0.31	0.40	0.06	0.30
Mean	0.31	0.27	0.31	0.34	**0.05**	0.34
Median	0.30	0.27	0.31	0.30	0.06	0.30
Std.Dev.	0.1	0.0	0.0	0.1	0.0	0.1
Rel.Std.Dev.	17.1%	2.62%	1.86%	16.1%	21.1%	16.1%
PDM[3]	-2.11%	-13.6%	-1.79%	8.77%	-83.4%	8.77%

Table B15. Analytical results for zinc in standard OREAS 45b (refer Table B1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AR*OES	AR*MS	AR*MS	AR*OES	AR*OES	AR*MS
1	191	170	161	175	173	163
2	185	173	161	176	175	164
3	179	173	164	181	173	167
4	183	175	169	**189**	178	164
5	190	180	168	173	177	**170**
Mean	186	174	165	179	175	166
Median	185	173	164	176	175	164
Std.Dev.	5.0	3.7	3.8	6.4	2.3	2.9
Rel.Std.Dev.	2.68%	2.12%	2.28%	3.59%	1.30%	1.74%
PDM[3]	7.03%	0.45%	-5.00%	3.10%	1.03%	-4.51%

APPENDIX C

Analytical Results for major elements, LOI, C & S by fusion XRF/ICPOES in OREAS 45b

Table C1. Key to abbreviations used in Tables C2 – C15.

Abbreviation	Explanation
Std.Dev.	one sigma standard deviation
Rel.Std.Dev.	one sigma relative standard deviation
PDM[3]	percent deviation of lab mean from corrected mean of means
AF	alkali fusion
BF	lithium metaborate fusion
Leco	Leco furnace method
LOI	Grav method after heating to 1000°C
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry
XRF	x-ray fluorescence

Table C2. Analytical results for aluminium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	7.51	8.07	7.40	7.69	7.83	7.65
2	7.62	8.06	7.41	7.67	7.83	7.69
3	7.55	8.08	7.48	7.67	7.78	7.64
4	7.58	8.07	7.49	7.69	7.73	7.58
5	7.62	8.07	7.54	7.75	7.78	7.61
Mean	7.58	**8.07**	7.46	7.69	7.79	7.63
Median	7.58	8.07	7.48	7.69	7.78	7.64
Std.Dev.	0.05	0.01	0.06	0.03	0.04	0.04
Rel.Std.Dev.	0.62%	0.10%	0.74%	0.43%	0.57%	0.54%
PDM[3]	-0.73%	5.77%	-2.21%	0.81%	2.10%	0.03%

Table C3. Analytical results for carbon in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	Leco	Leco	BF*OES	Leco	Leco	Leco
1	3.05	3.18	3.26	2.94	3.46	3.00
2	3.10	3.15	3.28	2.93	3.25	3.04
3	3.08	3.18	3.30	2.94	3.35	3.01
4	3.08	3.15	3.28	2.88	3.59	3.02
5	3.06	3.15	3.34	**2.87**	3.48	2.98
Mean	3.1	3.2	3.3	2.9	3.4	3.0
Median	3.1	3.2	3.3	2.9	3.5	3.0
Std.Dev.	0.0	0.0	0.0	0.0	0.1	0.0
Rel.Std.Dev.	0.63%	0.52%	0.86%	1.22%	3.80%	0.74%
PDM[3]	-2.34%	0.46%	4.56%	-7.49%	8.85%	-4.37%

Table C4. Analytical results for calcium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.40	0.34	0.36	0.36	0.36	0.36
2	0.40	0.36	0.35	0.36	0.36	0.35
3	0.40	0.35	0.35	0.36	0.36	0.35
4	0.40	0.36	0.35	0.36	0.36	0.35
5	0.40	0.35	0.35	0.35	0.36	0.35
Mean	**0.40**	0.35	0.35	0.36	0.36	0.35
Median	0.40	0.35	0.35	0.36	0.36	0.35
Std.Dev.	0.00	0.01	0.00	0.00	0.00	0.00
Rel.Std.Dev.	0.00%	1.70%	1.10%	1.25%	0.00%	1.27%
PDM[3]	12.8%	-0.86%	-0.05%	0.92%	0.75%	-0.77%

Table C5. Analytical results for chromium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.087	0.089	0.074	0.090	0.086	0.090
2	0.084	0.089	0.075	0.090	0.087	0.090
3	0.084	0.089	0.076	0.090	0.088	0.090
4	0.084	0.089	0.076	0.090	0.086	0.090
5	0.083	0.082	0.077	0.090	0.088	0.090
Mean	0.084	0.088	**0.076**	0.090	0.087	0.090
Median	0.084	0.089	0.076	0.090	0.087	0.090
Std.Dev.	0.002	0.003	0.001	0.000	0.001	0.000
Rel.Std.Dev.	1.81%	3.49%	1.55%	0.00%	1.03%	0.00%
PDM[3]	-3.83%	-0.28%	-14.0%	2.51%	-0.91%	2.51%

Table C6. Analytical results for iron in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	**17.19**	17.27	16.87	17.30	17.48	17.76
2	17.42	17.27	16.99	17.30	17.55	**17.83**
3	17.36	17.29	17.06	17.30	17.48	17.40
4	17.40	17.33	17.01	17.30	17.41	17.30
5	17.50	17.32	16.98	17.50	17.55	17.39
Mean	17.37	17.30	**16.98**	17.34	17.50	17.54
Median	17.40	17.29	16.99	17.30	17.48	17.40
Std.Dev.	0.11	0.03	0.07	0.09	0.06	0.24
Rel.Std.Dev.	0.66%	0.15%	0.42%	0.52%	0.33%	1.37%
PDM[3]	-0.17%	-0.61%	-2.42%	-0.36%	0.54%	0.76%

Table C7. Analytical results for potassium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.33	0.31	0.29	0.31	0.30	0.31
2	0.34	0.31	0.27	0.31	0.29	0.32
3	0.32	0.32	0.29	0.31	0.30	0.29
4	0.33	0.32	0.29	0.31	0.30	0.29
5	0.33	0.32	0.29	0.31	0.30	0.30
Mean	0.33	0.31	0.29	0.31	0.30	0.30
Median	0.33	0.32	0.29	0.31	0.30	0.30
Std.Dev.	0.01	0.01	0.01	0.00	0.00	0.01
Rel.Std.Dev.	2.14%	2.21%	3.55%	0.00%	1.25%	4.32%
PDM[3]	7.66%	2.34%	-6.59%	1.14%	-3.07%	-1.47%

Table C8. Analytical results for loss on ignition volatiles in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	LOI	BF*XRF	BF*OES	BF*XRF	LOI	BF*OES
1	12.63	12.65	14.95	13.10	12.61	12.37
2	12.65	12.65	15.05	13.04	12.59	12.35
3	12.50	12.75	14.85	12.99	12.63	**12.40**
4	12.75	12.85	15.15	12.99	12.54	12.36
5	12.84	13.05	14.80	12.87	12.57	12.34
Mean	12.67	12.79	**14.96**	13.00	12.59	12.36
Median	12.65	12.75	14.95	12.99	12.59	12.36
Std.Dev.	0.13	0.17	0.14	0.08	0.03	0.02
Rel.Std.Dev.	1.01%	1.31%	0.96%	0.65%	0.28%	0.19%
PDM[3]	-0.06%	0.86%	18.0%	2.50%	-0.73%	-2.50%

Table C9. Analytical results for magnesium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.27	0.27	0.26	0.23	0.27	0.25
2	0.26	0.27	0.25	0.24	0.27	0.25
3	0.26	0.26	0.25	0.24	0.25	0.25
4	0.26	0.27	0.24	0.24	0.25	0.26
5	0.26	0.28	0.24	0.23	0.26	0.25
Mean	0.26	0.27	0.25	0.24	0.26	0.25
Median	0.26	0.27	0.25	0.24	0.26	0.25
Std.Dev.	0.004	0.007	0.005	0.005	0.006	0.004
Rel.Std.Dev.	0.017	0.026	0.020	0.023	0.023	0.018
PDM[3]	0.030	0.053	-0.021	-0.072	0.020	-0.009

Table C10. Analytical results for manganese in OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.102	0.108	0.093	0.100	0.101	0.100
2	0.102	0.108	0.093	0.100	0.101	0.100
3	0.103	0.108	0.093	0.100	0.101	0.100
4	0.102	0.108	0.093	0.100	0.101	0.100
5	0.103	0.108	0.093	0.100	0.101	0.100
Mean	0.102	**0.108**	**0.093**	0.100	0.101	0.100
Median	0.102	0.108	0.093	0.100	0.101	0.100
Std.Dev.	0.000	0.000	0.000	0.000	0.000	0.000
Rel.Std.Dev.	0.38%	0.00%	0.00%	0.00%	0.00%	0.00%
PDM[3]	1.63%	7.60%	-7.77%	-0.77%	-0.08%	-0.77%

Table C11. Analytical results for sodium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	AF*OES	BF*XRF	BF*OES	BF*XRF	BF*XRF	BF*OES
1	0.080	0.077	0.052	0.070	0.060	0.089	0.080
2	0.079	0.077	0.045	0.063	0.070	0.089	0.080
3	0.080	0.079	0.045	0.059	0.070	0.089	0.080
4	0.081	0.079	0.052	0.067	0.060	0.082	0.080
5	0.075	0.078	0.045	0.063	0.070	0.089	0.080
6	0.078						
7	0.079						
8	0.080						
9	0.075						
10	0.077						
11	0.079						
12	0.079						
13	0.080						
14	0.079						
15	0.080						
16	0.078						
17	0.080						
18	0.078						
19	0.079						
20	0.078						
Mean	0.079	0.078	**0.047**	0.065	0.066	0.088	0.080
Median	0.079	0.078	0.045	0.063	0.070	0.089	0.080
Std.Dev.	0.002	0.001	0.004	0.004	0.005	0.003	0.000
Rel.Std.Dev.	2.0%	1.28%	8.56%	6.55%	8.30%	3.79%	0.00%
PDM[3]	3.90%	2.56%	-37.3%	-14.8%	-12.86%	15.6%	5.62%

Table C12. Analytical results for phospherous in OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	0.0596	0.0655	0.0567	0.0590	0.0563	<0.1
2	0.0577	0.0611	0.0567	0.0590	0.0567	<0.1
3	0.0568	0.0611	0.0567	0.0590	0.0572	<0.1
4	0.0571	0.0611	0.0633	0.0600	0.0572	<0.1
5	0.0581	0.0567	0.0589	0.0590	0.0585	<0.1
Mean	0.0579	0.0611	0.0585	0.0592	0.0572	**<0.1**
Median	0.0577	0.0611	0.0567	0.0590	0.0572	<0.1
Std.Dev.	0.0	0.0	0.0	0.0	0.0	-
Rel.Std.Dev.	1.90%	5.05%	4.87%	0.76%	1.43%	-
PDM[3]	-1.54%	3.98%	-0.47%	0.74%	-2.70%	-

Table C13. Analytical results for sulphur in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	Leco	Leco	BF*OES	Leco	Leco	Leco
1	0.031	<0.01	0.040	0.028	0.040	0.030
2	0.031	0.010	0.040	0.029	0.030	0.040
3	0.030	<0.01	0.045	0.034	0.040	0.030
4	0.030	<0.01	0.035	0.030	0.040	0.030
5	0.034	<0.01	0.035	0.026	0.040	0.030
Mean	0.031	0.010	0.039	0.029	0.038	0.032
Median	0.031	0.010	0.040	0.029	0.040	0.030
Std.Dev.	0.002	#DIV/0!	0.004	0.003	0.004	0.004
Rel.Std.Dev.	5.27%	#DIV/0!	10.7%	10.1%	11.8%	14.0%
PDM[3]	-8.02%	-70.5%	15.0%	-13.33%	12.0%	-5.66%

Table C14. Analytical results for silicon in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	20.20	19.86	19.79	20.08	20.10	20.90
2	20.00	19.79	19.68	20.03	20.06	21.08
3	20.30	19.82	19.68	20.07	20.06	20.79
4	20.30	19.78	19.58	20.08	20.20	20.45
5	20.50	19.73	19.67	20.17	20.06	20.55
Mean	20.26	19.79	19.68	20.09	20.09	**20.75**
Median	20.30	19.79	19.68	20.08	20.06	20.79
Std.Dev.	0.18	0.05	0.07	0.05	0.06	0.26
Rel.Std.Dev.	0.90%	0.24%	0.38%	0.26%	0.30%	1.24%
PDM[3]	0.74%	-1.58%	-2.15%	-0.12%	-0.09%	3.20%

Table C15. Analytical results for titanium in standard OREAS 45b (refer Table C1 for abbreviations; values in wt. %).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*OES	BF*XRF	BF*OES	BF*XRF	AF*XRF	BF*OES
1	1.53	1.71	1.53	1.50	1.47	1.60
2	1.55	1.71	1.52	1.49	1.48	1.62
3	1.53	1.71	1.53	1.49	1.48	1.60
4	1.54	1.71	1.53	1.49	1.49	1.59
5	1.54	1.71	1.54	1.50	1.50	1.57
Mean	1.54	1.71	1.53	1.49	1.48	1.60
Median	1.54	1.71	1.53	1.49	1.48	1.60
Std.Dev.	0.01	0.00	0.01	0.01	0.01	0.02
Rel.Std.Dev.	0.54%	0.19%	0.54%	0.37%	0.61%	1.14%
PDM[3]	0.63%	12.0%	0.07%	-2.25%	-2.88%	4.43%

APPENDIX D

Analytical Results for lithophile trace elements by fusion ICPMS in OREAS 45b

Table D1. Key to abbreviations used in Tables D2 – D24.

Abbreviation	Explanation
Std.Dev.	one sigma standard deviation
Rel.Std.Dev.	one sigma relative standard deviation
PDM[3]	percent deviation of lab mean from corrected mean of means
AF	alkali fusion
BF	lithium metaborate fusion
MS	inductively coupled plasma mass spectrometry

Table D2. Analytical results for barium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	Lab B AF*MS	Lab C BF*MS	Lab D AF*MS	Lab E AF*MS	Lab F AF*MS
1	228	278	222	225	230	247
2	235	267	222	225	230	241
3	218	278	224	230	240	240
4	233	278	228	230	230	247
5	228	280	229	230	240	238
Mean	228	276	225	228	234	243
Median	228	278	224	230	230	241
Std.Dev.	6.6	5.2	3.1	2.7	5.5	4.2
Rel.Std.Dev.	2.88%	1.89%	1.38%	1.20%	2.34%	1.71%
PDM[3]	-1.36%	19.3%	-2.95%	-1.53%	1.06%	4.78%

Table D3. Analytical results for cerium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G INAA (4.0g)	Lab A AF*MS	Lab B AF*MS	Lab C BF*MS	Lab D AF*MS	Lab E -	Lab F AF*MS
1	58.2	53.0	64.3	**52.9**	55.8	N/A	55.4
2	56.2	**55.8**	**61.4**	54.5	54.7	N/A	57.3
3	55.7	51.6	64.7	54.9	54.7	N/A	56.4
4	57.3	51.1	65.5	54.8	54.7	N/A	56.3
5	55.6	50.8	64.8	53.6	53.9	N/A	53.8
6	55.1						
7	56.6						
8	58.6						
9	56.4						
10	58.7						
11	53.8						
12	53.4						
13	57.2						
14	54.9						
15	54.8						
16	57.1						
17	55.7						
18	55.4						
19	54.9						
20	54.4						
Mean	56.0	**52.5**	**64.1**	54.1	54.8	-	55.8
Median	55.7	51.6	64.7	54.5	54.7	-	56.3
Std.Dev.	1.51	2.05	1.59	0.85	0.68	-	1.32
Rel.Std.Dev.	2.7%	3.91%	2.48%	1.58%	1.24%	-	2.37%
PDM[3]	1.35%	-5.05%	16.1%	-2.1%	-0.89%	-	1.06%

Table D4. Analytical results for dysprosium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	Lab B AF*MS	Lab C BF*MS	Lab D -	Lab E -	Lab F AF*MS
1	4.3	4.1	4.2	N/A	N/A	4.2
2	4.7	3.8	4.4	N/A	N/A	4.2
3	4.4	4.0	4.2	N/A	N/A	4.3
4	4.5	4.2	4.3	N/A	N/A	4.2
5	4.7	4.2	4.2	N/A	N/A	4.1
Mean	4.52	4.06	4.26	-	-	4.20
Median	4.50	4.10	4.21	-	-	4.20
Std.Dev.	0.18	0.17	0.09	-	-	0.07
Rel.Std.Dev.	3.96%	4.12%	2.18%	-	-	1.68%
PDM[3]	6.13%	-4.67%	-0.09%	-	-	-1.38%

Table D5. Analytical results for erbium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	2.20	2.30	2.08	N/A	N/A	2.30
2	2.20	2.20	2.12	N/A	N/A	2.30
3	**2.40**	2.30	**2.18**	N/A	N/A	2.30
4	2.20	2.30	2.11	N/A	N/A	2.30
5	2.10	2.40	2.14	N/A	N/A	2.30
Mean	2.22	2.30	2.12	-	-	2.30
Median	2.20	2.30	2.12	-	-	2.30
Std.Dev.	0.11	0.07	0.04	-	-	0.00
Rel.Std.Dev.	4.93%	3.07%	1.80%	-	-	0.00%
PDM[3]	-0.06%	3.55%	-4.38%	-	-	3.55%

Table D6. Analytical results for europium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	1.30	1.10	1.26	N/A	N/A	1.30
2	1.30	1.00	1.28	N/A	N/A	1.30
3	1.20	1.10	1.30	N/A	N/A	1.30
4	1.20	1.10	1.28	N/A	N/A	1.30
5	1.30	1.10	1.27	N/A	N/A	1.30
Mean	1.26	**1.08**	1.28	-	-	1.30
Median	1.30	1.10	1.28	-	-	1.30
Std.Dev.	0.1	0.0	0.0	-	-	0.0
Rel.Std.Dev.	4.35%	4.14%	1.07%	-	-	0.00%
PDM[3]	-1.43%	-15.5%	-0.26%	-	-	1.69%

Table D7. Analytical results for gadolinium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	**3.3**	4.4	4.1	N/A	N/A	4.9
2	4.2	**4.0**	4.3	N/A	N/A	4.9
3	3.9	4.3	4.4	N/A	N/A	5.0
4	4.2	4.4	4.3	N/A	N/A	4.8
5	4.0	4.4	4.2	N/A	N/A	4.6
Mean	3.9	4.3	4.3	-	-	4.8
Median	4.0	4.4	4.3	-	-	4.9
Std.Dev.	0.4	0.2	0.1	-	-	0.2
Rel.Std.Dev.	9.44%	4.03%	2.52%	-	-	3.13%
PDM[3]	-10.7%	-2.01%	-2.85%	-	-	10.3%

Table D8. Analytical results for holmium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	0.70	0.80	**0.74**	N/A	N/A	0.80
2	0.80	0.70	0.80	N/A	N/A	0.80
3	0.70	0.80	0.81	N/A	N/A	0.80
4	0.70	0.80	0.79	N/A	N/A	0.80
5	0.80	0.80	0.79	N/A	N/A	0.80
Mean	0.74	0.78	0.78	-	-	0.80
Median	0.70	0.80	0.79	-	-	0.80
Std.Dev.	0.05	0.04	0.03	-	-	0.00
Rel.Std.Dev.	7.40%	5.73%	3.30%	-	-	0.00%
PDM[3]	-6.53%	-1.47%	-0.97%	-	-	1.05%

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	AF*MS	AF*MS	BF*MS	AF*MS	-	AF*MS
1	28.58	27.5	33.6	28.4	31.0	N/A	28.5
2	28.40	**29.0**	**32.5**	29.0	30.5	N/A	28.6
3	28.12	26.4	34.0	29.3	30.7	N/A	29.5
4	28.32	27.0	34.1	29.0	30.6	N/A	29.4
5	28.16	26.5	33.8	28.7	29.5	N/A	28.6
6	28.11						
7	28.77						
8	28.04						
9	28.20						
10	28.19						
11	28.59						
12	28.43						
13	28.68						
14	28.26						
15	28.35						
16	28.47						
17	28.96						
18	28.13						
19	28.01						
20	28.09						
Mean	28.3	**27.3**	**33.6**	28.9	30.5	-	28.9
Median	28.3	27.0	33.8	29.0	30.6	-	28.6
Std.Dev.	0.26	1.06	0.64	0.37	0.57	-	0.49
Rel.Std.Dev.	0.9%	3.87%	1.92%	1.27%	1.87%	-	1.68%
PDM[3]	-2.75%	-6.40%	15.3%	-1.0%	4.51%	-	-0.77%

Table D10. Analytical results for lutetium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	0.31	0.34	0.30	0.31	N/A	N/A	0.30
2	0.29	0.29	0.30	0.31	N/A	N/A	0.30
3	0.29	0.28	0.30	0.33	N/A	N/A	0.40
4	0.30	0.34	0.30	0.32	N/A	N/A	0.30
5	0.30	0.29	0.30	0.31	N/A	N/A	0.30
6	0.28						
7	0.32						
8	0.29						
9	0.30						
10	0.30						
11	0.29						
12	0.30						
13	0.29						
14	0.31						
15	0.30						
16	0.30						
17	0.31						
18	0.29						
19	0.32						
20	0.31						
Mean	0.30	0.31	0.30	0.31	-	-	0.32
Median	0.30	0.29	0.30	0.31	-	-	0.30
Std.Dev.	0.01	0.03	0.00	0.01	-	-	0.04
Rel.Std.Dev.	3.6%	9.58%	0.00%	3.51%	-	-	14.0%
PDM[3]	-2.60%	0.00%	-2.6%	1.3%	-	-	3.90%

Table D11. Analytical results for niobium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	34	31	31	32	40	32
2	35	30	32	30	40	32
3	34	31	32	32	40	33
4	34	32	33	32	41	32
5	34	33	31	33	41	31
Mean	**34**	31	32	32	**40**	32
Median	34	31	32	32	40	32
Std.Dev.	0.4	1.1	0.7	1.1	0.5	0.7
Rel.Std.Dev.	1.31%	3.63%	2.32%	3.44%	1.36%	2.21%
PDM[3]	7.83%	-1.00%	-0.15%	0.26%	27.4%	0.89%

Table D12. Analytical results for neodymium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	23.2	27.7	23.3	N/A	N/A	24.3
2	23.6	26.5	23.5	N/A	N/A	24.5
3	22.8	27.3	24.2	N/A	N/A	26.1
4	23.3	27.8	23.2	N/A	N/A	24.5
5	23.8	27.2	23.6	N/A	N/A	23.3
Mean	23.3	**27.3**	23.6	-	-	24.5
Median	23.3	27.3	23.5	-	-	24.5
Std.Dev.	0.4	0.5	0.4	-	-	1.0
Rel.Std.Dev.	1.65%	1.89%	1.71%	-	-	4.09%
PDM[3]	-1.97%	14.7%	-1.09%	-	-	3.07%

Table D13. Analytical results for praseodymium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	6.23	7.60	6.01	N/A	N/A	6.00
2	6.58	7.40	6.28	N/A	N/A	6.10
3	5.95	7.60	6.37	N/A	N/A	6.00
4	6.18	7.60	6.32	N/A	N/A	6.20
5	6.00	7.60	6.20	N/A	N/A	5.90
Mean	6.19	**7.56**	6.23	-	-	6.04
Median	6.18	7.60	6.28	-	-	6.00
Std.Dev.	0.25	0.09	0.14	-	-	0.11
Rel.Std.Dev.	4.02%	1.18%	2.25%	-	-	1.89%
PDM[3]	0.55%	22.9%	1.30%	-	-	-1.85%

Table D14. Analytical results for rubidium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	20.7	21.0	**21.4**	22.2	24.0	22.5
2	21.6	20.0	22.4	21.9	24.0	21.8
3	20.8	20.5	23.1	22.1	24.0	21.9
4	20.6	21.4	22.7	22.1	24.0	22.4
5	21.7	21.8	22.2	21.8	24.0	21.6
Mean	21.1	20.9	22.3	22.0	24.0	22.0
Median	20.8	21.0	22.4	22.1	24.0	21.9
Std.Dev.	0.53	0.71	0.65	0.16	0.00	0.39
Rel.Std.Dev.	2.50%	3.40%	2.90%	0.75%	0.00%	1.77%
PDM[3]	-4.66%	-5.30%	1.03%	-0.41%	8.54%	-0.32%

Table D15. Analytical results for samarium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	5.13	4.7	5.7	5.1	N/A	N/A	4.9
2	5.18	4.9	5.9	5.3	N/A	N/A	5.2
3	5.15	5.0	6.1	5.0	N/A	N/A	5.0
4	5.15	4.6	6.1	5.3	N/A	N/A	5.0
5	5.10	5.0	5.9	4.9	N/A	N/A	4.9
6	5.18						
7	5.29						
8	5.14						
9	5.16						
10	5.17						
11	5.29						
12	5.21						
13	5.23						
14	5.27						
15	5.21						
16	5.14						
17	5.19						
18	5.20						
19	5.25						
20	5.25						
Mean	5.19	4.84	**5.94**	5.11	-	-	5.00
Median	5.19	4.90	5.90	5.10	-	-	5.00
Std.Dev.	0.05	0.18	0.17	0.17	-	-	0.12
Rel.Std.Dev.	1.1%	3.75%	2.82%	3.27%	-	-	2.4%
PDM[3]	3.14%	-3.89%	17.9%	1.5%	-	-	-0.72%

Table D16. Analytical results for tin in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	AF*MS	AF*MS
1	3.0	4.0	4.0	N/A	< 10	4.0
2	3.0	4.0	3.5	N/A	< 10	4.0
3	3.0	4.0	**7.5**	N/A	< 10	4.0
4	3.0	4.0	4.5	N/A	< 10	4.0
5	4.0	4.0	3.0	N/A	< 10	4.0
Mean	**3.2**	4.0	4.5	-	-	4.0
Median	3.0	4.0	4.0	-	-	4.0
Std.Dev.	0.4	0.0	1.8	-	-	0.0
Rel.Std.Dev.	13.98%	0.00%	39.28%	-	-	0.00%
PDM[3]	-18.3%	2.13%	14.9%	-	-	2.13%

Table D17. Analytical results for strontium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	45.0	37.5	34.4	34.8	37.0	36.9
2	45.0	33.2	35.6	35.1	38.0	36.2
3	44.0	34.4	37.2	34.6	38.0	37.0
4	48.0	35.6	37.0	33.4	36.0	36.3
5	**53.0**	35.5	35.0	34.9	38.0	37.1
Mean	**47.0**	35.2	35.8	34.6	37.4	36.7
Median	45.0	35.5	35.6	34.8	38.0	36.9
Std.Dev.	3.67	1.59	1.22	0.67	0.89	0.42
Rel.Std.Dev.	7.82%	4.53%	3.40%	1.95%	2.39%	1.14%
PDM[3]	30.8%	-1.96%	-0.34%	-3.85%	4.05%	2.10%

Table D18. Analytical results for terbium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	0.74	0.80	0.70	N/A	N/A	0.70
2	0.73	0.70	0.74	N/A	N/A	0.70
3	0.68	0.80	0.69	N/A	N/A	0.70
4	0.72	0.80	0.71	N/A	N/A	0.70
5	0.65	0.80	0.73	N/A	N/A	0.70
Mean	0.70	**0.78**	0.71	-	-	0.70
Median	0.72	0.80	0.71	-	-	0.70
Std.Dev.	0.04	0.04	0.02	-	-	0.00
Rel.Std.Dev.	5.37%	5.73%	2.84%	-	-	0.00%
PDM[3]	-0.19%	10.6%	0.95%	-	-	-0.76%

Table D19. Analytical results for thorium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	9.9	12.0	**9.3**	9.0	10.0	12.0
2	10.5	11.0	11.4	9.0	10.5	12.0
3	9.7	12.0	12.1	9.1	10.5	12.0
4	10.1	12.0	11.8	**9.5**	10.5	11.0
5	9.9	12.0	11.6	9.3	10.5	12.0
Mean	10.02	11.80	11.21	9.18	10.40	11.80
Median	9.90	12.00	11.60	9.10	10.50	12.00
Std.Dev.	0.30	0.45	1.13	0.22	0.22	0.45
Rel.Std.Dev.	3.03%	3.79%	10.0%	2.36%	2.15%	3.79%
PDM[3]	-7.25%	9.23%	3.76%	-15.0%	-3.73%	9.23%

Table D20. Analytical results for thulium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	-	AF*MS
1	0.30	0.30	0.33	N/A	N/A	0.30
2	0.40	0.30	0.33	N/A	N/A	0.30
3	0.30	0.30	0.35	N/A	N/A	0.30
4	0.30	0.30	0.32	N/A	N/A	0.30
5	0.30	0.30	0.33	N/A	N/A	0.30
Mean	0.32	0.30	0.33	-	-	0.30
Median	0.30	0.30	0.33	-	-	0.30
Std.Dev.	0.04	0.00	0.01	-	-	0.00
Rel.Std.Dev.	14.0%	0.00%	3.35%	-	-	0.00%
PDM[3]	2.65%	-3.77%	4.89%	-	-	-3.77%

Table D21. Analytical results for uranium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	2.6	2.7	2.6	2.2	3.0	2.6
2	2.7	2.7	2.9	2.2	3.0	2.6
3	2.4	2.9	2.8	2.2	3.0	2.8
4	2.4	2.9	2.7	2.3	3.0	2.6
5	2.5	2.9	2.7	2.2	3.0	2.8
Mean	2.5	2.8	2.7	2.2	3.0	2.7
Median	2.5	2.9	2.7	2.2	3.0	2.6
Std.Dev.	0.1	0.1	0.1	0.0	0.0	0.1
Rel.Std.Dev.	5.17%	3.88%	4.00%	2.01%	0.00%	4.09%
PDM[3]	-5.20%	6.08%	1.94%	-16.5%	12.9%	0.82%

Table D22. Analytical results for yttrium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	AF*MS	AF*MS	AF*MS
1	16.5	18.6	**19.7**	17.3	21.0	19.9
2	16.9	17.0	21.0	17.3	21.0	19.3
3	16.7	17.8	20.6	17.6	21.0	19.7
4	17.0	18.2	21.0	17.6	22.0	19.5
5	17.1	18.6	21.0	17.5	21.0	19.1
Mean	16.8	18.0	20.6	17.5	21.2	19.5
Median	16.9	18.2	21.0	17.5	21.0	19.5
Std.Dev.	0.24	0.67	0.55	0.15	0.45	0.32
Rel.Std.Dev.	1.43%	3.71%	2.66%	0.87%	2.11%	1.62%
PDM[3]	-11.3%	-4.98%	8.71%	-8.04%	11.7%	2.71%

Table D23. Analytical results for ytterbium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab G	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	INAA (4.0g)	AF*MS	AF*MS	BF*MS	AF*MS	-	AF*MS
1	2.3	2.0	2.2	2.1	2.1	N/A	2.2
2	2.1	2.1	2.1	2.2	2.0	N/A	2.2
3	2.4	1.8	2.1	2.1	2.0	N/A	2.3
4	2.2	1.8	2.3	2.3	2.1	N/A	2.1
5	2.2	2.1	2.4	2.3	2.0	N/A	2.2
6	2.2						
7	2.3						
8	2.2						
9	2.2						
10	2.3						
11	2.3						
12	2.1						
13	2.1						
14	2.2						
15	2.2						
16	2.3						
17	2.4						
18	2.3						
19	2.2						
20	2.3						
Mean	2.2	2.0	2.2	2.2	2.0	-	2.2
Median	2.2	2.0	2.2	2.2	2.0	-	2.2
Std.Dev.	0.1	0.2	0.1	0.1	0.1	-	0.1
Rel.Std.Dev.	3.68%	7.74%	5.87%	3.60%	2.68%	-	3.21%
PDM[3]	4.21%	-8.39%	3.77%	2.22%	-4.65%	-	2.83%

Table D24. Analytical results for zirconium in standard OREAS 45b (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	Lab B	Lab C	Lab D	Lab E	Lab F
	AF*MS	AF*MS	BF*MS	-	AF*MS	AF*MS
1	315	295	322	N/A	320	332
2	316	285	329	N/A	340	336
3	313	296	330	N/A	330	343
4	323	**317**	338	N/A	360	339
5	316	301	329	N/A	350	342
Mean	317	299	330	-	340	338
Median	316	296	329	-	340	339
Std.Dev.	3.8	11.7	5.8	-	15.8	4.5
Rel.Std.Dev.	1.19%	3.92%	1.75%	-	4.65%	1.33%
PDM[3]	-2.21%	-7.71%	1.80%	-	5.01%	4.52%