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CERTIFICATE OF ANALYSIS FOR

High Grade Uranium Reference Material

OREAS 106

SUMMARY STATISTICS

Constituent	Recommended Value	1SD
Uranium via Fusion, U (ppm)	1143	34
Uranium via PPP, U (ppm)	1213	43
Thorium via Fusion, Th (ppm)	644	30
Thorium via PPP, Th (ppm)	689	18
Potassium, K (wt.%)	1.59	0.03
Cerium, Ce (ppm)	137	11
Dysprosium, Dy (ppm)	19.0	1.1
Erbium, Er (ppm)	12.2	0.7
Europium, Eu (ppm)	2.00	0.17
Gadolinium, Gd (ppm)	18.2	1.3
Holmium, Ho (ppm)	3.9	0.3
Lanthanum, La (ppm)	54	3
Lutetium, Lu (ppm)	1.66	0.05
Neodymium, Nd (ppm)	84	5
Praseodymium, Pr (ppm)	19.7	1.2
Samarium, Sm (ppm)	20.7	1.5
Terbium, Tb (ppm)	3.10	0.18
Thulium, Tm (ppm)	1.88	0.12
Ytterbium, Yb (ppm)	12.1	0.6

Prepared by:
ORE Research & Exploration Pty Ltd
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INTRODUCTION

OREAS reference materials (RM) are intended to provide a low cost method of evaluating and improving the quality of precious and base metal analysis of geological samples. To the explorationist, they provide an important control in analytical data sets related to exploration from the grass roots level through to resource definition. To the analyst, they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

SOURCE MATERIALS

High grade uranium reference material OREAS 106 was prepared from samples sourced from the Crocker Well Project located in the Olary District of the Curnamona Province of South Australia. Uranium mineralization occurs within basement intrusives primarily as thorian brannerite as a disseminated accessory mineral or in fractures, breccias or quartz veins in sodic plagioclase rich mesoproterozoic granitoids and gneisses. In the east of the deposit uranium occurs as davidite. The Crocker Well material was blended with barren rhyodacite to achieve the desired grade of uranium in OREAS 106.

COMMINUTION AND HOMOGENISATION PROCEDURES

Reference material OREAS 106 was prepared in the following manner:

a) jaw crushing to minus 3mm
b) drying to constant mass at 105^0C
c) milling of the barren rhyodacite material to 98% minus 75 micron
d) milling of the Crocker Well material to 100% minus 30 microns
e) blending in appropriate proportions to achieve the desired grade
f) bagging into 25kg sublots
g) packaging into 30g units in laminated foil pouches

ANALYSIS OF OREAS 106

Ten commercial laboratories participated in the analytical program to certify U, Th, K, Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm and Yb by fusion methods. 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 an appendix (Tables A2 – A20). The parameter PDM^3 is a measure of laboratory accuracy while 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 indicated as codes at the head of each laboratory data set and explained in Table A1 of the appendix. To maintain anonymity laboratories have been randomly designated the letter codes A through J.
Results for U and Th are also presented in scatter plots (Figures 1 and 2) 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.

A batch of five 30g pulp samples was submitted to each of the participating laboratories for analysis. Each set of subsamples submitted to each laboratory was taken at regular intervals during packaging of the standard in order to maximise their representation.
Most laboratories employed lithium borate fusion with ICP to determine the seventeen analytes, however there were exceptions. For all analytes Lab C and Lab G used sodium peroxide fusion with ICP and Lab A, in addition to the lithium borate fusion analyses, determined U and Th by instrumental neutron activation analysis (INAA) and delayed neutron capture (DNC, for U only). All summary statistics including Recommended Values, 95% Confidence Intervals and Tolerance Intervals are given in Tables 1 and 2 and Performance Gates are shown in Table 3. Three laboratories also provided U and Th data via pressed powder pellet (PPP). These results are treated separately to the fusion data and because of the limited participation of labs the summary statistics for these analytes are indicative only.

STATISTICAL EVALUATION OF ANALYTICAL DATA FOR OREAS 106

Recommended Value and Confidence Limits
The recommended value is the mean of means of accepted replicate values of accepted participating laboratories computed according to the formulae

$$\overline{x_i} = \frac{1}{n_i}\sum_{j=1}^{n_i} x_{ij}$$

$$\ddot{x} = \frac{1}{p}\sum_{i=1}^{p} \overline{x_i}$$

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;*
$\overline{x}_i$ *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):

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

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

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 is 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

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

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

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.

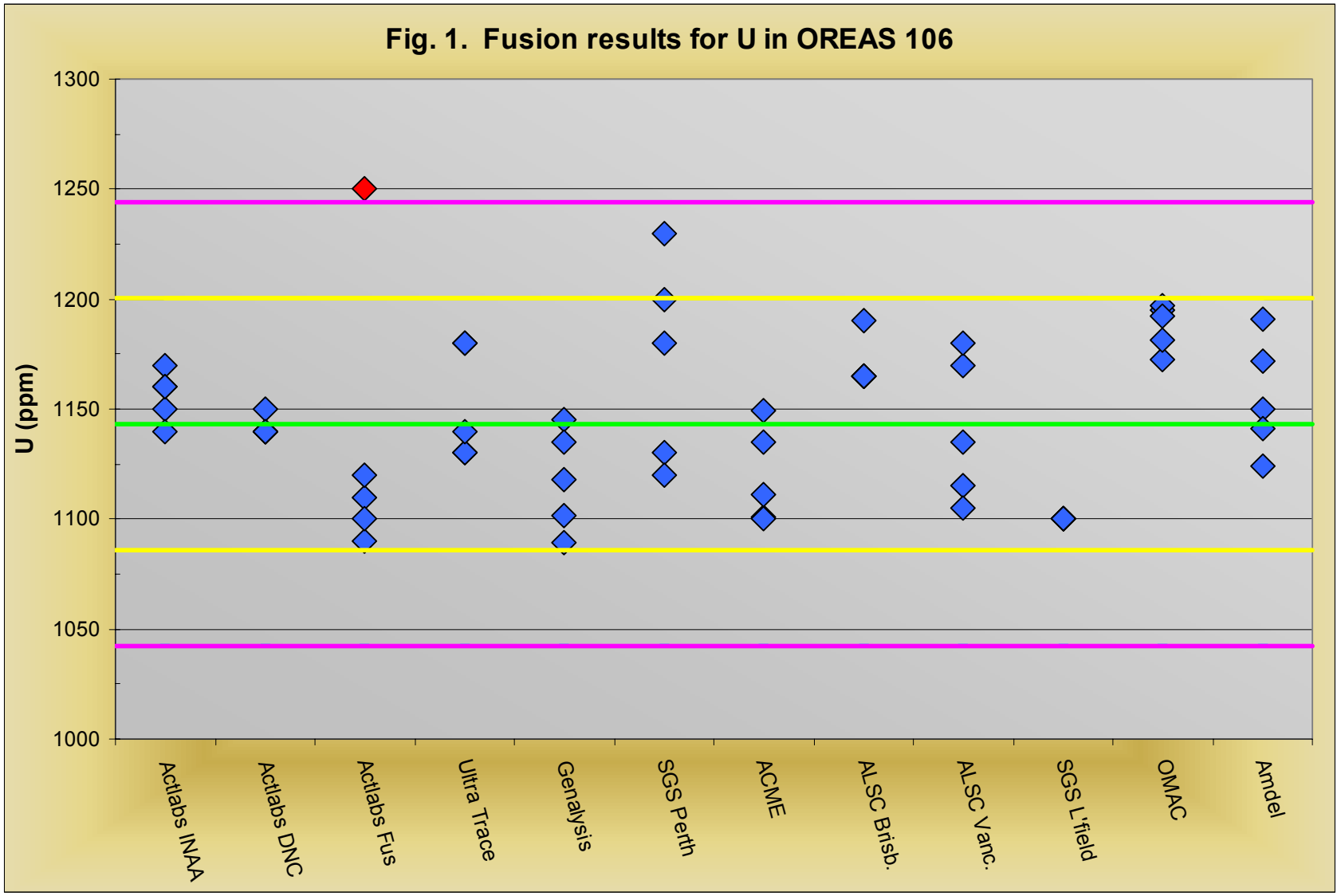
The z-score test is used in combination with a second method of individual outlier detection that determines the percent deviation of the individual value from the median. Outliers in general are selected on the basis of z-scores > 2.5 and with percent deviations > 1.5 %.
Each laboratory data set is also tested for outlying status based on z-score discrimination and rejected if $|z_i| > 2.5$. After individual and entire lab data set outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status. 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 left justified and in bold in the tabulated results (see Appendix) 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. A 95% confidence interval indicates a 95% probability that the interval includes the true value of the analyte under consideration.

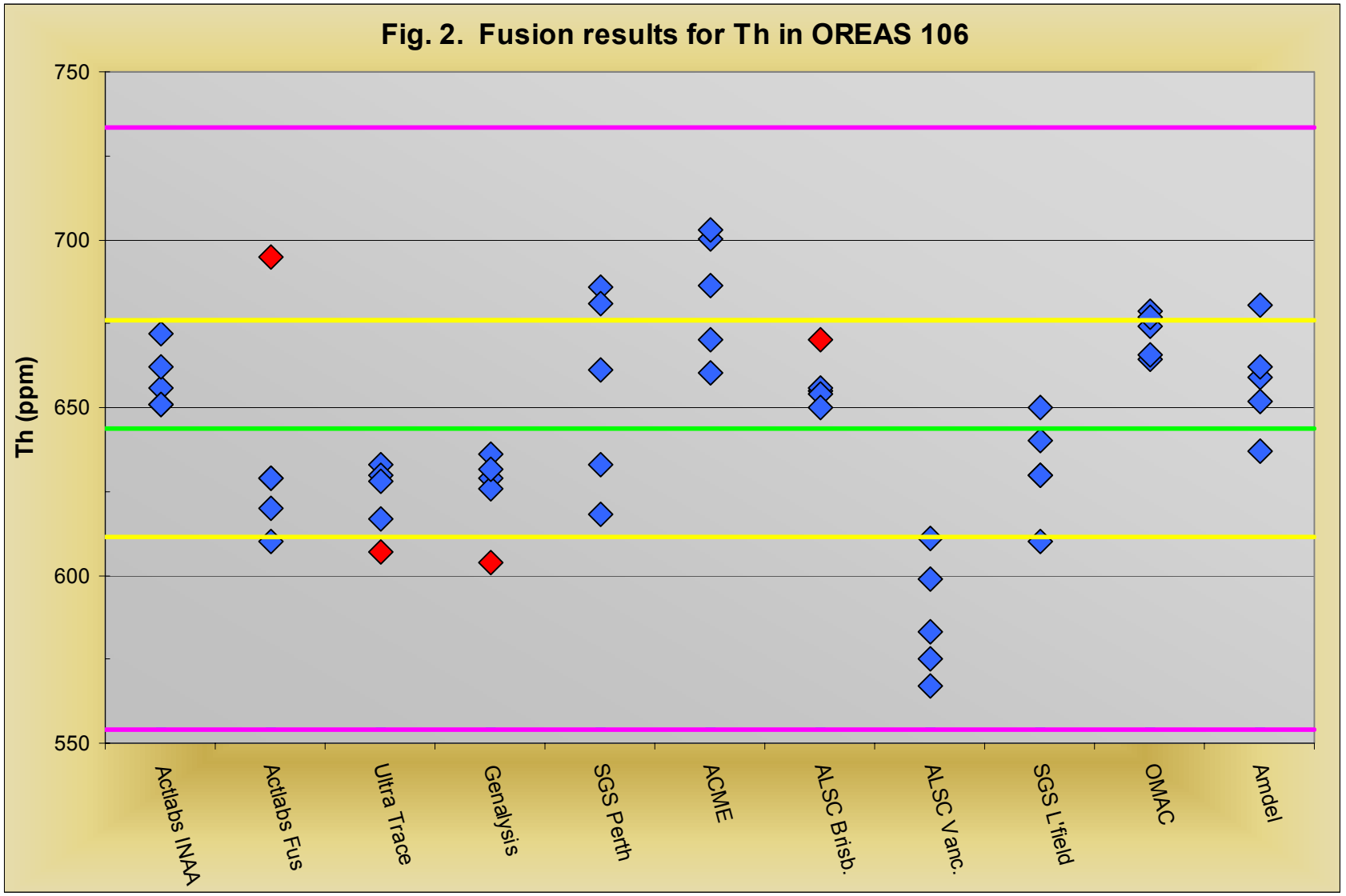
Table 1. Recommended values and 95% confidence intervals for OREAS 106

Constituent	Recommended Value	95% Confidence Interval	
		Low	High
Uranium via Fusion, U (ppm)	1143	1126	1161
Uranium via PPP, U (ppm)	1213	1091	1335
Thorium via Fusion, Th (ppm)	644	625	662
Thorium via PPP, Th (ppm)	689	637	741
Potassium, K (wt.%)	1.59	1.57	1.60
Cerium, Ce (ppm)	137	129	146
Dysprosium, Dy (ppm)	19.0	18.1	20.0
Erbium, Er (ppm)	12.2	11.5	12.8
Europium, Eu (ppm)	2.00	1.87	2.12
Gadolinium, Gd (ppm)	18.2	17.1	19.3
Holmium, Ho (ppm)	3.9	3.7	4.2
Lanthanum, La (ppm)	54	51	56
Lutetium, Lu (ppm)	1.66	1.63	1.69
Neodymium, Nd (ppm)	84	80	88
Praseodymium, Pr (ppm)	19.7	18.7	20.7
Samarium, Sm (ppm)	20.7	19.5	22.0
Terbium, Tb (ppm)	3.10	2.92	3.28
Thulium, Tm (ppm)	1.88	1.77	1.99
Ytterbium, Yb (ppm)	12.1	11.7	12.6

Note - intervals may appear asymmetric due to rounding; '~' value is indicative only

Fig. 1. Fusion results for U in OREAS 106





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 the 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*;

$1-\alpha$ *is the confidence level*;

p *is the proportion of results expected within the 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 intervals may be illustrated for uranium via fusion, where 99% of the time at least 95% of subsamples will have concentrations lying between 1116 and 1171 ppm (see Table 2). 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

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

s'_g *is the grand standard deviation computed from the transformed (i.e. means - adjusted) results*

according to the formula:

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

where $\bar{x}'_i$ *is the transformed mean for laboratory i*

Table 2. Recommended values and tolerance intervals for OREAS 106

Constituent	Recommended Value	Tolerance Interval 1-α=0.99, ρ=0.95	
		Low	High
Uranium via Fusion, U (ppm)	1143	1116	1171
Uranium via PPP, U (ppm)	1213	1140	1285
Thorium via Fusion, Th (ppm)	644	627	660
Thorium via PPP, Th (ppm)	689	654	724
Potassium, K (wt.%)	1.59	1.55	1.63
Cerium, Ce (ppm)	137	133	141
Dysprosium, Dy (ppm)	19.0	18.3	19.7
Erbium, Er (ppm)	12.2	11.8	12.5
Europium, Eu (ppm)	2.00	1.93	2.06
Gadolinium, Gd (ppm)	18.2	17.7	18.7
Holmium, Ho (ppm)	3.9	3.7	4.1
Lanthanum, La (ppm)	54	52	56
Lutetium, Lu (ppm)	1.66	1.615	1.709
Neodymium, Nd (ppm)	84	82	86
Praseodymium, Pr (ppm)	19.7	19.1	20.3
Samarium, Sm (ppm)	20.7	19.9	21.6
Terbium, Tb (ppm)	3.10	3.00	3.20
Thulium, Tm (ppm)	1.88	1.77	2.00
Ytterbium, Yb (ppm)	12.1	11.8	12.5

Note - intervals may appear asymmetric due to rounding; '~' value is indicative only

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 tolerance intervals and a weighting factor of zero was applied to those data sets where $s_l / 2s_g' > 1$ (i.e. where the weighting factor $1 - s_l / 2s_g' < 0$). Data sets displaying poor resolution (i.e. where the ratio of the reading increment divided by the measured value is $< {}^1/_{20}$) were also omitted.
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. Despite the limitations of this method, the tolerance intervals presented in Table 2 are considered to confirm a high level of homogeneity for this CRM.

Performance Gates

Performance gates provide an indication of a level of performance that might reasonably be expected for a particular analyte from a laboratory being monitored by this standard in a QA/QC program. They incorporate 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. Two methods have been employed to calculate performance gates. The first method uses the standard deviation of the pooled individual analyses generated from the certification program after removal of all individual and lab dataset (batch) outliers as well as application of a non-iterative 3 standard deviation filter. These outliers can only be removed if they can be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM.

Table 3. Performance Gates for OREAS 106

Constituent	Rec'd Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
U-Fus (ppm)	1143	34	1076	1210	1042	1244	2.94%	5.87%	8.8%	1086	1200
U-PPP (ppm)	1213	43	1127	1298	1085	1340	3.51%	7.03%	10.54%	1152	1273
Th-Fus (ppm)	644	30	584	704	554	733	4.65%	9.30%	14.0%	612	676
Th-PPP (ppm)	689	18	652	726	634	744	2.67%	5.35%	8.02%	655	724
K (wt.%)	1.59	0.03	1.53	1.64	1.50	1.67	1.74%	3.48%	5.22%	1.51	1.67
Ce (ppm)	137	11	116	159	105	169	7.73%	15.5%	23.2%	130	144
Dy (ppm)	19.0	1.1	16.7	21.3	15.6	22.5	6.02%	12.0%	18.1%	18.1	20.0
Er (ppm)	12.2	0.7	10.7	13.7	9.9	14.4	6.15%	12.3%	18.5%	11.5	12.8
Eu (ppm)	2.00	0.17	1.66	2.34	1.49	2.50	8.51%	17.0%	25.5%	1.90	2.10
Gd (ppm)	18.2	1.3	15.6	20.9	14.3	22.2	7.24%	14.5%	21.7%	17.3	19.1
Ho (ppm)	3.9	0.3	3.3	4.5	3.0	4.8	7.58%	15.2%	22.7%	3.7	4.1
La (ppm)	54	3	47	60	44	64	6.21%	12.4%	18.6%	51	56
Lu (ppm)	1.66	0.05	1.56	1.77	1.51	1.82	3.13%	6.25%	9.38%	1.58	1.75
Nd (ppm)	84	5	74	95	69	100	6.10%	12.2%	18.3%	80	89
Pr (ppm)	19.7	1.2	17.4	22.0	16.2	23.2	5.86%	11.7%	17.6%	18.7	20.7
Sm (ppm)	20.7	1.5	17.8	23.7	16.3	25.2	7.15%	14.3%	21.4%	19.7	21.8
Tb (ppm)	3.10	0.18	2.74	3.46	2.55	3.65	5.87%	11.7%	17.6%	2.94	3.25
Tm (ppm)	1.88	0.12	1.64	2.12	1.52	2.24	6.36%	12.7%	19.1%	1.79	1.98
Yb (ppm)	12.1	0.6	10.9	13.3	10.3	14.0	5.07%	10.1%	15.2%	11.5	12.7

Note - intervals may appear asymmetric due to rounding; '~' value is indicative only

Performance gates have been calculated for one, two and three standard deviations of the accepted pool of certification data and are presented in Table 3. As a guide these intervals may be regarded as informational (1SD), warning or rejection for multiple outliers (2SD), or rejection for individual outliers (3SD) in QC monitoring although their precise application should be at the discretion of the QC manager concerned.
For the second method a simple ±5% error bar on the certified value is used as the window of acceptability (refer Table 3). 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

Acme Analytical Laboratories Ltd, Vancouver, BC, Canada
Activation Laboratories, Ancaster, ON, Canada
Amdel Laboratories Ltd, Adelaide, SA, Australia
ALS Chemex, Brisbane, QLD, Australia
ALS Chemex, Vancouver, BC, Canada
Genalysis Laboratory Services, Perth, WA, Australia
OMAC Laboratories Ltd, Loughrea, County Galway, Ireland
SGS Lakefield Research Ltd, Lakefield, ON, Canada
SGS Australia, Perth, WA, Australia
Ultra Trace Pty Ltd, Perth, WA, Australia

PREPARER AND SUPPLIER OF THE REFERENCE MATERIALS

OREAS 106 has been prepared and certified and is supplied by:

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Facsimile	(03) 9729 4777	International	+613-9729 4777

It has been packaged in unit sizes of 30g sealed in laminated foil packets.

INTENDED USE

OREAS 106 is a reference material intended for the following:

i) for the monitoring of laboratory performance in the analysis of U, Th, K, Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm and Yb in geological samples;
ii) for the calibration of instruments used in the determination of the concentration of U, Th, K, Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm and Yb;
iii) for the verification of analytical methods for U, Th, K, Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm and Yb.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 106 has been prepared from uranium ore samples sourced from the Crocker Well Project and diluted with barren rhyodacite. The CRM is considered to have long-term stability under normal storage conditions.

INSTRUCTIONS FOR THE CORRECT USE OF THE REFERENCE MATERIAL

The recommended values for OREAS 106 refer to the concentration level of U, Th, K, Ce, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Tm and Yb in their packaged state. Therefore it should not be dried prior to weighing and 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

Craig Hamlyn (B.Sc. Hons.), Geology

REFERENCES

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

ISO Guide 35 (2006), Reference materials - General and statistical principals for certification.

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

APPENDIX

Analytical Data for OREAS 106

Table A1. Explanation of abbreviations used in Tables A2 – A20.

Abbreviation	Explanation
Std.Dev.	one standard deviation
Rel.Std.Dev.	one relative standard deviation (%)
PDM[3]	percent deviation of lab mean from corrected mean of means
NR	not reported
BF	lithium borate fusion
PF	sodium peroxide fusion
INAA	atomic absorption spectrometry
DNC	delayed neutron capture
PPP	pressed powder pellet
ICP	unspecified – combination of OES and MS used
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry
XRF	x-ray fluorescence

Table A2. Results for U via *fusion in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A INAA	Lab A DNC	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H PF*MS	Lab I BF*ICP	Lab J PF*OES
1	1150	1140	1110	1130	1102	1130	1149	1165	1115	1100	1195	1191
2	1170	1140	1090	1180	1118	1120	1135	1165	1105	1100	1173	1172
3	1160	1140	**1250**	1180	1089	1180	1101	1165	1135	1100	1181	1150
4	1140	1150	1120	1130	1145	1200	1100	1165	1170	1100	1197	1124
5	1160	1140	1100	1140	1135	1230	1111	1190	1180	1100	1192	1141
Mean	1156	1142	1134	1152	1118	1172	1119	1170	1141	1100	1188	1156
Median	1160	1140	1110	1140	1118	1180	1111	1165	1135	1100	1192	1150
Std.Dev.	11	4	66	26	23	47	22	11	33	0	10	26
Rel.Std.Dev.	0.99%	0.39%	5.80%	2.25%	2.0%	3.97%	1.96%	0.96%	2.90%	0.00%	0.87%	2.28%
PDM[3]	1.12%	-0.10%	-0.80%	0.77%	-2.22%	2.52%	-2.10%	2.35%	-0.19%	-3.78%	3.88%	1.09%

*with the exception of INAA and DNC

Table A3. Results for U via PPP in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A -	Lab B -	Lab C PPP*XRF	Lab D PPP*XRF	Lab E -	Lab F -	Lab G -	Lab H -	Lab I -	Lab J PPP*XRF
1	NR	NR	1205	1270	NR	NR	NR	NR	NR	1160
2	NR	NR	1208	1270	NR	NR	NR	NR	NR	1180
3	NR	NR	1185	1250	NR	NR	NR	NR	NR	1170
4	NR	NR	1186	1270	NR	NR	NR	NR	NR	1180
5	NR	NR	1196	1280	NR	NR	NR	NR	NR	1180
Mean			1196	1268						1174
Median			1196	1270						1180
Std.Dev.			11	11						9
Rel.Std.Dev.			0.88%	0.86%						0.76%
PDM[3]			-1.37%	4.56%						-3.19%

Table A4. Results for Th via *fusion in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A INAA	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H PF*MS	Lab I BF*ICP	Lab J PF*OES
1	656	629	**607**	629	633	700	655	575	630	664	680
2	662	610	633	636	618	703	656	567	640	674	659
3	672	**695**	617	**604**	661	660	654	583	650	679	662
4	651	629	630	626	686	687	650	599	630	677	637
5	651	620	628	631	681	670	**670**	611	610	666	652
Mean	658	637	623	625	656	684	657	587	632	672	658
Median	656	629	628	629	661	687	655	583	630	674	659
Std.Dev.	9	34	11	13	30	19	8	18	15	7	16
Rel.Std.Dev.	1.34%	5.27%	1.73%	2.00%	4.53%	2.72%	1.16%	3.05%	2.35%	0.98%	2.39%
PDM[3]	2.29%	-1.10%	-3.21%	-2.87%	1.88%	6.26%	2.07%	-8.81%	-1.82%	4.40%	2.23%

*with the exception of INAA

Table A5. Results for Th via PPP in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A -	Lab B -	Lab C PPP*XRF	Lab D PPP*XRF	Lab E -	Lab F -	Lab G -	Lab H -	Lab I -	Lab J PPP*XRF
1	NR	NR	687	720	NR	NR	NR	NR	NR	675
2	NR	NR	689	713	NR	NR	NR	NR	NR	675
3	NR	NR	680	711	NR	NR	NR	NR	NR	675
4	NR	NR	676	709	NR	NR	NR	NR	NR	675
5	NR	NR	682	709	NR	NR	NR	NR	NR	660
Mean			683	712						672
Median			682	711						675
Std.Dev.			5	5						7
Rel.Std.Dev.			0.77%	0.64%						1.00%
PDM[3]			-0.91%	3.39%						-2.48%

Table A6. Results for K in OREAS 106 (abbreviations as in Table A1; values in wt.%).

Replicate No.	Lab A BF*OES	Lab B BF*OES	Lab C PPP*XRF	Lab D PF*OES	Lab E BF*ICP	Lab F BF*OES	Lab G BF*OES	Lab H PF*OES	Lab I BF*ICP	Lab J PF*OES
1	**1.62**	1.65	1.52	1.79	1.63	1.58	1.46	1.52	1.78	1.58
2	1.57	1.60	1.51	1.82	1.59	1.64	1.45	1.58	1.74	1.57
3	1.59	1.55	1.49	1.75	1.56	1.64	1.50	1.58	1.82	1.60
4	1.57	1.60	1.49	1.71	1.59	1.58	1.54	1.60	1.73	**1.67**
5	1.56	1.60	1.50	1.73	1.59	1.58	1.54	1.58	1.70	1.60
Mean	1.58	1.60	**1.50**	**1.76**	1.59	1.60	**1.50**	1.57	**1.75**	1.60
Median	1.57	1.60	1.50	1.75	1.59	1.58	1.50	1.58	1.74	1.60
Std.Dev.	0.02	0.04	0.01	0.04	0.02	0.03	0.04	0.03	0.05	0.04
Rel.Std.Dev.	1.47%	2.21%	0.72%	2.54%	1.47%	2.14%	2.85%	1.93%	2.77%	2.49%
PDM[3]	-0.45%	0.78%	-5.26%	10.9%	0.36%	0.91%	-5.77%	-0.99%	10.5%	1.08%

Table A7. Results for Ce in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	159	**131**	121	136	129	143	133	NR	131	143
2	156	140	117	134	131	141	132	NR	130	144
3	156	139	114	139	127	143	134	NR	130	145
4	**142**	138	123	**177**	128	143	140	NR	132	145
5	151	140	119	152	125	146	142	NR	131	148
Mean	153	138	119	148	128	143	136		131	145
Median	156	139	119	139	128	143	134		131	145
Std.Dev.	7	4	3	18	2	2	5		1	2
Rel.Std.Dev.	4.38%	2.75%	2.75%	12.1%	1.86%	1.25%	3.32%		0.59%	1.29%
PDM[3]	11.3%	0.19%	-13.6%	7.47%	-6.89%	3.98%	-0.97%		-4.87%	5.58%

Table A8. Results for Dy in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	18.9	21.0	18.2	NR	18.0	20.0	17.4	NR	18.5	20.0
2	18.7	21.0	19.0	NR	17.8	19.5	17.5	NR	18.2	20.4
3	19.7	21.0	**17.6**	NR	17.2	19.5	17.9	NR	18.3	20.1
4	17.9	20.5	18.9	NR	17.7	20.0	18.1	NR	18.8	19.7
5	18.2	21.0	18.8	NR	17.6	20.2	18.4	NR	18.5	20.2
Mean	18.7	20.9	18.5		17.6	19.8	17.9		18.5	20.1
Median	18.7	21.0	18.8		17.7	20.0	17.9		18.5	20.1
Std.Dev.	0.7	0.2	0.6		0.3	0.3	0.4		0.2	0.3
Rel.Std.Dev.	3.72%	1.07%	3.20%		1.76%	1.62%	2.33%		1.24%	1.38%
PDM[3]	-1.817%	9.85%	-2.76%		-7.24%	4.28%	-6.18%		-2.87%	5.55%

Table A9. Results for Er in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	13.2	12.5	10.9	NR	11.6	12.8	12.3	NR	11.8	12.4
2	13.0	12.5	10.8	NR	11.5	12.8	12.0	NR	11.6	12.4
3	13.9	12.5	**10.2**	NR	11.4	13.0	12.3	NR	11.6	12.4
4	12.5	12.5	10.9	NR	11.5	13.2	12.9	NR	11.8	12.2
5	12.7	12.0	10.8	NR	11.2	13.3	12.9	NR	11.8	12.2
Mean	13.06	12.40	10.72		11.46	13.02	12.46		11.71	12.29
Median	13.00	12.50	10.80		11.50	13.00	12.30		11.79	12.35
Std.Dev.	0.54	0.22	0.29		0.16	0.23	0.40		0.14	0.10
Rel.Std.Dev.	4.14%	1.80%	2.75%		1.38%	1.75%	3.18%		1.16%	0.82%
PDM[3]	7.43%	2.00%	-11.8%		-5.70%	7.10%	2.49%		-3.68%	1.11%

Table A10. Results for Eu in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	2.15	2.20	1.90	NR	1.98	2.20	1.99	NR	**1.85**	2.19
2	2.09	2.40	1.80	NR	1.91	2.10	2.00	NR	1.77	2.17
3	2.18	1.80	1.70	NR	1.86	2.10	1.98	NR	1.79	2.15
4	2.00	1.80	1.80	NR	1.93	2.10	2.04	NR	1.78	2.12
5	2.09	2.20	1.80	NR	1.88	2.20	**2.15**	NR	1.79	2.09
Mean	2.10	2.08	1.80		1.91	2.14	2.03		1.80	2.14
Median	2.09	2.20	1.80		1.91	2.10	2.00		1.79	2.15
Std.Dev.	0.07	0.27	0.07		0.05	0.05	0.07		0.03	0.04
Rel.Std.Dev.	3.29%	12.9%	3.93%		2.44%	2.56%	3.43%		1.67%	1.93%
PDM[3]	5.34%	4.24%	-9.80%		-4.18%	7.24%	1.83%		-9.95%	7.41%

Table A11. Results for Gd in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	19.9	18.0	16.6	19.3	17.5	19.2	16.7	NR	17.8	22.7
2	19.7	18.0	16.3	19.0	17.5	19.6	16.5	NR	17.2	23.3
3	**20.8**	18.0	15.5	19.8	16.7	19.3	17.2	NR	17.7	23.2
4	**18.8**	18.0	17.3	21.3	17.4	19.5	17.7	NR	17.5	23.0
5	19.8	18.0	17.0	20.5	16.8	19.5	18.0	NR	17.8	23.2
Mean	19.8	18.0	16.5	20.0	17.2	19.4	17.2		17.6	**23.1**
Median	19.8	18.0	16.6	19.8	17.4	19.5	17.2		17.7	23.2
Std.Dev.	0.7	0.0	0.7	0.9	0.4	0.2	0.6		0.2	0.2
Rel.Std.Dev.	3.59%	0.00%	4.20%	4.66%	2.17%	0.85%	3.57%		1.42%	0.99%
PDM[3]	8.69%	-1.20%	-9.2%	9.67%	-5.62%	6.60%	-5.59%		-3.35%	26.7%

Table A12. Results for Ho in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	4.10	4.40	3.80	NR	3.95	4.20	3.59	NR	3.57	3.92
2	4.00	4.40	3.80	NR	3.95	4.10	3.67	NR	3.40	3.89
3	4.30	4.40	3.60	NR	3.78	4.20	3.75	NR	3.51	3.94
4	3.90	4.60	3.80	NR	3.79	4.30	3.82	NR	3.63	3.83
5	3.90	4.40	3.60	NR	3.72	4.30	3.89	NR	3.47	3.90
Mean	4.04	4.44	3.72		3.84	4.22	3.74		3.51	3.90
Median	4.00	4.40	3.80		3.79	4.20	3.75		3.51	3.90
Std.Dev.	0.17	0.09	0.11		0.11	0.08	0.12		0.09	0.04
Rel.Std.Dev.	4.14%	2.01%	2.94%		2.75%	1.98%	3.17%		2.57%	1.11%
PDM[3]	2.89%	13.1%	-5.26%		-2.25%	7.47%	-4.65%		-10.5%	-0.75%

Table A13. Results for La in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	60.0	52.5	52.4	56.8	49.8	55.9	50.6	NR	51.0	52.8
2	58.2	53.0	52.7	57.2	50.2	54.8	49.3	NR	48.9	53.0
3	58.2	53.0	50.7	60.6	49.4	55.6	50.4	NR	49.9	53.3
4	**53.0**	52.5	54.5	**70.5**	50.0	56.1	53.2	NR	50.8	53.7
5	56.8	53.5	53.5	62.4	49.0	**57.4**	54.0	NR	49.6	54.2
Mean	57.2	52.9	52.8	61.5	49.7	56.0	51.5		50.1	53.4
Median	58.2	53.0	52.7	60.6	49.8	55.9	50.6		49.9	53.3
Std.Dev.	2.6	0.4	1.4	5.5	0.5	0.9	2.0		0.9	0.5
Rel.Std.Dev.	4.59%	0.79%	2.67%	9.02%	0.97%	1.69%	3.88%		1.73%	0.99%
PDM[3]	6.56%	-1.52%	-1.78%	14.5%	-7.51%	4.18%	-4.13%		-6.82%	-0.58%

Table A14. Results for Lu in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	1.77	1.60	1.61	NR	1.70	1.90	1.61	NR	1.66	1.69
2	1.71	1.60	1.64	NR	1.68	1.80	1.60	NR	1.59	1.70
3	**1.86**	1.80	1.58	NR	1.67	1.80	1.65	NR	1.65	1.69
4	1.69	1.60	1.66	NR	1.68	1.80	1.68	NR	1.63	1.67
5	1.67	1.60	1.62	NR	**1.62**	1.90	1.72	NR	1.69	**1.75**
Mean	1.74	1.64	1.62		1.67	**1.84**	1.65		1.64	1.70
Median	1.71	1.60	1.62		1.68	1.80	1.65		1.65	1.69
Std.Dev.	0.08	0.09	0.03		0.03	0.05	0.05		0.04	0.03
Rel.Std.Dev.	4.41%	5.45%	1.87%		1.80%	2.98%	3.01%		2.23%	1.71%
PDM[3]	4.69%	-1.32%	-2.41%		0.48%	10.7%	-0.60%		-1.28%	2.21%

Table A15. Results for Nd in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	88.0	90.0	79.4	74.7	**85.5**	83.8	83.2	NR	**85.5**	93.2
2	87.2	90.5	77.4	77.4	81.6	83.2	80.0	NR	83.1	93.3
3	88.7	91.0	76.4	76.9	81.4	83.5	83.2	NR	82.2	92.9
4	**80.1**	88.5	83.2	**89.5**	82.5	85.9	86.5	NR	83.0	92.6
5	83.7	**86.0**	79.8	78.9	81.4	**86.8**	88.4	NR	82.7	92.3
Mean	85.5	89.2	79.2	79.5	82.5	84.6	84.3		83.3	92.8
Median	87.2	90.0	79.4	77.4	81.6	83.8	83.2		83.0	92.9
Std.Dev.	3.6	2.0	2.6	5.8	1.7	1.6	3.3		1.3	0.4
Rel.Std.Dev.	4.21%	2.26%	3.31%	7.30%	2.12%	1.90%	3.87%		1.51%	0.44%
PDM[3]	1.46%	5.80%	-6.01%	-5.73%	-2.17%	0.39%	-0.06%		-1.21%	10.1%

Table A16. Results for Pr in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	20.7	20.2	17.6	19.4	19.4	19.7	18.9	NR	16.1	21.4
2	20.4	21.0	17.3	19.7	19.2	19.7	18.4	NR	15.9	21.4
3	20.7	20.6	**16.8**	20.1	18.6	19.7	18.9	NR	16.5	21.4
4	**18.9**	20.6	17.7	**23.3**	18.7	20.1	19.9	NR	16.9	21.4
5	19.7	20.2	17.5	20.2	18.4	20.3	20.0	NR	16.1	21.1
Mean	20.1	20.5	17.4	20.5	18.9	19.9	19.2		**16.3**	21.4
Median	20.4	20.6	17.5	20.1	18.7	19.7	18.9		16.1	21.4
Std.Dev.	0.8	0.3	0.3	1.6	0.4	0.3	0.7		0.4	0.1
Rel.Std.Dev.	3.86%	1.63%	2.00%	7.67%	2.34%	1.42%	3.63%		2.46%	0.59%
PDM[3]	1.96%	4.19%	-11.8%	4.29%	-4.29%	1.05%	-2.56%		-17.3%	8.44%

Table A17. Results for Sm in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	22.2	21.5	20.2	9.9	19.7	20.6	19.9	NR	18.1	23.1
2	21.7	21.5	19.8	10.5	19.6	20.5	20.0	NR	18.7	23.3
3	22.6	21.5	18.8	10.4	19.2	20.8	20.1	NR	18.7	23.5
4	20.5	22.5	20.7	**11.5**	19.5	20.7	21.0	NR	19.2	23.1
5	21.2	22.5	19.9	10.2	19.0	21.4	21.0	NR	18.5	23.0
Mean	21.6	21.9	19.9	**10.5**	19.4	20.8	20.4		18.6	23.2
Median	21.7	21.5	19.9	10.4	19.5	20.7	20.1		18.7	23.1
Std.Dev.	0.8	0.5	0.7	0.6	0.3	0.4	0.6		0.4	0.2
Rel.Std.Dev.	3.82%	2.50%	3.51%	5.75%	1.67%	1.70%	2.71%		2.22%	0.85%
PDM[3]	4.37%	5.62%	-4.12%	-49.4%	-6.40%	0.32%	-1.61%		-10.1%	12.0%

Table A18. Results for Tb in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	3.20	3.20	2.76	NR	3.11	3.30	3.06	NR	2.03	3.80
2	3.20	3.40	2.78	NR	3.13	3.30	2.97	NR	1.94	3.77
3	3.30	3.20	2.71	NR	3.00	3.30	3.00	NR	2.00	3.76
4	3.00	3.20	2.90	NR	3.04	3.40	3.11	NR	2.03	3.75
5	3.10	3.00	2.89	NR	2.99	3.30	3.13	NR	1.99	3.75
Mean	3.16	3.20	2.81		3.05	3.32	3.05		**2.00**	**3.77**
Median	3.20	3.20	2.78		3.04	3.30	3.06		2.00	3.76
Std.Dev.	0.11	0.14	0.08		0.06	0.04	0.07		0.03	0.02
Rel.Std.Dev.	3.61%	4.42%	2.97%		2.08%	1.35%	2.25%		1.72%	0.53%
PDM[3]	1.96%	3.25%	-9.40%		-1.46%	7.12%	-1.46%		-35.5%	21.5%

Table A19. Results for Tm in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D -	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	2.07	1.80	1.70	NR	1.91	2.00	1.93	NR	1.41	1.81
2	2.04	1.80	1.70	NR	1.94	2.00	1.87	NR	1.36	1.84
3	2.16	1.80	1.70	NR	1.84	2.00	1.90	NR	1.41	1.75
4	1.93	1.80	1.80	NR	1.90	2.00	1.94	NR	1.40	1.78
5	1.98	1.80	1.70	NR	1.90	2.10	1.96	NR	1.44	1.79
Mean	2.04	1.80	1.72		1.90	2.02	1.92		**1.40**	1.79
Median	2.04	1.80	1.70		1.90	2.00	1.93		1.41	1.79
Std.Dev.	0.09	0.00	0.04		0.04	0.04	0.04		0.03	0.04
Rel.Std.Dev.	4.32%	0.00%	2.60%		1.91%	2.21%	1.84%		1.86%	1.98%
PDM[3]	8.07%	-4.46%	-8.70%		0.75%	7.22%	1.91%		-25.5%	-4.80%

Table A20. Results for Yb in OREAS 106 (abbreviations as in Table A1; values in ppm).

Replicate No.	Lab A BF*MS	Lab B BF*MS	Lab C PF*MS	Lab D PF*MS	Lab E BF*ICP	Lab F BF*MS	Lab G PF*MS	Lab H -	Lab I BF*ICP	Lab J BF*MS
1	12.9	12.5	11.0	12.3	11.7	13.1	11.9	NR	11.6	12.1
2	12.5	12.5	11.0	12.2	11.8	12.7	11.5	NR	11.8	12.3
3	**13.6**	13.5	10.8	12.1	11.4	12.5	11.7	NR	11.6	12.1
4	12.4	13.0	11.5	12.2	11.7	12.5	12.2	NR	12.2	12.2
5	12.3	13.0	11.2	**13.1**	11.4	13.2	12.2	NR	11.9	12.3
Mean	12.7	12.9	11.1	12.4	11.6	12.8	11.9		11.8	12.2
Median	12.5	13.0	11.0	12.2	11.7	12.7	11.9		11.8	12.2
Std.Dev.	0.5	0.4	0.3	0.4	0.2	0.3	0.3		0.2	0.1
Rel.Std.Dev.	4.18%	3.24%	2.38%	3.30%	1.53%	2.59%	2.80%		2.00%	0.88%
PDM[3]	5.17%	6.49%	-8.37%	2.20%	-4.24%	5.67%	-1.93%		-2.44%	0.71%