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CERTIFICATE OF ANALYSIS FOR

Medium Grade Uranium Reference Material

OREAS 105

SUMMARY STATISTICS

Constituent	Certified Value	1SD
Uranium via Fusion, U (ppm)	532	23
Uranium via PPP, U (ppm)	~563	~18
Thorium via Fusion, Th (ppm)	369	24
Thorium via PPP, Th (ppm)	~382	~13
Potassium, K (wt.%)	1.97	0.11
Cerium, Ce (ppm)	117	9
Dysprosium, Dy (ppm)	12.2	0.6
Erbium, Er (ppm)	7.5	0.5
Europium, Eu (ppm)	1.50	0.12
Gadolinium, Gd (ppm)	13.0	1.0
Holmium, Ho (ppm)	2.44	0.07
Lanthanum, La (ppm)	51	3
Lutetium, Lu (ppm)	0.992	0.022
Neodymium, Nd (ppm)	64.3	2.9
Praseodymium, Pr (ppm)	16.0	0.6
Samarium, Sm (ppm)	14.8	0.9
Terbium, Tb (ppm)	2.18	0.19
Thulium, Tm (ppm)	1.14	0.09
Ytterbium, Yb (ppm)	7.3	0.4

Prepared by:
ORE Research & Exploration Pty Ltd
February 2009

REPORT 08-734-105

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

Medium grade uranium reference material OREAS 105 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 105.

COMMINUTION AND HOMOGENISATION PROCEDURES

Reference material OREAS 105 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 105

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.

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 Certified 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 105

Certified 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):

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

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

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

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

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

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.

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 certified 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 certified value, i.e. the narrower the confidence interval the greater the certainty in the certified value. A 95% confidence interval indicates a 95% probability that the interval includes the true value of the analyte under consideration.

Table 1. Certified values and 95% confidence intervals for OREAS 105

Constituent	Certified Value	95% Confidence Interval	
		Low	High
Uranium via Fusion, U (ppm)	532	519	545
Uranium via PPP, U (ppm)	~563	~513	~612
Thorium via Fusion, Th (ppm)	369	353	384
Thorium via PPP, Th (ppm)	~382	~348	~416
Potassium, K (wt.%)	1.97	1.89	2.04
Cerium, Ce (ppm)	117	111	124
Dysprosium, Dy (ppm)	12.2	11.8	12.7
Erbium, Er (ppm)	7.5	7.1	7.9
Europium, Eu (ppm)	1.50	1.42	1.58
Gadolinium, Gd (ppm)	13.0	12.3	13.8
Holmium, Ho (ppm)	2.44	2.37	2.52
Lanthanum, La (ppm)	51	48	53
Lutetium, Lu (ppm)	0.992	0.978	1.007
Neodymium, Nd (ppm)	64.3	62.5	66.1
Praseodymium, Pr (ppm)	16.0	15.6	16.5
Samarium, Sm (ppm)	14.8	14.1	15.5
Terbium, Tb (ppm)	2.18	2.01	2.36
Thulium, Tm (ppm)	1.14	1.07	1.22
Ytterbium, Yb (ppm)	7.3	7.0	7.5

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

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 517 and 547 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. Certified values and tolerance intervals for OREAS 105

Constituent	Certified Value	Tolerance Interval 1-α=0.99, ρ=0.95	
		Low	High
Uranium via Fusion, U (ppm)	532	517	547
Uranium via PPP, U (ppm)	~563	~557	~568
Thorium via Fusion, Th (ppm)	369	358	379
Thorium via PPP, Th (ppm)	~382	~333	~430
Potassium, K (wt.%)	1.97	1.92	2.01
Cerium, Ce (ppm)	117	112	122
Dysprosium, Dy (ppm)	12.2	11.8	12.7
Erbium, Er (ppm)	7.5	7.1	7.9
Europium, Eu (ppm)	1.50	1.45	1.56
Gadolinium, Gd (ppm)	13.0	12.4	13.7
Holmium, Ho (ppm)	2.44	2.39	2.50
Lanthanum, La (ppm)	51	49	53
Lutetium, Lu (ppm)	0.992	0.964	1.021
Neodymium, Nd (ppm)	64.3	61.3	67.3
Praseodymium, Pr (ppm)	16.0	15.5	16.6
Samarium, Sm (ppm)	14.8	14.0	15.5
Terbium, Tb (ppm)	2.18	2.00	2.37
Thulium, Tm (ppm)	1.14	1.11	1.18
Ytterbium, Yb (ppm)	7.3	7.0	7.5

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 105

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)	532	23	487	577	464	600	4.25%	8.51%	12.8%	505	559
U-PPP (ppm)	~563	~18	~526	~599	~508	~617	~3.25%	~6.50%	~9.74%	~534	~591
Th-Fus (ppm)	369	24	322	416	298	439	6.39%	12.8%	19.2%	350	387
Th-PPP (ppm)	~382	~13	~355	~408	~342	~421	~3.46%	~6.93%	~10.4%	~363	~401
K (wt.%)	1.97	0.11	1.75	2.19	1.64	2.30	5.61%	11.2%	16.8%	1.87	2.07
Ce (ppm)	117	9	99	135	90	144	7.60%	15.2%	22.8%	111	123
Dy (ppm)	12.2	0.6	11.1	13.4	10.6	13.9	4.55%	9.10%	13.7%	11.6	12.9
Er (ppm)	7.5	0.5	6.5	8.5	5.9	9.0	6.86%	13.7%	20.6%	7.1	7.9
Eu (ppm)	1.50	0.12	1.27	1.73	1.16	1.85	7.68%	15.4%	23.0%	1.43	1.58
Gd (ppm)	13.0	1.0	11.1	15.0	10.1	15.9	7.40%	14.8%	22.2%	12.4	13.7
Ho (ppm)	2.44	0.07	2.30	2.59	2.22	2.66	2.98%	5.95%	8.93%	2.32	2.56
La (ppm)	51	3	44	57	40	61	6.79%	13.6%	20.4%	48	53
Lu (ppm)	0.992	0.022	0.948	1.037	0.925	1.059	2.25%	4.50%	6.75%	0.943	1.042
Nd (ppm)	64.3	2.9	58.6	70.1	55.7	73.0	4.48%	8.96%	13.4%	61.1	67.5
Pr (ppm)	16.0	0.6	14.8	17.2	14.3	17.8	3.64%	7.28%	10.9%	15.2	16.8
Sm (ppm)	14.8	0.9	13.0	16.5	12.2	17.4	5.91%	11.8%	17.7%	14.0	15.5
Tb (ppm)	2.18	0.19	1.80	2.57	1.61	2.76	8.78%	17.6%	26.3%	2.08	2.29
Tm (ppm)	1.14	0.09	0.96	1.33	0.87	1.42	7.87%	15.7%	23.6%	1.09	1.20
Yb (ppm)	7.3	0.4	6.5	8.1	6.1	8.5	5.49%	11.0%	16.5%	6.9	7.6

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 105 has been prepared and certified and is supplied by:

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

INTENDED USE

OREAS 105 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 105 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 certified values for OREAS 105 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 105

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	instrumental neutron activation analysis
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 105 (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	545	530	509	513	523	**490**	555	560	523	500	488	546
2	535	539	481	547	512	564	562	561	522	510	482	558
3	549	531	498	542	529	531	546	542	517	510	540	**511**
4	549	535	495	527	523	564	551	569	518	500	516	541
5	538	**553**	520	539	512	582	533	**506**	517	510	541	544
Mean	543	538	501	534	520	546	549	548	519	506	513	540
Median	545	535	498	539	523	564	551	560	518	510	516	544
Std.Dev.	6	9	15	14	8	36	11	25	3	5	28	17
Rel.Std.Dev.	1.18%	1.73%	2.94%	2.56%	1.5%	6.67%	2.00%	4.61%	0.55%	1.08%	5.37%	3.24%
PDM[3]	2.10%	1.04%	-5.91%	0.29%	-2.30%	2.66%	3.25%	2.92%	-2.38%	-4.90%	-3.52%	1.50%

*with the exception of INAA and DNC

Table A3. Results for U via PPP in OREAS 105 (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	573	577	NR	NR	NR	NR	NR	540
2	NR	NR	565	**590**	NR	NR	NR	NR	NR	540
3	NR	NR	588	576	NR	NR	NR	NR	NR	540
4	NR	NR	563	576	NR	NR	NR	NR	NR	540
5	NR	NR	558	584	NR	NR	NR	NR	NR	540
Mean			569	581						540
Median			565	577						540
Std.Dev.			12	6						0
Rel.Std.Dev.			2.06%	1.07%						0.00%
PDM[3]			1.22%	3.21%						-4.01%

Table A4. Results for Th via *fusion in OREAS 105 (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	376	338	**310**	350	**359**	397	378	360	350	344	374
2	369	323	338	349	418	390	377	365	360	398	387
3	378	333	344	354	387	393	367	356	350	383	366
4	381	329	335	354	417	396	381	363	350	375	374
5	371	345	360	351	427	**378**	**340**	363	350	407	370
Mean	375	334	337	352	402	391	369	361	352	382	374
Median	376	333	338	351	417	393	377	363	350	383	374
Std.Dev.	5	8	18	2	28	8	17	4	4	24	8
Rel.Std.Dev.	1.32%	2.52%	5.37%	0.61%	7.02%	1.97%	4.57%	0.97%	1.27%	6.34%	2.10%
PDM[3]	1.71%	-9.52%	-8.49%	-4.66%	8.93%	6.02%	-0.02%	-1.98%	-4.53%	3.50%	1.46%

*with the exception of INAA

Table A5. Results for Th via PPP in OREAS 105 (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	389	389	NR	NR	NR	NR	NR	358
2	NR	NR	381	400	NR	NR	NR	NR	NR	365
3	NR	NR	395	395	NR	NR	NR	NR	NR	375
4	NR	NR	380	400	NR	NR	NR	NR	NR	373
5	NR	NR	377	386	NR	NR	NR	NR	NR	365
Mean			384	394						367
Median			381	395						365
Std.Dev.			7	6						7
Rel.Std.Dev.			1.93%	1.62%						1.89%
PDM[3]			0.68%	3.20%						-3.88%

Table A6. Results for K in OREAS 105 (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	1.83	2.05	1.89	2.05	2.07	2.01	1.82	2.00	**1.94**	1.92
2	1.87	2.00	1.86	2.06	2.04	**1.93**	1.83	1.87	2.15	1.93
3	1.94	2.00	1.93	2.22	2.07	1.99	1.82	1.88	2.11	**1.88**
4	1.88	2.00	1.87	2.22	1.97	2.00	1.85	1.79	2.03	**1.97**
5	1.92	2.00	1.84	2.11	2.00	2.02	1.83	1.82	2.12	1.94
Mean	1.89	2.01	1.88	2.13	2.03	1.99	1.83	1.87	2.07	1.93
Median	1.88	2.00	1.87	2.11	2.04	2.00	1.83	1.87	2.11	1.93
Std.Dev.	0.04	0.02	0.04	0.08	0.05	0.04	0.01	0.08	0.08	0.03
Rel.Std.Dev.	2.38%	1.11%	1.89%	3.92%	2.25%	1.83%	0.69%	4.30%	4.04%	1.62%
PDM[3]	-4.05%	2.17%	-4.47%	8.37%	3.18%	1.10%	-7.14%	-4.85%	5.25%	-2.00%

Table A7. Results for Ce in OREAS 105 (abbreviations as in Table A1; values in ppm).

Replicate	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	133	**113**	105	107	114	123	113	NR	106	125
2	128	119	101	123	111	122	116	NR	105	122
3	131	120	106	115	110	121	113	NR	115	122
4	131	117	105	121	112	125	113	NR	111	121
5	138	120	100	127	109	**112**	116	NR	117	125
Mean	132	118	103	119	111	120	114		111	123
Median	131	119	105	121	111	122	113		111	122
Std.Dev.	4	3	3	8	2	5	2		5	2
Rel.Std.Dev.	2.80%	2.50%	2.64%	6.57%	1.61%	4.24%	1.38%		4.79%	1.52%
PDM[3]	12.9%	0.59%	-11.7%	1.27%	-5.17%	2.64%	-2.83%		-5.57%	5.03%

Table A8. Results for Dy in OREAS 105 (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	12.1	13.0	12.6	NR	11.7	13.2	12.0	NR	11.3	13.1
2	11.6	13.5	12.2	NR	11.9	13.3	12.1	NR	11.5	12.7
3	11.9	13.5	12.5	NR	11.6	12.8	11.8	NR	12.3	12.3
4	11.9	13.5	12.2	NR	11.7	13.2	12.0	NR	12.0	12.6
5	12.3	13.5	11.8	NR	**11.2**	**12.0**	11.7	NR	12.7	13.2
Mean	12.0	**13.4**	12.3		11.6	12.9	11.9		12.0	12.8
Median	11.9	13.5	12.2		11.7	13.2	12.0		12.0	12.7
Std.Dev.	0.3	0.2	0.3		0.2	0.5	0.2		0.6	0.4
Rel.Std.Dev.	2.18%	1.67%	2.55%		2.12%	4.17%	1.49%		4.77%	3.13%
PDM[3]	-2.33%	9.43%	0.12%		-5.06%	5.34%	-2.82%		-2.35%	4.41%

Table A9. Results for Er in OREAS 105 (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	8.00	7.50	6.80	NR	7.36	8.20	8.02	NR	6.71	7.35
2	7.60	7.00	6.60	NR	7.21	8.30	8.06	NR	6.67	7.27
3	7.80	8.00	6.90	NR	7.40	7.90	7.92	NR	7.36	7.05
4	7.70	8.00	6.60	NR	7.26	8.30	7.81	NR	7.08	7.26
5	8.20	8.00	6.80	NR	7.18	**7.50**	7.62	NR	7.33	**7.64**
Mean	7.86	7.70	6.74		7.28	8.04	7.89		7.03	7.31
Median	7.80	8.00	6.80		7.26	8.20	7.92		7.08	7.27
Std.Dev.	0.24	0.45	0.13		0.09	0.34	0.18		0.33	0.21
Rel.Std.Dev.	3.06%	5.81%	1.99%		1.30%	4.27%	2.25%		4.66%	2.90%
PDM[3]	4.96%	2.83%	-9.99%		-2.75%	7.37%	5.31%		-6.12%	-2.33%

Table A10. Results for Eu in OREAS 105 (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	1.59	1.20	1.40	NR	1.49	1.60	1.56	NR	1.36	1.59
2	1.52	1.60	1.30	NR	1.49	1.70	1.54	NR	1.33	1.57
3	1.56	1.40	1.40	NR	1.44	1.70	1.57	NR	1.47	1.53
4	1.54	1.40	1.40	NR	1.41	1.70	**1.63**	NR	1.41	1.57
5	1.63	1.60	1.40	NR	1.40	1.50	1.57	NR	1.50	1.65
Mean	1.57	1.44	1.38		1.45	1.64	1.57		1.41	1.58
Median	1.56	1.40	1.40		1.44	1.70	1.57		1.41	1.57
Std.Dev.	0.04	0.17	0.04		0.04	0.09	0.03		0.07	0.04
Rel.Std.Dev.	2.76%	11.6%	3.24%		2.96%	5.45%	2.14%		4.96%	2.75%
PDM[3]	4.29%	-4.23%	-8.22%		-3.83%	9.08%	4.69%		-6.05%	5.20%

Table A11. Results for Gd in OREAS 105 (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	14.0	12.0	12.2	12.4	12.8	14.4	12.9	NR	11.9	16.4
2	13.5	12.0	11.8	14.3	12.9	14.3	12.8	NR	11.9	15.5
3	13.9	12.0	12.2	13.7	12.5	14.1	12.7	NR	13.2	16.7
4	13.6	12.0	12.4	15.0	12.5	14.5	12.5	NR	12.7	15.6
5	14.4	12.0	**11.1**	15.0	12.1	**13.0**	12.7	NR	13.5	16.6
Mean	13.9	12.0	11.9	14.1	12.6	14.1	12.7		12.7	**16.2**
Median	13.9	12.0	12.2	14.3	12.5	14.3	12.7		12.7	16.4
Std.Dev.	0.4	0.0	0.5	1.1	0.3	0.6	0.2		0.7	0.5
Rel.Std.Dev.	2.57%	0.00%	4.34%	7.71%	2.27%	4.34%	1.19%		5.68%	3.37%
PDM[3]	6.39%	-8.02%	-8.48%	7.93%	-3.65%	7.77%	-2.57%		-3.02%	23.9%

Table A12. Results for Ho in OREAS 105 (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	2.60	2.80	2.40	NR	2.51	2.80	2.39	NR	2.10	2.47
2	2.40	2.80	2.40	NR	2.51	2.80	2.40	NR	2.16	2.38
3	2.50	2.80	2.40	NR	2.47	2.70	2.42	NR	2.32	2.33
4	2.50	3.00	2.40	NR	2.54	2.80	2.36	NR	2.24	2.38
5	2.60	2.80	2.40	NR	2.43	2.50	2.38	NR	2.32	2.49
Mean	2.52	**2.84**	2.40		2.49	**2.72**	2.39		**2.23**	2.41
Median	2.50	2.80	2.40		2.51	2.80	2.39		2.24	2.38
Std.Dev.	0.08	0.09	0.00		0.04	0.13	0.02		0.10	0.07
Rel.Std.Dev.	3.32%	3.15%	0.00%		1.71%	4.79%	0.94%		4.45%	2.90%
PDM[3]	3.17%	16.3%	-1.74%		2.02%	11.4%	-2.15%		-8.73%	-1.29%

Table A13. Results for La in OREAS 105 (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	55.5	49.0	50.4	51.1	47.7	54.6	47.3	NR	45.9	50.8
2	53.7	50.5	49.2	55.6	47.8	52.2	47.5	NR	44.5	50.0
3	54.3	51.0	51.0	53.5	47.5	50.5	46.6	NR	49.4	49.5
4	54.3	50.5	51.5	59.6	46.7	56.0	47.2	NR	48.1	49.7
5	**57.4**	50.0	49.0	59.5	46.4	48.1	**48.2**	NR	49.6	50.9
Mean	55.0	50.2	50.2	55.9	47.2	52.3	47.4		47.5	50.2
Median	54.3	50.5	50.4	55.6	47.5	52.2	47.3		48.1	50.0
Std.Dev.	1.5	0.8	1.1	3.7	0.6	3.2	0.6		2.2	0.6
Rel.Std.Dev.	2.68%	1.51%	2.18%	6.67%	1.33%	6.04%	1.22%		4.70%	1.26%
PDM[3]	8.85%	-0.72%	-0.68%	10.5%	-6.61%	3.39%	-6.34%		-6.06%	-0.72%

Table A14. Results for Lu in OREAS 105 (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	1.02	**0.80**	0.96	NR	1.02	1.10	0.99	NR	**0.93**	0.99
2	**0.97**	**1.20**	0.99	NR	1.02	1.10	1.03	NR	**0.90**	0.97
3	1.01	1.00	0.97	NR	0.99	1.10	0.99	NR	0.98	0.97
4	1.00	1.00	1.01	NR	1.00	1.20	1.02	NR	0.98	0.97
5	1.03	1.00	0.95	NR	0.99	1.00	0.95	NR	0.99	**1.00**
Mean	1.01	1.00	0.98		1.00	**1.10**	1.00		0.96	0.98
Median	1.01	1.00	0.97		1.00	1.10	0.99		0.98	0.97
Std.Dev.	0.02	0.14	0.02		0.02	0.07	0.03		0.04	0.02
Rel.Std.Dev.	2.29%	14.1%	2.47%		1.51%	6.43%	3.14%		3.98%	1.55%
PDM[3]	1.37%	0.77%	-1.65%		1.17%	10.8%	0.36%		-3.73%	-1.29%

Table A15. Results for Nd in OREAS 105 (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	65.9	64.5	62.6	**53.8**	65.1	65.9	64.8	NR	60.7	70.7
2	63.6	66.5	60.1	60.2	64.3	65.9	65.2	NR	59.8	68.1
3	65.6	69.0	62.1	59.9	63.1	64.2	63.6	NR	65.8	65.0
4	64.6	65.5	63.2	61.0	63.2	67.7	64.1	NR	62.9	67.4
5	68.2	65.5	60.8	62.1	62.1	60.1	63.8	NR	67.6	71.9
Mean	65.6	66.2	61.8	59.4	63.6	64.8	64.3		63.4	68.6
Median	65.6	65.5	62.1	60.2	63.2	65.9	64.1		62.9	68.1
Std.Dev.	1.7	1.7	1.3	3.2	1.2	2.9	0.7		3.3	2.7
Rel.Std.Dev.	2.62%	2.59%	2.08%	5.46%	1.83%	4.45%	1.05%		5.22%	3.98%
PDM[3]	1.94%	2.91%	-4.00%	-7.66%	-1.20%	0.67%	-0.05%		-1.50%	6.71%

Table A16. Results for Pr in OREAS 105 (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	16.3	16.0	14.4	**14.2**	15.8	16.1	15.2	NR	12.6	17.0
2	15.8	**18.4**	13.9	16.4	15.6	16.1	15.6	NR	12.3	16.4
3	16.1	16.6	14.6	16.2	15.2	15.7	15.4	NR	13.7	15.9
4	15.9	16.6	14.2	16.2	15.4	16.5	15.2	NR	13.2	16.4
5	16.8	16.4	13.7	16.4	15.2	14.8	15.5	NR	13.9	17.3
Mean	16.2	16.8	**14.2**	15.9	15.4	15.8	15.3		**13.1**	16.6
Median	16.1	16.6	14.2	16.2	15.4	16.1	15.4		13.2	16.4
Std.Dev.	0.4	0.9	0.4	0.9	0.3	0.6	0.2		0.7	0.5
Rel.Std.Dev.	2.45%	5.52%	2.49%	5.95%	1.71%	4.08%	1.17%		5.06%	3.17%
PDM[3]	1.06%	4.93%	-11.6%	-0.81%	-3.56%	-1.06%	-4.25%		-17.9%	3.56%

Table A17. Results for Sm in OREAS 105 (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	15.7	14.5	14.7	**6.3**	14.6	15.1	14.3	NR	13.1	16.5
2	15.2	15.0	14.1	7.2	14.3	14.9	14.8	NR	12.6	15.9
3	15.4	15.5	14.4	7.4	14.0	14.8	14.3	NR	14.3	15.4
4	15.0	14.5	14.7	7.3	14.3	15.5	14.8	NR	13.4	15.8
5	16.1	15.0	14.1	7.2	13.9	**13.7**	14.7	NR	13.7	16.9
Mean	15.5	14.9	14.4	**7.1**	14.2	14.8	14.6		13.4	16.1
Median	15.4	15.0	14.4	7.2	14.3	14.9	14.7		13.4	15.9
Std.Dev.	0.4	0.4	0.3	0.4	0.3	0.7	0.2		0.6	0.6
Rel.Std.Dev.	2.79%	2.81%	2.08%	6.27%	1.85%	4.53%	1.64%		4.69%	3.63%
PDM[3]	4.81%	0.88%	-2.50%	-52.1%	-3.69%	0.21%	-1.42%		-9.17%	9.02%

Table A18. Results for Tb in OREAS 105 (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	2.10	2.20	1.96	NR	2.17	2.30	2.13	NR	1.29	2.59
2	2.00	2.40	1.90	NR	2.14	2.40	2.08	NR	1.28	2.47
3	2.10	2.40	1.97	NR	2.12	2.20	2.08	NR	1.39	2.35
4	2.00	2.20	2.01	NR	2.14	2.30	2.14	NR	1.34	2.47
5	2.20	2.40	1.79	NR	2.07	2.10	2.01	NR	1.40	2.58
Mean	2.08	2.32	1.93		2.13	2.26	2.09		**1.34**	2.49
Median	2.10	2.40	1.96		2.14	2.30	2.08		1.34	2.47
Std.Dev.	0.08	0.11	0.09		0.04	0.11	0.05		0.06	0.10
Rel.Std.Dev.	4.02%	4.72%	4.45%		1.74%	5.05%	2.47%		4.13%	3.97%
PDM[3]	-4.79%	6.20%	-11.8%		-2.59%	3.45%	-4.42%		-38.7%	14.0%

Table A19. Results for Tm in OREAS 105 (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	1.24	1.20	1.10	NR	1.18	1.30	1.16	NR	0.80	1.05
2	1.16	1.20	1.00	NR	1.15	1.30	1.17	NR	0.80	1.04
3	1.22	1.20	1.00	NR	1.15	1.20	1.19	NR	0.83	**1.01**
4	1.19	1.00	1.00	NR	1.12	1.30	1.19	NR	0.82	1.05
5	1.25	1.20	1.00	NR	1.12	1.20	1.14	NR	0.88	**1.09**
Mean	1.21	1.16	1.02		1.14	1.26	1.17		**0.83**	1.05
Median	1.22	1.20	1.00		1.15	1.30	1.17		0.82	1.05
Std.Dev.	0.04	0.09	0.04		0.03	0.05	0.02		0.03	0.03
Rel.Std.Dev.	3.05%	7.71%	4.38%		2.19%	4.35%	1.81%		4.22%	2.79%
PDM[3]	5.86%	1.31%	-10.9%		-0.08%	10.0%	2.19%		-27.7%	-8.29%

Table A20. Results for Yb in OREAS 105 (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	7.60	7.50	6.50	7.00	7.16	7.70	7.22	NR	6.72	7.18
2	7.20	8.00	6.60	7.50	7.08	7.60	7.33	NR	**6.42**	7.00
3	7.30	8.00	6.70	7.30	7.00	7.60	7.29	NR	7.04	6.91
4	7.40	7.50	6.80	7.60	7.02	7.70	7.16	NR	7.14	7.05
5	7.60	8.00	6.50	8.10	6.89	**7.10**	7.03	NR	7.18	7.29
Mean	7.42	7.80	6.62	7.50	7.03	7.54	7.21		6.90	7.08
Median	7.40	8.00	6.60	7.50	7.02	7.60	7.22		7.04	7.05
Std.Dev.	0.18	0.27	0.13	0.41	0.10	0.25	0.12		0.32	0.15
Rel.Std.Dev.	2.41%	3.51%	1.97%	5.42%	1.42%	3.33%	1.64%		4.70%	2.14%
PDM[3]	2.22%	7.45%	-8.80%	3.32%	-3.16%	3.87%	-0.73%		-4.93%	-2.41%