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CERTIFICATE OF ANALYSIS FOR

ALKALI OLIVINE BASALT
SECONDARY REFERENCE MATERIAL
OREAS 24P

Prepared by:
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REPORT 04/500

Summary Statistics

Table 1. Major elements, LOI, C & S (fusion XRF/ICPOES & Leco)

Constituent	Recommended value	95% Confidence Interval		Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High	Low	High
Aluminium, Al (wt.%)	7.66	7.61	7.70	7.56	7.75
Calcium, Ca (wt.%)	6.07	5.99	6.14	6.01	6.13
Carbon, C (wt.%)	0.075	0.062	0.087	0.058	0.091
Chromium, Cr (wt.%)	0.025	0.021	0.029	0.025	0.025
Iron, Fe (wt.%)	7.97	7.87	8.08	7.95	7.99
Loss on Ignition, LOI (wt.%)	0.61	0.39	0.83	0.56	0.66
Magnesium, Mg (wt.%)	4.13	3.95	4.31	4.09	4.16
Manganese, Mn (wt.%)	0.11	0.10	0.12	0.11	0.11
Phosphorous, P (wt.%)	0.136	0.132	0.140	0.132	0.140
Potassium, K (wt.%)	0.70	0.57	0.82	0.68	0.72
Silicon, Si (wt.%)	24.2	24.0	24.4	24.1	24.3
Sodium, Na (wt.%)	2.31	2.21	2.41	2.29	2.33
Sulphur, S (wt.%)	0.013	0.008	0.018	0.011	0.015
Titanium, Ti (wt.%)	1.10	1.07	1.13	1.08	1.11

IND - Indeterminate

Table 2. Lithophile trace elements (fusion ICPMS)

Constituent	Recommended value	95% Confidence Interval		Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High	Low	High
Barium, Ba (ppm)	285	274	296	278	292
Cerium, Ce (ppm)	37.6	36.1	39.1	36.8	38.4
Dysprosium, Dy (ppm)	4.6	4.3	4.9	4.3	5.0
Erbium, Er (ppm)	2.2	1.9	2.6	2.0	2.4
Europium, Eu (ppm)	1.6	1.6	1.7	1.6	1.7
Gadolinium, Gd (ppm)	5.3	4.5	6.1	5.2	5.4
Holmium, Ho (ppm)	0.8	0.7	0.9	0.8	0.8
Lanthanum, La (ppm)	17.4	15.2	19.6	17.0	17.8
Lutetium, Lu (ppm)	~ 0.2	IND	IND	IND	IND
Niobium, Nb (ppm)	21	16	26	20	22
Neodymium, Nd (ppm)	19.9	18.6	21.1	18.7	21.0
Praseodymium, Pr (ppm)	4.7	4.5	4.9	4.5	4.9
Rubidium, Rb (ppm)	22.4	21.3	23.5	21.5	23.2
Samarium, Sm (ppm)	4.7	4.6	4.8	4.4	4.9
Tin, Sn (ppm)	~ 2	IND	IND	IND	IND
Strontium, Sr (ppm)	403	394	411	389	416
Terbium, Tb (ppm)	0.81	0.80	0.83	0.79	0.83
Thorium, Th (ppm)	2.85	2.60	3.10	2.79	2.91
Thulium, Tm (ppm)	0.3	0.1	0.5	0.3	0.3
Uranium, U (ppm)	0.75	0.56	0.93	0.70	0.80
Yitrium, Y (ppm)	22.9	22.0	23.7	22.4	23.4
Ytterbium, Yb (ppm)	1.83	1.63	2.02	1.80	1.86
Zirconium, Zr (ppm)	141	115	166	129	152

IND - Indeterminate

Table 3. Precious & base metals (fire assay & 4 acid digest ICPOES/MS)

Constituent	Recommended value	95% Confidence Interval		Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High	Low	High
Antimony, Sb (ppm)	0.14	0.02	0.26	0.13	0.15
Arsenic, As (ppm)	2.0	0.7	3.4	0.6	3.5
Bismuth, Bi (ppm)	< 0.05	IND	IND	IND	IND
Cadmium, Cd (ppm)	< 0.3	IND	IND	IND	IND
Chromium, Cr (ppm)	221	191	250	210	231
Cobalt, Co (ppm)	44.0	41.5	46.4	41.1	46.8
Copper, Cu (ppm)	52	44	60	49	55
Gold, Au (ppb)	< 2	IND	IND	IND	IND
Lead, Pb (ppm)	2.9	2.6	3.1	2.4	3.3
Nickel, Ni (ppm)	141	138	145	134	149
Palladium, Pd (ppb)	< 2	IND	IND	IND	IND
Platinum, Pt (ppb)	< 1	IND	IND	IND	IND
Silver, Ag (ppm)	~ 0.1	IND	IND	IND	IND
Zinc, Zn (ppm)	114	112	117	98	131

IND - Indeterminate

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 analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures. To the explorationist they provide an important control in analytical data sets related to exploration from the grass roots level through to prospect evaluation.

As a rule only source materials exhibiting an exceptional level of homogeneity of the element(s) of interest are used in the preparation of these materials. This has enabled Ore Research & Exploration to produce a range of gold RM exhibiting homogeneity that matches or exceeds that of currently available international reference materials. In many instances RM produced from a single source are sufficiently homogeneous to produce a relatively coarse-grained form designed to simulate drill chip samples. These have a grain size of minus 3mm and are designated with a "C" suffix to the RM identification number. These standards are packaged in 1kg units following homogenisation and are intended for submission to analytical laboratories in subsample sizes of as little as 250g. They offer the added advantages of providing a check on both sample preparation and analytical procedures while acting as a blind standard to the assay laboratory. The more conventional pulped standards have a grain size of minus 20 to 75 microns and a higher degree of homogeneity. These standards are distinguished by a "P" suffix to the standard identification number. In line with ISO recommendations successive batch numbers are now designated by the lower case suffixes "a", "b", "c", "d", etc.

SOURCE MATERIALS

The material used to produce basalt standard OREAS 24P was prepared from alkali olivine basalt from the Quaternary Newer Volcanics Province, Victoria, Australia.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material was prepared in the following manner:

a) drying to constant mass at 105^0 C;
b) crushing and screening;
c) preliminary homogenisation;
d) milling to 98% minus 75 microns;
e) final homogenisation;
f) packaging into 60g and 1kg lots.

ANALYSIS OF OREAS 24P

Five commercial laboratories participated in the analytical program to characterise elements listed in Tables 1 - 3. 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 Appendix A, B and C. 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.
Five 100g samples 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, Ni, Pb, Sb and Zn by four-acid digest ICPOES and ICPMS; major elements Si, Al, Ti, Ca, Mg, Fe, Mn, Na, K, P by fusion with an ICPOES or XRF finish; LOI by thermo-gravimetry; C and S by Leco infra-red furnace; and lithophile trace elements by fusion ICPMS.

STATISTICAL EVALUATION OF ANALYTICAL DATA FOR OREAS 24P

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

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

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

Table 4. Recommended values and 95% confidence intervals for major elements, LOI, C & S by fusion XRF/ICPOES & Leco in OREAS 24P.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Aluminium, Al (wt.%)	7.66	7.61	7.70
Calcium, Ca (wt.%)	6.07	5.99	6.14
Carbon, C (wt.%)	0.075	0.062	0.087
Chromium, Cr (wt.%)	0.025	0.021	0.029
Iron, Fe (wt.%)	7.97	7.87	8.08
Loss on Ignition, LOI (wt.%)	0.61	0.39	0.83
Magnesium, Mg (wt.%)	4.13	3.95	4.31
Manganese, Mn (wt.%)	0.11	0.10	0.12
Phosphorous, P (wt.%)	0.136	0.132	0.140
Potassium, K (wt.%)	0.70	0.57	0.82
Silicon, Si (wt.%)	24.2	24.0	24.4
Sodium, Na (wt.%)	2.31	2.21	2.41
Sulphur, S (wt.%)	0.013	0.008	0.018
Titanium, Ti (wt.%)	1.10	1.07	1.13

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 lithophile trace elements by fusion ICPMS in OREAS 24P.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Barium, Ba (ppm)	285	274	296
Cerium, Ce (ppm)	37.6	36.1	39.1
Dysprosium, Dy (ppm)	4.6	4.3	4.9
Erbium, Er (ppm)	2.2	1.9	2.6
Europium, Eu (ppm)	1.6	1.6	1.7
Gadolinium, Gd (ppm)	5.3	4.5	6.1
Holmium, Ho (ppm)	0.8	0.7	0.9
Lanthanum, La (ppm)	17.4	15.2	19.6
Lutetium, Lu (ppm)	~ 0.2	IND	IND
Niobium, Nb (ppm)	21	16	26
Neodymium, Nd (ppm)	19.9	18.6	21.1
Praseodymium, Pr (ppm)	4.7	4.5	4.9
Rubidium, Rb (ppm)	22.4	21.3	23.5
Samarium, Sm (ppm)	4.7	4.6	4.8
Tin, Sn (ppm)	~ 2	IND	IND
Strontium, Sr (ppm)	403	394	411
Terbium, Tb (ppm)	0.81	0.80	0.83
Thorium, Th (ppm)	2.85	2.60	3.10
Thulium, Tm (ppm)	0.3	0.1	0.5
Uranium, U (ppm)	0.75	0.56	0.93
Yitrium, Y (ppm)	22.9	22.0	23.7
Ytterbium, Yb (ppm)	1.83	1.63	2.02
Zirconium, Zr (ppm)	141	115	166

IND - Indeterminate

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 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.

Table 6. Recommended values and 95% confidence intervals for precious and base metals by fire assay and 4 acid digest ICPOES/MS in OREAS 24P.

Constituent	Recommended value	95% Confidence Interval	
		Low	High
Antimony, Sb (ppm)	0.14	0.02	0.26
Arsenic, As (ppm)	2.0	0.7	3.4
Bismuth, Bi (ppm)	< 0.05	IND	IND
Cadmium, Cd (ppm)	< 0.3	IND	IND
Chromium, Cr (ppm)	221	191	250
Cobalt, Co (ppm)	44.0	41.5	46.4
Copper, Cu (ppm)	52	44	60
Gold, Au (ppb)	< 2	IND	IND
Lead, Pb (ppm)	2.9	2.6	3.1
Nickel, Ni (ppm)	141	138	145
Palladium, Pd (ppb)	< 2	IND	IND
Platinum, Pt (ppb)	< 1	IND	IND
Silver, Ag (ppm)	~ 0.1	IND	IND
Zinc, Zn (ppm)	114	112	117

IND - Indeterminate

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* j*th raw result reported by laboratory* i;

x'_{ij} *is the* j*th 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 limits may be illustrated for aluminium by fusion, where 99% of the time at least 95% of subsamples will have concentrations lying between 7.56 and 7.75%. 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 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.

Table 7. Recommended values and tolerance limits for major elements, LOI, C & S by fusion XRF/ICPOES & Leco in OREAS 24P.

Constituent	Recommended value	Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High
Aluminium, Al (wt.%)	7.66	7.56	7.75
Calcium, Ca (wt.%)	6.07	6.01	6.13
Carbon, C (wt.%)	0.075	0.058	0.091
Chromium, Cr (wt.%)	0.025	0.025	0.025
Iron, Fe (wt.%)	7.97	7.95	7.99
Loss on Ignition, LOI (wt.%)	0.61	0.56	0.66
Magnesium, Mg (wt.%)	4.13	4.09	4.16
Manganese, Mn (wt.%)	0.11	0.11	0.11
Phosphorous, P (wt.%)	0.136	0.132	0.140
Potassium, K (wt.%)	0.70	0.68	0.72
Silicon, Si (wt.%)	24.2	24.1	24.3
Sodium, Na (wt.%)	2.31	2.29	2.33
Sulphur, S (wt.%)	0.013	0.011	0.015
Titanium, Ti (wt.%)	1.10	1.08	1.11

Table 8. Recommended values and tolerance limits for lithophile trace elements by fusion ICPMS.

Constituent	Recommended value	Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High
Barium, Ba (ppm)	285	278	292
Cerium, Ce (ppm)	37.6	36.8	38.4
Dysprosium, Dy (ppm)	4.6	4.3	5.0
Erbium, Er (ppm)	2.2	2.0	2.4
Europium, Eu (ppm)	1.6	1.6	1.7
Gadolinium, Gd (ppm)	5.3	5.2	5.4
Holmium, Ho (ppm)	0.8	0.8	0.8
Lanthanum, La (ppm)	17.4	17.0	17.8
Lutetium, Lu (ppm)	~ 0.2	IND	IND
Niobium, Nb (ppm)	21	20	22
Neodymium, Nd (ppm)	19.9	18.7	21.0
Praseodymium, Pr (ppm)	4.7	4.5	4.9
Rubidium, Rb (ppm)	22.4	21.5	23.2
Samarium, Sm (ppm)	4.7	4.4	4.9
Tin, Sn (ppm)	~ 2	IND	IND
Strontium, Sr (ppm)	403	389	416
Terbium, Tb (ppm)	0.81	0.79	0.83
Thorium, Th (ppm)	2.85	2.79	2.91
Thulium, Tm (ppm)	0.3	0.3	0.3
Uranium, U (ppm)	0.75	0.70	0.80
Yitrium, Y (ppm)	22.9	22.4	23.4
Ytterbium, Yb (ppm)	1.83	1.80	1.86
Zirconium, Zr (ppm)	141	129	152

IND - Indeterminate

Table 9. Recommended values and tolerance limits for precious and base metals by fire assay and 4 acid digest ICPOES/MS.

Constituent	Recommended value	Tolerance limits 1-α=0.99, ρ=0.95	
		Low	High
Antimony, Sb (ppm)	0.14	0.13	0.15
Arsenic, As (ppm)	2.0	0.6	3.5
Bismuth, Bi (ppm)	< 0.05	IND	IND
Cadmium, Cd (ppm)	< 0.3	IND	IND
Chromium, Cr (ppm)	221	210	231
Cobalt, Co (ppm)	44.0	41.1	46.8
Copper, Cu (ppm)	52	49	55
Gold, Au (ppb)	< 2	IND	IND
Lead, Pb (ppm)	2.9	2.4	3.3
Nickel, Ni (ppm)	141	134	149
Palladium, Pd (ppb)	< 2	IND	IND
Platinum, Pt (ppb)	< 1	IND	IND
Silver, Ag (ppm)	~ 0.1	IND	IND
Zinc, Zn (ppm)	114	98	131

IND – Indeterminate

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.

Table 10. Performance gates for major elements by fusion & Leco in OREAS 24P

Constituent	Recommended value	Performance Gates		
		1 σ	2 σ	3 σ
Aluminium, Al (wt.%)	7.66	0.04	0.08	0.12
Calcium, Ca (wt.%)	6.07	0.07	0.14	0.21
Carbon, C (wt.%)	0.075	0.015	0.029	0.044
Chromium, Cr (wt.%)	0.0252	0.0024	0.0048	0.0072
Iron, Fe (wt.%)	7.97	0.08	0.17	0.25
Loss on Ignition, LOI (wt.%)	0.61	0.18	0.35	0.53
Magnesium, Mg (wt.%)	4.13	0.13	0.26	0.40
Manganese, Mn (wt.%)	0.11	0.01	0.01	0.02
Phosphorous, P (wt.%)	0.136	0.005	0.010	0.015
Potassium, K (wt.%)	0.70	0.09	0.17	0.26
Silicon, Si (wt.%)	24.2	0.11	0.21	0.32
Sodium, Na (wt.%)	2.31	0.05	0.10	0.16
Sulphur, S (wt.%)	0.013	0.005	0.009	0.014
Titanium, Ti (wt.%)	1.10	0.02	0.04	0.07

The standard deviation is determined from 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. Performance gates have been calculated for one, two and three standard deviations of the accepted pool of certification data and are presented in Tables 10-12. 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.

Table 11. Performance gates for trace elements by fusion in OREAS 24P

Constituent	Recommended value	Performance Gates		
		1 σ	2 σ	3 σ
Barium, Ba (ppm)	285	10	19	29
Cerium, Ce (ppm)	37.6	0.7	1.3	2.0
Dysprosium, Dy (ppm)	4.6	0.2	0.5	0.7
Erbium, Er (ppm)	2.2	0.3	0.5	0.8
Europium, Eu (ppm)	1.6	0.0	0.1	0.1
Gadolinium, Gd (ppm)	5.3	0.5	1.0	1.5
Holmium, Ho (ppm)	0.8	0.1	0.2	0.3
Lanthanum, La (ppm)	17.4	1.3	2.7	4.0
Lutetium, Lu (ppm)	~ 0.2	IND	IND	IND
Niobium, Nb (ppm)	21	3	5	8
Neodymium, Nd (ppm)	19.9	0.9	1.7	2.6
Praseodymium, Pr (ppm)	4.7	0.1	0.2	0.3
Rubidium, Rb (ppm)	22.4	0.9	1.8	2.7
Samarium, Sm (ppm)	4.7	0.1	0.2	0.3
Tin, Sn (ppm)	~ 2	IND	IND	IND
Strontium, Sr (ppm)	403	8	16	24
Terbium, Tb (ppm)	0.81	0.03	0.05	0.08
Thorium, Th (ppm)	2.85	0.30	0.61	0.91
Thulium, Tm (ppm)	0.3	0.1	0.2	0.3
Uranium, U (ppm)	0.75	0.17	0.33	0.50
Yitrium, Y (ppm)	22.9	0.9	1.8	2.7
Ytterbium, Yb (ppm)	1.83	0.15	0.31	0.46
Zirconium, Zr (ppm)	141	15	30	45

IND - Indeterminate

Table 12. Performance gates for precious and base metals by fire assay and 4 acid digest (ICPMS finish) methods in OREAS 24P.

Constituent	Recommended value	Performance Gates		
		1 σ	2 σ	3 σ
Antimony, Sb (ppm)	0.14	0.06	0.13	0.19
Arsenic, As (ppm)	2.0	1.3	2.6	3.9
Bismuth, Bi (ppm)	< 0.05	IND	IND	IND
Cadmium, Cd (ppm)	< 0.3	IND	IND	IND
Chromium, Cr (ppm)	221	18	35	53
Cobalt, Co (ppm)	44.0	1.8	3.5	5.3
Copper, Cu (ppm)	52	7	13	20
Gold, Au (ppb)	< 2	IND	IND	IND
Lead, Pb (ppm)	2.9	0.3	0.6	1.0
Nickel, Ni (ppm)	141	4	9	13
Palladium, Pd (ppb)	< 2	IND	IND	IND
Platinum, Pt (ppb)	< 1	IND	IND	IND
Silver, Ag (ppm)	~ 0.1	IND	IND	IND
Zinc, Zn (ppm)	114	5	9	14

IND - Indeterminate

PARTICIPATING LABORATORIES

Acme Analytical Laboratories, Vancouver, BC, Canada
ALS Chemex, North Vancouver, BC, Canada
Genalysis Laboratory Services, Maddington, WA, Australia
SGS Analabs, Welshpool, WA, Australia
Ultra Trace, Cannington, WA, Australia

PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

The gold ore reference material, OREAS 24P has been prepared and certified and is supplied by:

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

Telephone	(03) 9729 0333	International	+613-9729 0333
Facsimile	(03) 9729 4777	International	+613-9729 4777
Email	info@ore.com.au	Web	www.ore.com.au

It is available in unit sizes of 60 grams and 1 kg.

INTENDED USE

OREAS 24P is a secondary reference material intended for the the QC monitoring of analytical data.

STABILITY AND STORAGE INSTRUCTIONS

OREAS 24P has been prepared from an alkali olivine basalt from the Newer Volcanics Province, Victoria, Australia. Its has a very low sulphide content and is considered to have excellent long-term stability..

INSTRUCTIONS FOR THE CORRECT USE OF THE REFERENCE MATERIAL

The recommended value for OREAS 24P refers to the concentration level of elements after removal of hygroscopic moisture by drying in air to constant mass at 105^0 C. In its undried state a hygroscopic moisture content of ~0.3% has been established. If the reference material is not dried by the user prior to analysis, the recommended value should be corrected to the moisture-bearing basis.

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.

APPENDIX A

Analytical Results for Precious and Base Metals by Fire Assay and Four-acid Digest Methods in OREAS 24P

Table A1. Key to abbreviations used in Tables A2 – A18.

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
4A	four acid (HF-HNO_3-$HClO_4$-HCl) digestion
FA	fire assay (lead collection with a HCl leach)
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry

Table A2. Analytical results for silver in OREAS 24P (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
1	< 0.1	0.07	< .1	< 0.1	< 0.5
2	0.10	0.08	< .1	< 0.1	< 0.5
3	0.10	0.06	< .1	< 0.1	< 0.5
4	< 0.1	0.05	0.10	< 0.1	< 0.5
5	< 0.1	0.05	< .1	< 0.1	< 0.5
Mean	0.10	0.06	0.10	< 0.1	< 0.5
Median	0.1	0.1	0.1	< 0.1	< 0.5
Std.Dev.	0.0	0.0	-	-	-
Rel.Std.Dev.	0.00%	21.03%	-	-	-
PDM[3]	14.5%	-29.0%	-	-	-

Table A3. Analytical results for arsenic in OREAS 24P (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
1	1.0	0.5	3.0	2.0	4.0
2	1.0	0.6	4.0	3.0	0.5
3	2.0	0.3	4.0	3.0	1.5
4	2.0	0.4	3.0	2.0	1.5
5	2.0	0.3	3.0	2.0	4.5
Mean	1.6	0.4	3.4	2.4	2.4
Median	2.0	0.4	3.0	2.0	1.5
Std.Dev.	0.5	0.1	0.5	0.5	1.7
Rel.Std.Dev.	34.2%	31.0%	16.1%	22.8%	72.8%
PDM[3]	-21.7%	-79.5%	66.3%	17.4%	17.4%

Table A4. Analytical results for gold in OREAS 24P (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
1	3	1	2	< 1	< 1
2	1	4	1	< 1	1
3	2	1	< 1	< 1	1
4	1	1	1	2	2
5	**21**	2	1	< 1	2
Mean	5.6	1.8	1.3	< 1	1.5
Median	2.0	1.0	1.0	< 1	1.5
Std.Dev.	8.6	1.3	0.5	-	0.6
Rel.Std.Dev.	154%	72.4%	40.0%	-	38.5%
PDM[3]	237%	8.43%	-24.7%	-	-9.64%

Table A5. Analytical results for bismuth in OREAS 24P (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
1	0.02	0.01	< .1	< 0.1	< 0.1
2	0.04	0.01	< .1	< 0.1	< 0.1
3	0.02	0.01	< .1	< 0.1	< 0.1
4	0.01	0.01	< .1	< 0.1	< 0.1
5	0.01	0.01	< .1	< 0.1	< 0.1
Mean	0.02	0.01	< .1	< 0.1	< 0.1
Median	0.02	0.01	< .1	< 0.1	< 0.1
Std.Dev.	0.01	0.00	-	-	-
Rel.Std.Dev.	61.24%	0.00%	-	-	-
PDM[3]	33.3%	-33.3%	-	-	-

Table A7. Analytical results for cadmium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A	LAB B 4A*MS	Lab C 4A*MS	LAB D 4A*MS	Lab E 4A*MS
1	NR	0.04	0.10	< 0.1	< 0.5
2	NR	0.06	0.10	< 0.1	< 0.5
3	NR	0.05	0.20	< 0.1	< 0.5
4	NR	0.04	0.20	< 0.1	< 0.5
5	NR	0.04	0.10	< 0.1	< 0.5
Mean	-	0.05	0.1	< 0.1	< 0.5
Median	-	0.04	0.1	< 0.1	< 0.5
Std.Dev.	-	0.01	0.1	-	-
Rel.Std.Dev.	-	19.44%	39.12%	-	-
PDM[3]	-	-	-	-	-

Table A8. Analytical results for cobalt in OREAS 24P (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
1	41.8	46.1	44.0	41.7	30.0
2	42.9	46.9	47.0	42.0	30.0
3	41.5	44.2	44.0	42.9	35.0
4	45.3	45.4	45.0	42.1	35.0
5	44.7	45.5	44.0	**44.1**	35.0
Mean	43.2	45.6	44.8	42.6	33.0
Median	42.9	45.5	44.0	42.1	35.0
Std.Dev.	1.7	1.0	1.3	1.0	2.7
Rel.Std.Dev.	3.94%	2.18%	2.91%	2.28%	8.30%
PDM[3]	-1.64%	3.78%	1.91%	-3.18%	-24.9%

Table A9. Analytical results for chromium in OREAS 24P (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
1	246	143	211.7	205	210
2	245	143	219.1	**180**	200
3	248	146	218.6	210	220
4	250	140	214.9	190	230
5	244	142	221.6	205	220
Mean	246.6	142.8	217.2	198.0	216.0
Median	246.0	143.0	218.6	205.0	220.0
Std.Dev.	2.4	2.2	3.9	12.5	11.4
Rel.Std.Dev.	0.98%	1.52%	1.79%	6.34%	5.28%
PDM[3]	11.8%	-35.3%	-1.54%	-10.2%	-2.07%

Table A10. Analytical results for copper in OREAS 24P (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
1	51	47.7	44.6	51	55
2	52	49.3	48.5	**45**	65
3	51	43.9	48.0	52	65
4	52	46.2	46.7	50	65
5	52	46.7	45.3	51	65
Mean	51.6	46.8	46.6	49.8	63.0
Median	52.0	46.7	46.7	51.0	65.0
Std.Dev.	0.5	2.0	1.7	2.8	4.5
Rel.Std.Dev.	1.06%	4.25%	3.60%	5.57%	7.10%
PDM[3]	-0.38%	-9.72%	-9.99%	-3.85%	21.6%

Table A12. Analytical results for nickel in OREAS 24P (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
1	144	146	138	135	135
2	144	150	148	**123**	140
3	146	139	141	140	145
4	147	139	138	137	145
5	146	143	138	137	140
Mean	145	143	140	134	141
Median	146	143	138	137	140
Std.Dev.	1.3	4.8	4.2	6.6	4.2
Rel.Std.Dev.	0.92%	3.35%	2.97%	4.92%	2.97%
PDM[3]	2.81%	1.18%	-0.73%	-4.97%	-0.30%

Table A13. Analytical results for lead in OREAS 24P (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
1	3	2.9	2.8	3	4
2	3	2.9	3.1	3	3
3	3	6.2	3.0	3	3
4	3	3.1	2.8	2	5
5	3	3.0	2.6	2	6
Mean	3.0	3.0	2.9	2.6	**4.2**
Median	3.0	3.0	2.8	3.0	4.0
Std.Dev.	0.0	0.1	0.2	0.5	1.3
Rel.Std.Dev.	0.00%	3.22%	6.82%	21.1%	31.0%
PDM[3]	4.94%	4.07%	0.04%	-9.05%	46.9%

Table A14. Analytical results for palladium in OREAS 24P (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
1	< 1	< 1	< .5	< 0.5	< 1
2	< 1	< 1	< .5	< 0.5	< 1
3	< 1	< 1	< .5	< 0.5	< 1
4	< 1	1.0	< .5	< 0.5	< 1
5	< 1	1.0	< .5	< 0.5	< 1
Mean	< 1	< 1	< .5	< 0.5	< 1
Median	< 1	< 1	< .5	< 0.5	< 1
Std.Dev.	-	-	-	-	-
Rel.Std.Dev.	-	-	-	-	-
PDM[3]	-	-	-	-	-

Table A15. Analytical results for platinum in OREAS 24P (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
1	< 1	0.5	< .1	< 0.5	< 1
2	< 1	0.8	< .1	< 0.5	< 1
3	< 1	0.8	< .1	< 0.5	< 1
4	< 1	0.6	0.2	< 0.5	< 1
5	< 1	0.7	0.1	< 0.5	1.0
Mean	< 1	0.7	0.15	< 0.5	< 1
Median	< 1	0.7	0.15	< 0.5	< 1
Std.Dev.	-	0.1	0.1	-	-
Rel.Std.Dev.	-	19.2%	47.1%	-	-
PDM[3]	-	-	-	-	-

Table A17. Analytical results for antimony in OREAS 24P (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
1	0.17	<0.05	0.10	0.30	< 0.2
2	0.19	0.05	0.10	0.20	< 0.2
3	**0.14**	<0.05	0.10	0.20	< 0.2
4	0.18	<0.05	0.10	0.20	< 0.2
5	0.18	<0.05	0.10	0.20	< 0.2
Mean	0.17	<0.05	0.10	0.22	< 0.2
Median	0.18	<0.05	0.10	0.20	< 0.2
Std.Dev.	0.02	-	0.00	0.04	-
Rel.Std.Dev.	11.18%	-	0.00%	20.33%	-
PDM[3]	25.1%	-	-27.3%	60.0%	-

Table A18. Analytical results for zinc in OREAS 24P (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
1	108	118	121	115	115
2	109	120	135	105	110
3	108	114	127	120	120
4	116	110	127	116	120
5	120	114	130	116	115
Mean	112	115	128	114	116
Median	109	114	127	116	115
Std.Dev.	5	4	5	6	4
Rel.Std.Dev.	4.90%	3.38%	3.98%	4.89%	3.61%
PDM[3]	-1.97%	0.66%	11.8%	-0.04%	1.35%

NR – Element not recorded for this laboratory

APPENDIX B

Analytical Results for Trace Elements by Fusion ICP Mass Spectrometry in OREAS 24P

Table B1. Key to abbreviations used in Tables B2 – B24.

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
BF	lithium metaborate fusion
AF	oxidative alkaline fusion using sodium peroxide
MS	inductively coupled plasma mass spectrometry

Table B2. Analytical results for barium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	286	292	277	300	280
2	279	291	266	300	280
3	**298**	293	280	300	280
4	276	289	266	290	290
5	275	293	287	290	290
Mean	282.8	291.6	275.0	296.0	284.0
Median	279.0	292.0	276.9	300.0	280.0
Std.Dev.	9.5	1.7	9.1	5.5	5.5
Rel.Std.Dev.	3.37%	0.57%	3.31%	1.85%	1.93%
PDM[3]	-0.81%	2.28%	-3.56%	3.82%	-0.39%

Table B3. Analytical results for cerium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	34.1	38.2	36.5	41.7	38.0
2	34.2	38.1	36.4	42.1	37.5
3	**35.8**	37.8	37.4	**43.7**	37.5
4	34.4	37.9	37.5	42.2	37.0
5	34.4	38.6	37.0	41.5	38.5
Mean	**34.6**	38.1	37.0	**42.2**	37.7
Median	34.4	38.1	37.0	42.1	37.5
Std.Dev.	0.7	0.3	0.5	0.9	0.6
Rel.Std.Dev.	2.01%	0.82%	1.36%	2.05%	1.51%
PDM[3]	-8.02%	1.40%	-1.68%	12.4%	0.28%

Table B4. Analytical results for dysprosium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	4.7	4.7	4.5	NR	5.0
2	4.6	4.6	4.4	NR	5.0
3	4.8	4.5	4.4	NR	4.5
4	4.6	4.7	4.2	NR	5.0
5	4.6	4.8	4.2	NR	4.5
Mean	4.7	4.7	4.4	-	4.8
Median	4.6	4.7	4.4	-	5.0
Std.Dev.	0.1	0.1	0.1	-	0.3
Rel.Std.Dev.	1.92%	2.45%	3.41%	-	5.71%
PDM[3]	0.88%	0.88%	-5.66%	-	3.91%

Table B5. Analytical results for erbium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	2.0	2.3	2.1	NR	2.5
2	2.0	2.2	2.1	NR	2.0
3	2.1	2.2	2.1	NR	3.0
4	2.1	2.2	2.0	NR	2.5
5	2.0	2.4	2.0	NR	2.5
Mean	2.0	2.3	2.0	-	2.5
Median	2.0	2.2	2.1	-	2.5
Std.Dev.	0.1	0.1	0.0	-	0.4
Rel.Std.Dev.	2.68%	3.96%	2.32%	-	14.1%
PDM[3]	-7.63%	2.33%	-7.90%	-	13.2%

Table B6. Analytical results for europium in OREAS 24P (refer Table A1 for abbreviations; values in wt. %).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	1.60	1.60	1.67	NR	2.00
2	1.60	1.60	1.65	NR	1.80
3	1.70	1.60	1.64	NR	1.80
4	1.70	1.60	**1.59**	NR	1.80
5	1.60	1.60	1.65	NR	1.80
Mean	1.6	1.6	1.6	-	**1.8**
Median	1.6	1.6	1.7	-	1.8
Std.Dev.	0.1	0.0	0.0	-	0.1
Rel.Std.Dev.	3.34%	0.00%	1.83%	-	4.86%
PDM[3]	0.56%	-1.89%	0.56%	-	12.8%

Table B7. Analytical results for gadolinium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	4.70	5.00	5.40	NR	6.00
2	5.20	4.70	5.50	NR	6.00
3	4.60	4.80	5.42	NR	6.00
4	5.00	5.00	**4.75**	NR	6.00
5	5.10	5.00	5.19	NR	6.00
Mean	4.92	4.90	5.25	-	6.00
Median	5.00	5.00	5.40	-	6.00
Std.Dev.	0.3	0.1	0.3	-	0.0
Rel.Std.Dev.	5.26%	2.89%	5.77%	-	0.00%
PDM[3]	-7.16%	-7.54%	-0.89%	-	13.2%

Table B8. Analytical results for holmium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	0.70	0.90	0.82	NR	1.00
2	0.70	0.80	0.72	NR	0.80
3	0.70	0.80	0.75	NR	1.00
4	0.70	0.90	0.70	NR	0.80
5	0.70	0.90	0.71	NR	0.80
Mean	0.7	0.9	0.7	-	0.9
Median	0.7	0.9	0.7	-	0.8
Std.Dev.	0.0	0.1	0.0	-	0.1
Rel.Std.Dev.	0.00%	6.37%	6.55%	-	12.45%
PDM[3]	-11.9%	8.18%	-6.92%	-	10.7%

Table B9. Analytical results for lanthanum in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	17.4	19.2	16.7	20.8	18.0
2	17.2	18.4	16.3	21.3	18.0
3	17.6	18.6	15.6	22.0	18.0
4	17.3	18.6	14.3	20.9	18.0
5	17.1	19.1	14.7	20.6	18.0
Mean	17.3	18.8	15.5	**21.1**	18.0
Median	17.3	18.6	15.6	20.9	18.0
Std.Dev.	0.2	0.3	1.0	0.6	0.0
Rel.Std.Dev.	1.11%	1.86%	6.58%	2.62%	0.00%
PDM[3]	-0.49%	7.90%	-10.8%	21.3%	3.42%

Table B10. Analytical results for lutetium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	0.14	0.30	0.24	NR	0.40
2	0.15	0.30	0.21	NR	< 0.2
3	0.14	0.30	0.22	NR	< 0.2
4	0.11	0.30	0.21	NR	< 0.2
5	0.12	0.30	0.21	NR	< 0.2
Mean	0.13	0.30	0.22	-	< 0.2
Median	0.14	0.30	0.21	-	< 0.2
Std.Dev.	0.02	0.00	0.01	-	-
Rel.Std.Dev.	12.5%	0.00%	5.98%	-	-
PDM[3]	-39.1%	38.5%	0.62%	-	-

Table B11. Analytical results for niobium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	21	20	19	9	25
2	21	20	19	11	25
3	22	20	17	10	25
4	22	21	16	13	25
5	22	21	18	9	25
Mean	22	20	18	**10**	25
Median	22	20	18	10	25
Std.Dev.	1	1	1	2	0
Rel.Std.Dev.	2.54%	2.68%	6.54%	16.1%	0.00%
PDM[3]	1.81%	-3.84%	-15.8%	-51.0%	17.8%

Table B12. Analytical results for neodymium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	18.6	20.3	20.9	NR	21.5
2	18.5	19.9	20.9	NR	20.0
3	**20.0**	19.8	19.7	NR	21.5
4	19.1	19.8	19.4	NR	20.0
5	18.7	20.2	19.7	NR	20.0
Mean	19.0	20.0	20.1	-	20.6
Median	18.7	19.9	19.7	-	20.0
Std.Dev.	0.6	0.2	0.7	-	0.8
Rel.Std.Dev.	3.24%	1.17%	3.59%	-	3.99%
PDM[3]	-4.44%	0.70%	1.30%	-	3.72%

Table B13. Analytical results for praseodymium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	4.6	4.7	4.3	NR	4.6
2	4.6	4.7	4.3	NR	5.0
3	**4.9**	4.7	4.2	NR	4.8
4	4.7	4.6	4.0	NR	4.8
5	4.6	4.7	4.1	NR	4.8
Mean	4.7	4.7	4.2	-	4.8
Median	4.6	4.7	4.2	-	4.8
Std.Dev.	0.1	0.0	0.1	-	0.1
Rel.Std.Dev.	2.68%	0.96%	2.90%	-	2.95%
PDM[3]	-0.55%	-0.43%	-11.0%	-	2.13%

Table B14. Analytical results for rubidium in OREAS 24P (refer Table A1 for abbreviations; values in ppb).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	22.0	22.4	21.9	22.9	23.0
2	21.3	22.1	21.8	22.9	23.5
3	21.8	22.0	22.2	23.1	24.0
4	21.2	21.7	**20.2**	22.5	24.5
5	21.6	22.2	21.0	22.7	23.5
Mean	21.6	22.1	21.4	22.8	23.7
Median	21.6	22.1	21.8	22.9	23.5
Std.Dev.	0.3	0.3	0.8	0.2	0.6
Rel.Std.Dev.	1.55%	1.17%	3.80%	1.00%	2.41%
PDM[3]	-3.58%	-1.34%	-4.29%	1.96%	5.89%

Table B15. Analytical results for samarium in OREAS 24P (refer Table A1 for abbreviations; values in ppb).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	4.6	4.8	4.7	NR	5.0
2	4.6	4.6	4.7	NR	5.5
3	4.7	4.7	4.8	NR	5.5
4	4.7	4.6	4.8	NR	5.5
5	4.6	4.8	4.5	NR	5.5
Mean	4.6	4.7	4.7	-	5.4
Median	4.6	4.7	4.7	-	5.5
Std.Dev.	0.1	0.1	0.1	-	0.2
Rel.Std.Dev.	1.18%	2.13%	2.61%	-	4.14%
PDM[3]	-0.85%	0.43%	0.43%	-	15.4%

Table B16. Analytical results for tin in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	< 2	2	2	NR	< 10
2	< 2	2	2	NR	< 10
3	2	2	2	NR	< 10
4	< 2	2	**4**	NR	< 10
5	< 2	2	2	NR	< 10
Mean	2	2	2	-	< 10
Median	2	2	2	-	< 10
Std.Dev.	-	0.0	0.9	-	-
Rel.Std.Dev.	-	0.00%	37.3%	-	-
PDM[3]	0.00%	0.00%	20.0%	-	-

Table B17. Analytical results for strontium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	389	402	413	421	405
2	383	408	406	424	405
3	416	403	404	432	404
4	396	403	**382**	420	396
5	395	411	408	430	397
Mean	396	405	402	**425**	401
Median	395	403	406	424	404
Std.Dev.	12.4	3.9	12.0	5.4	4.5
Rel.Std.Dev.	3.14%	0.96%	2.98%	1.26%	1.12%
PDM[3]	-1.67%	0.71%	-0.04%	5.68%	-0.28%

Table B18. Analytical results for terbium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	0.78	0.80	0.80	NR	0.80
2	0.80	0.80	0.79	NR	0.80
3	0.80	0.80	0.82	NR	0.80
4	0.82	0.90	0.84	NR	0.80
5	0.83	0.80	0.84	NR	0.80
Mean	0.8	0.8	0.8	-	0.8
Median	0.8	0.8	0.8	-	0.8
Std.Dev.	0.0	0.0	0.0	-	0.0
Rel.Std.Dev.	2.42%	5.45%	2.79%	-	0.00%
PDM[3]	-0.62%	1.11%	0.86%	-	-1.36%

Table B19. Analytical results for thorium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	2.5	3.0	2.4	2.5	3.0
2	2.5	3.0	2.9	2.6	3.0
3	2.6	3.0	3.0	**7.4**	3.0
4	2.6	3.0	2.5	3.8	3.0
5	2.6	3.0	2.8	3.0	3.0
Mean	2.6	3.0	2.7	3.9	3.0
Median	2.6	3.0	2.8	3.0	3.0
Std.Dev.	0.1	0.0	0.3	2.0	0.0
Rel.Std.Dev.	2.14%	0.00%	9.52%	52.9%	0.00%
PDM[3]	-10.2%	5.23%	-4.59%	35.4%	5.23%

Table B20. Analytical results for thulium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	0.10	0.30	0.28	NR	0.40
2	0.10	0.30	0.28	NR	0.40
3	0.20	0.30	0.25	NR	0.40
4	0.10	0.30	0.26	NR	0.40
5	0.10	0.30	0.24	NR	0.40
Mean	0.12	0.30	0.26	-	0.40
Median	0.10	0.30	0.26	-	0.40
Std.Dev.	0.0	0.0	0.0	-	0.0
Rel.Std.Dev.	37.3%	0.00%	6.83%	-	0.00%
PDM[3]	-55.6%	10.9%	-3.14%	-	47.9%

Table B21. Analytical results for uranium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	0.5	0.7	0.7	0.9	1.0
2	0.6	0.7	0.6	0.9	0.5
3	0.5	0.7	0.7	**1.5**	1.0
4	0.6	0.7	0.7	0.9	1.0
5	0.6	0.7	0.7	0.9	1.0
Mean	0.6	0.7	0.7	1.0	0.9
Median	0.6	0.7	0.7	0.9	1.0
Std.Dev.	0.1	0.0	0.0	0.3	0.2
Rel.Std.Dev.	9.78%	0.00%	6.58%	26.3%	24.9%
PDM[3]	-25.1%	-6.42%	-9.09%	36.4%	20.3%

Table B22. Analytical results for yitrium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	22.1	23.0	23.8	23.4	24.0
2	**21.4**	23.1	22.2	23.4	23.0
3	22.5	22.7	22.3	**24.1**	24.0
4	22.5	22.9	20.5	23.5	24.0
5	22.3	**23.6**	21.2	23.5	23.0
Mean	22.2	23.1	22.0	23.6	23.6
Median	22.3	23.0	22.2	23.5	24.0
Std.Dev.	0.5	0.3	1.3	0.3	0.5
Rel.Std.Dev.	2.06%	1.46%	5.69%	1.25%	2.32%
PDM[3]	-3.08%	0.85%	-3.78%	3.13%	3.21%

Table B23. Analytical results for ytterbium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D AF*MS	Lab E AF*MS
1	1.5	1.8	**2.0**	2.0	2.0
2	1.7	1.8	1.8	1.9	2.0
3	1.7	1.7	1.7	2.0	2.0
4	1.7	1.8	1.7	2.0	2.0
5	1.6	1.8	1.8	2.0	2.0
Mean	1.6	1.8	1.8	2.0	2.0
Median	1.7	1.8	1.8	2.0	2.0
Std.Dev.	0.1	0.0	0.1	0.0	0.0
Rel.Std.Dev.	5.45%	2.51%	7.09%	2.26%	0.00%
PDM[3]	-10.3%	-2.63%	-1.97%	8.32%	9.41%

Table B24. Analytical results for zirconium in OREAS 24P (refer Table A1 for abbreviations; values in ppm).

Replicate No.	Lab A AF*MS	LAB B BF*MS	Lab C BF*MS	LAB D	Lab E AF*MS
1	166	137	124	NR	140
2	159	132	125	NR	150
3	151	135	122	NR	**170**
4	156	134	118	NR	150
5	162	138	119	NR	150
Mean	159	135	122	-	152
Median	159	135	122	-	150
Std.Dev.	5.7	2.4	3.0	-	11.0
Rel.Std.Dev.	3.60%	1.77%	2.48%	-	7.21%
PDM[3]	12.9%	-4.21%	-13.6%	-	8.09%

NR – Element not recorded for this laboratory

APPENDIX C

Analytical Results for Major Elements by Fusion Methods in OREAS 24P

Table C1. Key to abbreviations used in Tables C2 – C24.

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
LOI	Gravity method after heating to 1000°C
Leco	Leco furnace
4A	four acid (HF-HNO_3-$HClO_4$-HCl) digestion
AF	alkali fusion
BF	lithium metaborate fusion
XRF	x-ray fluorescence
OES	inductively coupled plasma optical emission spectrometry
MS	inductively coupled plasma mass spectrometry

Table C2. Analytical results for aluminium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	7.42	7.66	7.63	7.63	7.68
2	7.38	7.62	7.67	**7.73**	7.68
3	7.30	7.69	7.67	7.69	7.73
4	7.34	7.68	7.55	7.62	7.68
5	7.38	7.69	7.63	7.62	7.68
Mean	**7.36**	7.67	7.63	7.66	7.69
Median	7.38	7.68	7.63	7.63	7.68
Std.Dev.	0.05	0.03	0.05	0.05	0.02
Rel.Std.Dev.	0.62%	0.37%	0.63%	0.65%	0.31%
PDM[3]	-3.82%	0.16%	-0.35%	0.04%	0.40%

Table C3. Analytical results for calcium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	6.10	6.02	6.05	6.20	6.10
2	6.00	6.00	6.04	6.10	6.11
3	5.90	6.03	6.06	6.12	6.09
4	6.00	5.99	6.10	6.17	6.09
5	6.00	6.00	6.14	6.15	6.11
Mean	6.00	6.01	6.08	6.15	6.10
Median	6.00	6.00	6.06	6.15	6.10
Std.Dev.	0.07	0.02	0.04	0.04	0.01
Rel.Std.Dev.	1.18%	0.30%	0.66%	0.65%	0.18%
PDM[3]	-1.10%	-0.98%	0.20%	1.33%	0.55%

Table C4. Analytical results for chromium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*MS	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	0.026	0.026	0.022	0.027	0.020
2	0.026	0.026	0.021	0.027	0.021
3	0.026	0.027	0.021	0.027	0.021
4	0.025	0.026	0.021	0.027	0.021
5	0.027	0.026	0.021	0.027	0.021
Mean	0.0260	0.0262	0.0213	0.0274	**0.0205**
Median	0.0261	0.0260	0.0212	0.0274	0.0205
Std.Dev.	0.0006	0.0004	0.0003	0.0000	0.0005
Rel.Std.Dev.	2.39%	1.71%	1.43%	0.00%	2.36%
PDM[3]	3.01%	3.89%	-15.4%	8.48%	-18.6%

Table C5. Analytical results for iron in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	8.10	8.08	7.84	7.92	7.97
2	8.07	8.04	7.88	**7.96**	7.97
3	7.99	8.06	7.85	7.90	7.97
4	8.04	8.06	7.88	7.90	7.97
5	8.07	8.08	7.92	7.89	7.97
Mean	8.05	8.07	7.87	7.91	7.97
Median	8.07	8.06	7.88	7.90	7.97
Std.Dev.	0.04	0.02	0.03	0.03	0.00
Rel.Std.Dev.	0.52%	0.23%	0.38%	0.34%	0.00%
PDM[3]	1.01%	1.16%	-1.25%	-0.76%	-0.02%

Table C6. Analytical results for potassium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	0.75	0.82	0.57	0.68	0.67
2	0.74	0.83	0.56	0.68	0.68
3	0.73	0.84	**0.65**	0.68	0.68
4	0.75	0.81	0.55	0.67	0.67
5	0.74	0.81	0.56	0.67	0.68
Mean	0.74	0.82	0.58	0.68	0.68
Median	0.74	0.82	0.56	0.68	0.68
Std.Dev.	0.01	0.01	0.04	0.00	0.00
Rel.Std.Dev.	1.13%	1.31%	7.10%	0.67%	0.67%
PDM[3]	6.68%	18.4%	-17.2%	-2.64%	-2.64%

Table C7. Analytical results for loss on ignition in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A LOI	LAB B LOI	Lab C LOI	LAB D LOI	Lab E LOI
1	0.65	0.80	0.60	0.48	0.46
2	0.55	0.78	0.80	0.42	0.46
3	0.43	0.79	0.80	0.46	0.47
4	0.60	0.81	1.00	0.43	0.47
5	0.56	0.80	0.80	0.38	0.45
Mean	0.56	0.80	0.80	0.43	0.46
Median	0.56	0.80	0.80	0.43	0.46
Std.Dev.	0.08	0.01	0.14	0.04	0.01
Rel.Std.Dev.	14.6%	1.43%	17.7%	8.86%	1.81%
PDM[3]	-8.52%	30.5%	31.15%	-28.8%	-24.3%

Table C8. Analytical results for magnesium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	4.35	4.07	3.93	4.17	4.17
2	4.34	4.06	3.91	4.11	4.19
3	4.29	4.07	3.90	4.13	4.19
4	4.28	4.05	3.95	4.19	4.18
5	4.32	4.07	3.97	4.14	4.17
Mean	4.32	4.06	3.93	4.15	4.18
Median	4.32	4.07	3.93	4.14	4.18
Std.Dev.	0.03	0.01	0.03	0.03	0.01
Rel.Std.Dev.	0.71%	0.19%	0.75%	0.74%	0.19%
PDM[3]	4.55%	-1.55%	-4.77%	0.49%	1.28%

Table C9. Analytical results for manganese in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	0.11	0.10	0.11	0.14	0.12
2	0.11	0.09	0.11	0.14	0.12
3	0.11	0.10	0.11	0.14	0.12
4	0.11	0.09	0.11	0.14	0.12
5	0.11	0.10	0.11	0.14	0.12
Mean	0.11	0.10	0.11	**0.14**	0.12
Median	0.11	0.10	0.11	0.14	0.12
Std.Dev.	0.00	0.00	0.00	0.00	0.00
Rel.Std.Dev.	0.54%	4.35%	0.00%	0.00%	0.00%
PDM[3]	1.55%	-9.60%	0.44%	29.14%	7.61%

Table C10. Analytical results for sodium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A 4A*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	**2.34**	2.01	2.23	2.32	2.28
2	2.39	2.03	2.26	2.33	2.29
3	2.38	2.05	2.23	2.32	2.31
4	2.39	2.04	**2.20**	2.32	2.30
5	2.38	2.01	2.24	2.30	2.29
Mean	2.38	**2.03**	2.23	2.32	2.30
Median	2.38	2.03	2.23	2.32	2.29
Std.Dev.	0.02	0.02	0.02	0.01	0.01
Rel.Std.Dev.	0.78%	0.84%	0.99%	0.49%	0.37%
PDM[3]	2.91%	-12.2%	-3.44%	0.42%	-0.61%

Table C11. Analytical results for phosphorous in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A 4A*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	0.135	0.131	0.140	0.144	0.140
2	0.133	0.135	0.131	0.135	0.139
3	0.137	0.135	0.135	0.140	0.139
4	0.139	0.135	0.131	0.135	0.139
5	0.135	0.118	0.135	0.140	0.140
Mean	0.136	0.131	0.134	0.139	0.139
Median	0.135	0.135	0.135	0.140	0.139
Std.Dev.	0.002	0.008	0.004	0.004	0.001
Rel.Std.Dev.	1.80%	5.77%	2.72%	2.63%	0.41%
PDM[3]	-0.20%	-3.58%	-1.01%	2.20%	2.59%

Table C12. Analytical results for silicon in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A AF*OES	LAB B BF*XRF	Lab C BF*OES	LAB D BF*XRF	Lab E BF*XRF
1	**25.0**	24.1	24.4	24.2	24.2
2	24.6	24.0	24.3	24.2	24.2
3	24.4	24.0	24.3	24.2	24.2
4	24.6	24.0	24.2	24.1	24.2
5	24.7	24.0	24.2	24.2	24.3
Mean	24.7	24.0	24.3	24.2	24.2
Median	24.6	24.0	24.3	24.2	24.2
Std.Dev.	0.2	0.0	0.1	0.0	0.0
Rel.Std.Dev.	0.89%	0.13%	0.27%	0.14%	0.09%
PDM[3]	1.99%	-0.64%	0.44%	0.01%	0.19%

Table C13. Analytical results for titanium in OREAS 24P (refer Table A1 for abbreviations; values in weight percent).

Replicate No.	Lab A Perth AF*OES	LAB B Vancouver BF*XRF	Lab C Vancouver BF*OES	LAB D Perth BF*XRF	Lab E Perth BF*XRF
1	1.12	1.07	1.11	1.10	1.08
2	1.12	1.08	1.12	1.09	1.09
3	1.11	1.07	1.13	1.10	1.08
4	1.11	1.07	1.13	1.08	1.09
5	1.12	1.07	1.14	1.10	1.08
Mean	1.12	1.07	1.12	1.09	1.08
Median	1.12	1.07	1.13	1.10	1.08
Std.Dev.	0.01	0.01	0.01	0.01	0.00
Rel.Std.Dev.	0.49%	0.50%	0.97%	0.83%	0.30%
PDM[3]	1.70%	-2.42%	2.50%	-0.34%	-1.44%

Table C14. Analytical results for carbon in OREAS 24P (refer Table A1 for abbreviations; values in wt. %).

Replicate No.	Lab A Perth Leco	LAB B Vancouver Leco	Lab C Vancouver Leco	LAB D Perth Leco	Lab E Perth Leco
1	0.08	0.07	0.06	0.10	0.06
2	0.08	0.07	0.07	0.10	0.05
3	0.10	0.08	0.07	0.10	0.04
4	**0.12**	0.09	0.08	0.10	0.08
5	0.07	0.08	0.09	0.09	0.09
Mean	0.09	0.08	0.07	0.10	0.06
Median	0.08	0.08	0.07	0.10	0.06
Std.Dev.	0.02	0.01	0.01	0.00	0.02
Rel.Std.Dev.	22.2%	10.7%	15.4%	4.18%	32.4%
PDM[3]	20.6%	4.52%	-0.84%	32.9%	-14.24%

Table C15. Analytical results for sulphur in OREAS 24P (refer Table A1 for abbreviations; values in wt. %).

Replicate No.	Lab A Perth Leco	LAB B Vancouver Leco	Lab C Vancouver Leco	LAB D Perth Leco	Lab E Perth Leco
1	0.010	0.020	0.010	0.017	< 0.01
2	< 0.005	0.020	< .01	0.018	< 0.01
3	< 0.005	0.010	0.010	0.014	0.010
4	0.007	0.020	0.010	0.020	< 0.01
5	0.013	0.020	0.010	0.016	< 0.01
Mean	0.010	0.018	0.010	0.017	< 0.01
Median	0.010	0.020	0.010	0.017	< 0.01
Std.Dev.	0.003	0.004	0.000	0.002	-
Rel.Std.Dev.	30.0%	24.8%	0.00%	13.2%	-
PDM[3]	-23.1%	38.5%	-23.1%	30.8%	-