

**CERTIFICATE OF ANALYSIS FOR  
 NICKEL SULPHIDE ORE REFERENCE  
 MATERIAL OREAS 77a**

**SUMMARY STATISTICS**

| Constituent  | Recommended value | 95% Confidence Interval |       | Tolerance limits<br>1- $\alpha$ =0.99, $\rho$ =0.95 |       |
|--|-------------------|-------------------------|-------|---|-------|
|  |                   | Low                     | High  | Low   | High  |
| <b><u>Lead fire assay</u></b>                          |                   |                         |       |   |       |
| Gold, Au (ppb)   | 61                | 57                      | 66    | 56  | 66    |
| Palladium, Pd (ppb)                                    | 566               | 538                     | 593   | 549   | 582   |
| Platinum, Pt (ppb)                                     | 1088              | 1034                    | 1142  | 1053  | 1123  |
| <b><u>4 Acid digest</u></b>                            |                   |                         |       |   |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.45              | 1.40                    | 1.49  | 1.41  | 1.48  |
| Arsenic, As (ppm)                                      | 154               | 146                     | 161   | 149   | 158   |
| Chromium, Cr (ppm)                                     | 709               | 661                     | 757   | 661   | 758   |
| Cobalt, Co (ppm)                                       | 1714              | 1669                    | 1760  | 1688  | 1741  |
| Copper, Cu (ppm)                                       | 4311              | 4225                    | 4397  | 4259  | 4363  |
| Iron, Fe (wt.%)  | 34.3              | 33.3                    | 35.4  | 34.0  | 34.7  |
| Magnesium oxide, MgO (wt.%)                            | 7.25              | 7.03                    | 7.47  | 7.10  | 7.41  |
| Nickel, Ni (wt.%)                                      | 10.59             | 10.38                   | 10.80 | 10.43   | 10.74 |
| Sulphur, S (wt.%)                                      | 24.4              | 22.2                    | 26.5  | 23.9  | 24.8  |
| <b><u>Fusion</u></b>                                   |                   |                         |       |   |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.48              | 1.43                    | 1.54  | 1.44  | 1.52  |
| Arsenic, As (ppm)                                      | 162               | 146                     | 179   | 152   | 173   |
| Chromium, Cr (ppm)                                     | 840               | 812                     | 868   | 789   | 891   |
| Cobalt, Co (ppm)                                       | 1675              | 1578                    | 1773  | 1625  | 1726  |
| Copper, Cu (ppm)                                       | 4400              | 4247                    | 4552  | 4202  | 4597  |
| Iron, Fe (wt.%)  | 34.0              | 33.1                    | 34.8  | 33.5  | 34.4  |
| Magnesium oxide, MgO (wt.%)                            | 7.27              | 7.17                    | 7.36  | 7.17  | 7.36  |
| Nickel, Ni (wt.%)                                      | 10.71             | 10.39                   | 11.02 | 10.51   | 10.91 |
| Silicon dioxide, SiO <sub>2</sub> (wt.%)               | 13.3              | 13.1                    | 13.6  | 13.1  | 13.5  |
| Sulphur, S (wt.%)                                      | 26.2              | 24.2                    | 28.2  | 25.5  | 26.9  |
| <b><u>IR Combustion</u></b>                            |                   |                         |       |   |       |
| Sulphur, S (wt.%)                                      | 26.83             | 26.48                   | 27.19 | 26.42   | 27.24 |

Intervals may appear asymmetric due to rounding

Prepared by:  
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## INTRODUCTION

OREAS certified reference materials (CRMs) 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 geologist they provide a means of implementing quality control in analytical data sets generated in exploration, from the grass roots level through to prospect evaluation, and in grade control at mining operations.

## SOURCE MATERIAL

Reference material OREAS 77a is one of a suite of six nickel sulphide CRMs (OREAS 72a to OREAS 77a) prepared from high grade massive nickel sulphide ore and barren ultramafic material from the Cosmos Nickel mine located in the Kathleen Valley area approximately 30km north of Leinster in Western Australia. Cosmos is situated within the Agnew-Wiluna portion of the Norseman-Wiluna greenstone belt. This portion of the belt is strongly attenuated and characterised by large scale faults, complex folding and typically steep dips. It is a typical Kambalda-style, komatiite associated, massive sulphide deposit representing an essentially in-situ accumulation of primary magmatic Ni-Fe sulphides with minor by-products including Cu, Co and platinum group elements (PGE's). The Cosmos deposit comprises one discrete zone of massive and semi-massive sulphides extending over a strike length of 240m. Mineralisation is strata bound between the overlying ultramafic unit and the underlying dolerite and felsic volcanic rocks. Continuity of grade and width of mineralisation are strong both along strike and down dip.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 77a was prepared in the following manner:

- a) *drying to constant mass at 65°C (Ni ore) and 105°C (barren ultramafic);*
- b) *crushing;*
- c) *milling of the nickel ore to 100% minus 25 microns;*
- d) *milling of the barren ultramafic to 98% minus 75 microns;*
- e) *combining in appropriate proportions to achieve the desired grade;*
- f) *homogenisation;*
- g) *packaging in 10g units sealed under nitrogen, in laminated foil pouches.*

## ANALYTICAL PROGRAM FOR OREAS 77a

Fifteen commercial laboratories participated in the analytical program to certify Au, Pt, Pd, Al<sub>2</sub>O<sub>3</sub>, As, Cr, Co, Cu, Fe, MgO, Ni, SiO<sub>2</sub> and S by both total and partial 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<sup>3</sup>) are presented in an appendix (Tables A2 – A24). 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.

Table 1. Approximate major and trace element composition of nickel sulphide reference material OREAS 77a; wt.% - weight percent; ppm - parts per million.

| Constituent                   | wt. % | Constituent | ppm  | Constituent | ppm  | Constituent | ppm |
|-------------------------------|-------|-------------|------|-------------|------|-------------|-----|
| TiO <sub>2</sub>              | 0.10  | Ag          | 2.2  | Ho          | 0.1  | Sm          | 0.5 |
| MnO                           | 0.16  | Ba          | 51   | In          | 0.1  | Sn          | 1   |
| CaO                           | 1.20  | Be          | 0.5  | La          | 5    | Sr          | 15  |
| K <sub>2</sub> O              | 0.20  | Bi          | 1.3  | Li          | 11   | Ta          | <1  |
| P <sub>2</sub> O <sub>5</sub> | 0.10  | Cd          | 1    | Lu          | 0.05 | Tb          | 0.1 |
| Na <sub>2</sub> O             | 0.2   | Ce          | 9.0  | Mo          | 2.5  | Te          | 1.2 |
| C                             | 0.10  | Cs          | 1.7  | Nb          | 2.2  | Th          | 1.9 |
|                               |       | Dy          | 0.4  | Nd          | 2.2  | U           | 0.5 |
|                               |       | Er          | 0.3  | Pb          | 22   | W           | 2   |
|                               |       | Eu          | 0.10 | Pr          | 0.8  | Y           | 2.7 |
|                               |       | Ga          | 2.1  | Rb          | 9    | Yb          | 0.3 |
|                               |       | Gd          | 0.6  | Sb          | 2.2  | Zn          | 90  |
|                               |       | Hf          | 0.5  | Sc          | 2    | Zr          | 16  |

The intent of the certification program was to characterise the analytes by a) fire assay ICP-MS, b) total acid digest methods (mainly HF-HCl-HNO<sub>3</sub>-HClO<sub>4</sub>) with ICP-OES, ICP-MS and AAS finish, and b) sodium peroxide or lithium borate fusion with ICP-OES, ICP-MS, AAS or XRF finish. S was also analysed by Leco IR combustion furnace. A batch of five dried and vacuum-packed samples were submitted to each of the participating laboratories for analysis. Each batch was composed of two 110g sub-samples scoop-split from each of two separate 1kg test units taken during the bagging stage and immediately following homogenisation. This two-stage nested design for the interlaboratory programme was amenable to analysis of variance (ANOVA) treatment and enables a comparative assessment of within- and between-unit homogeneity. A fifth randomly chosen sample was included from a third 1kg test unit to make up batches of five samples.

## STATISTICAL EVALUATION OF OREAS 77a

### 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

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

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

where

$x_{ij}$  is the  $j$ th 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  $i$ ;

$\bar{\bar{x}}$  is the mean of means.

Table 2. Recommended values and 95% confidence intervals for OREAS 77a

| Constituent  | Recommended value | 95% Confidence Interval |       |
|--|-------------------|-------------------------|-------|
|  |                   | Low                     | High  |
| <b>Lead fire assay</b>                                 |                   |                         |       |
| Gold, Au (ppb)   | 61                | 57                      | 66    |
| Palladium, Pd (ppb)                                    | 566               | 538                     | 593   |
| Platinum, Pt (ppb)                                     | 1088              | 1034                    | 1142  |
| <b>4 Acid digest</b>                                   |                   |                         |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.45              | 1.40                    | 1.49  |
| Arsenic, As (ppm)                                      | 154               | 146                     | 161   |
| Chromium, Cr (ppm)                                     | 709               | 661                     | 757   |
| Cobalt, Co (ppm)                                       | 1714              | 1669                    | 1760  |
| Copper, Cu (ppm)                                       | 4311              | 4225                    | 4397  |
| Iron, Fe (wt.%)  | 34.3              | 33.3                    | 35.4  |
| Magnesium oxide, MgO (wt.%)                            | 7.25              | 7.03                    | 7.47  |
| Nickel, Ni (wt.%)                                      | 10.59             | 10.38                   | 10.80 |
| Sulphur, S (wt.%)                                      | 24.4              | 22.2                    | 26.5  |
| <b>Fusion</b>  |                   |                         |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.48              | 1.43                    | 1.54  |
| Arsenic, As (ppm)                                      | 162               | 146                     | 179   |
| Chromium, Cr (ppm)                                     | 840               | 812                     | 868   |
| Cobalt, Co (ppm)                                       | 1675              | 1578                    | 1773  |
| Copper, Cu (ppm)                                       | 4400              | 4247                    | 4552  |
| Iron, Fe (wt.%)  | 34.0              | 33.1                    | 34.8  |
| Magnesium oxide, MgO (wt.%)                            | 7.27              | 7.17                    | 7.36  |
| Nickel, Ni (wt.%)                                      | 10.71             | 10.39                   | 11.02 |
| Silicon dioxide, SiO <sub>2</sub> (wt.%)               | 13.3              | 13.1                    | 13.6  |
| Sulphur, S (wt.%)                                      | 26.2              | 24.2                    | 28.2  |
| <b>IR Combustion</b>                                   |                   |                         |       |
| Sulphur, S (wt.%)                                      | 26.83             | 26.48                   | 27.19 |

Intervals may appear asymmetric due to rounding

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).

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

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

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

The distributions 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

$$S = 1.483 \text{ median} / x_j - \text{median} (x_i) /$$

$$j=1 \dots n \quad i=1 \dots n$$

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

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.

Individual outliers and, more rarely, laboratory means deemed to be outlying are shown in bold in the tabulated results (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.

### 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 *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

$$\text{Lower limit is } \bar{x} - k'_2(n, p, 1 - \alpha) s_g''$$

$$\text{Upper limit is } \bar{x} + k'_2(n, p, 1 - \alpha) s_g''$$

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 (*n*, *p*,  $1 - \alpha$  unknown);

$s_g''$  is the corrected grand standard deviation.

The meaning of these tolerance limits may be illustrated for nickel by 4 acid digest, where 99% of the time at least 95% of subsamples will have concentrations lying between 10.4 and 10.7 percent (see Table 3). 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 (ISO 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:

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

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

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. 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. Outliers were removed prior to the calculation of tolerance intervals and a weighting factor of zero was applied to those data sets where  $s_i / 2s_g' > 1$  (i.e. where the weighting factor  $1 - s_i / 2s_g' < 0$ ).

Table 3. Recommended values and tolerance limits for OREAS 77a

| Constituent  | Recommended value | Tolerance limits<br>1- $\alpha$ = 0.99, $\rho$ = 0.95 |       |
|--|-------------------|---|-------|
|  |                   | Low   | High  |
| <b>Lead fire assay</b>                                 |                   |   |       |
| Gold, Au (ppb)   | 61                | 56  | 66    |
| Palladium, Pd (ppb)                                    | 566               | 549   | 582   |
| Platinum, Pt (ppb)                                     | 1088              | 1053  | 1123  |
| <b>4 Acid digest</b>                                   |                   |   |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.45              | 1.41  | 1.48  |
| Arsenic, As (ppm)                                      | 154               | 149   | 159   |
| Chromium, Cr (ppm)                                     | 709               | 661   | 758   |
| Cobalt, Co (ppm)                                       | 1714              | 1688  | 1741  |
| Copper, Cu (ppm)                                       | 4311              | 4259  | 4363  |
| Iron, Fe (wt.%)  | 34.3              | 34.0  | 34.7  |
| Magnesium oxide, MgO (wt.%)                            | 7.25              | 7.20  | 7.31  |
| Nickel, Ni (wt.%)                                      | 10.59             | 10.43   | 10.74 |
| Sulphur, S (wt.%)                                      | 24.4              | 23.9  | 24.8  |
| <b>Fusion</b>  |                   |   |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.48              | 1.44  | 1.52  |
| Arsenic, As (ppm)                                      | 162               | 152   | 173   |
| Chromium, Cr (ppm)                                     | 840               | 794   | 886   |
| Cobalt, Co (ppm)                                       | 1675              | 1625  | 1726  |
| Copper, Cu (ppm)                                       | 4400              | 4205  | 4595  |
| Iron, Fe (wt.%)  | 34.0              | 33.5  | 34.4  |
| Magnesium oxide, MgO (wt.%)                            | 7.27              | 7.17  | 7.36  |
| Nickel, Ni (wt.%)                                      | 10.71             | 10.51   | 10.91 |
| Silicon dioxide, SiO <sub>2</sub> (wt.%)               | 13.3              | 13.1  | 13.5  |
| Sulphur, S (wt.%)                                      | 26.2              | 25.5  | 26.9  |
| <b>IR Combustion</b>                                   |                   |   |       |
| Sulphur, S (wt.%)                                      | 26.83             | 26.42   | 27.24 |

Intervals may appear asymmetric due to rounding

### 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. 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 (SDs) of the accepted pool of certification data and are presented in Table 4. 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.

Table 4. Proposed performance gates for OREAS 77a

| Constituent  | Recommended value | Performance Gates |       |      |       |      |       |       |       |
|--|-------------------|-------------------|-------|------|-------|------|-------|-------|-------|
|  |                   | 1SD               |       | 2SD  |       | 3SD  |       | 5%    |       |
|  |                   | Low               | High  | Low  | High  | Low  | High  | Low   | High  |
| <b><u>Lead fire assay</u></b>                          |                   |                   |       |      |       |      |       |       |       |
| Gold, Au (ppb)   | 61                | 54                | 69    | 47   | 76    | 39   | 83    | 58    | 64    |
| Palladium, Pd (ppb)                                    | 566               | 521               | 611   | 475  | 656   | 430  | 702   | 538   | 594   |
| Platinum, Pt (ppb)                                     | 1088              | 992               | 1183  | 897  | 1279  | 802  | 1374  | 1033  | 1142  |
| <b><u>4 Acid digest</u></b>                            |                   |                   |       |      |       |      |       |       |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.45              | 1.39              | 1.51  | 1.33 | 1.57  | 1.27 | 1.63  | 1.38  | 1.52  |
| Arsenic, As (ppm)                                      | 154               | 142               | 165   | 131  | 176   | 120  | 187   | 146   | 161   |
| Chromium, Cr (ppm)                                     | 709               | 647               | 772   | 584  | 834   | 522  | 897   | 674   | 745   |
| Cobalt, Co (ppm)                                       | 1714              | 1638              | 1791  | 1562 | 1867  | 1486 | 1943  | 1629  | 1800  |
| Copper, Cu (ppm)                                       | 4311              | 4167              | 4454  | 4024 | 4598  | 3881 | 4741  | 4095  | 4526  |
| Iron, Fe (wt.%)  | 34.3              | 32.8              | 35.9  | 31.3 | 37.4  | 29.7 | 38.9  | 32.6  | 36.0  |
| Magnesium oxide, MgO (wt.%)                            | 7.25              | 6.92              | 7.58  | 6.59 | 7.91  | 6.26 | 8.24  | 6.89  | 7.62  |
| Nickel, Ni (wt.%)                                      | 10.59             | 10.22             | 10.95 | 9.85 | 11.32 | 9.48 | 11.69 | 10.06 | 11.12 |
| Sulphur, S (wt.%)                                      | 24.4              | 21.4              | 27.3  | 18.4 | 30.3  | 15.4 | 33.3  | 23.1  | 25.6  |
| <b><u>Fusion</u></b>                                   |                   |                   |       |      |       |      |       |       |       |
| Aluminium oxide, Al <sub>2</sub> O <sub>3</sub> (wt.%) | 1.48              | 1.38              | 1.59  | 1.27 | 1.70  | 1.16 | 1.81  | 1.41  | 1.56  |
| Arsenic, As (ppm)                                      | 162               | 135               | 190   | 108  | 217   | 81   | 244   | 154   | 171   |
| Chromium, Cr (ppm)                                     | 840               | 789               | 892   | 737  | 943   | 686  | 995   | 798   | 882   |
| Cobalt, Co (ppm)                                       | 1675              | 1520              | 1831  | 1364 | 1986  | 1209 | 2142  | 1592  | 1759  |
| Copper, Cu (ppm)                                       | 4400              | 4181              | 4618  | 3963 | 4836  | 3745 | 5054  | 4180  | 4620  |
| Iron, Fe (wt.%)  | 34.0              | 32.3              | 35.6  | 30.7 | 37.2  | 29.1 | 38.9  | 32.3  | 35.7  |
| Magnesium oxide, MgO (wt.%)                            | 7.27              | 7.08              | 7.46  | 6.88 | 7.65  | 6.69 | 7.84  | 6.90  | 7.63  |
| Nickel, Ni (wt.%)                                      | 10.71             | 10.24             | 11.17 | 9.77 | 11.64 | 9.30 | 12.11 | 10.17 | 11.24 |
| Silicon dioxide, SiO <sub>2</sub> (wt.%)               | 13.3              | 12.8              | 13.9  | 12.3 | 14.4  | 11.7 | 14.9  | 12.7  | 14.0  |
| Sulphur, S (wt.%)                                      | 26.2              | 25.5              | 26.9  | 24.8 | 27.7  | 24.0 | 28.4  | 24.9  | 27.5  |
| <b><u>IR Combustion</u></b>                            |                   |                   |       |      |       |      |       |       |       |
| Sulphur, S (wt.%)                                      | 26.8              | 26.3              | 27.4  | 25.7 | 28.0  | 25.2 | 28.5  | 25.5  | 28.2  |

Intervals may appear asymmetric due to rounding

For the second method a  $\pm 5\%$  error bar on the recommended value is used as the window of acceptability (refer Table 4).

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, Vancouver, BC, Canada  
 Activation Laboratories, Ancaster, ON, Canada  
 Actlabs Pacific, Redcliffe, WA, Australia  
 ALS Chemex, Malaga, WA, Australia  
 ALS Chemex, Stafford, QLD, Australia  
 ALS Chemex, North Vancouver, BC, Canada  
 Amdel Laboratories, Thebarton, SA, Australia  
 Amdel Laboratories, Wangara, WA, Australia  
 Genalysis Laboratory Services, Maddington, WA, Australia  
 Intertek Testing Services, Jakarta, Indonesia  
 Kalgoorlie Assay Laboratories, Kalgoorlie WA, Australia  
 McPhar Geoservices (Phil.) Inc., Makati, Philippines  
 SGS, Welshpool, WA, Australia  
 SGS Geosol, Brazil, Sth America  
 Ultra Trace Laboratories, Canning Vale, WA, Australia



## PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

The nickel sulphide ore reference material OREAS 77a has been prepared and certified and is supplied by:

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

|           |                  |               |                |
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| Email     | info @ore.com.au | Web           | www.ore.com.au |

It is available in unit sizes of 10g in laminated foil packets.

### INTENDED USE

OREAS 77a is a reference material intended for the following:

- i) for the calibration of instruments used in the determination of the concentration of Ni, Au, Pt, Pd, Fe, Cu, Cr, Co, MgO, Al<sub>2</sub>O<sub>3</sub>, As, SiO<sub>2</sub> and S;
- ii) for the verification of analytical methods for Ni, Au, Pt, Pd, Fe, Cu, Cr, Co, MgO, Al<sub>2</sub>O<sub>3</sub>, As, SiO<sub>2</sub> and S;
- iii) for the preparation of secondary reference materials of similar composition.

### STABILITY AND STORAGE INSTRUCTIONS

OREAS 77a has been prepared from high grade nickel sulphide ore and barren ultramafic. Packaging under nitrogen in robust foil laminate it is considered to provide long-term stability for this CRM under normal storage conditions.

### INSTRUCTIONS FOR THE CORRECT USE OF THE REFERENCE MATERIAL

The recommended values for OREAS 77a refer to the concentration levels of Ni, Au, Pt, Pd, Fe, Cu, Cr, Co, MgO, Al<sub>2</sub>O<sub>3</sub>, As, SiO<sub>2</sub> and S after removal of hygroscopic moisture (~0.42 wt.%) by drying in air to constant mass at 65<sup>0</sup> C. If the reference material is not dried 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

## DOCUMENT HISTORY

| Revision No. | Date                            | Changes applied                       |
|--------------|---------------------------------|---------------------------------------|
| 3            | 17 <sup>th</sup> July, 2024     | Fixed a minor typo.                   |
| 2            | 6 <sup>th</sup> August, 2014    | Fixed a minor typo.                   |
| 1            | 25 <sup>th</sup> April, 2013    | Updated template to reflect new logo. |
| 0            | 30 <sup>th</sup> November, 2006 | First publication.                    |

## CERTIFICATION DATE

November 30, 2006

## REFERENCES

ISO Guide 35 (1985), Certification of reference materials - General and statistical principals.  
ISO Guide 3207 (1975), Statistical interpretation of data - Determination of a statistical tolerance interval.  
Kleeman, A. W. (1967), *J. Geol. Soc. Australia*,

## **APPENDIX**

### **Analytical Results for OREAS 77a**

Table A1. Explanation of abbreviations used in Tables A2 – A24.

| Abbreviation     | Explanation   |
|------------------|---|
| Std. Dev         | one sigma standard deviation                                      |
| Rel.Std.Dev.     | one sigma relative standard deviation                             |
| PDM <sup>3</sup> | percent deviation of lab mean from corrected mean of means        |
| 4A               | four acid (HF-HNO <sub>3</sub> -HClO <sub>4</sub> -HCl) digestion |
| AAS              | atomic absorption spectrometry                                    |
| OES              | inductively coupled plasma optical emission spectrometry          |
| MS               | inductively coupled plasma mass spectrometry                      |
| PPP              | inductively coupled plasma optical emission spectrometry          |
| XRF              | x-ray fluorescence  |
| BF               | lithium metaborate fusion   |
| PF               | sodium peroxide fusion  |
| LECO             | Leco infrared furnace   |
| HG               | hydride generation  |

Table A2. Analytical results for gold in OREAS 77a (abbreviations as in Table A1; values in ppb).

| Replicate No.    | Lab A<br>FA*MS | Lab B<br>FA*MS | Lab C<br>FA*MS | Lab D<br>- | Lab E<br>FA*MS | Lab F<br>FA*MS | Lab G<br>FA*MS | Lab H<br>FA*MS | Lab I<br>- | Lab J<br>FA*MS | Lab K<br>FA*MS | Lab L<br>FA*OES | Lab M<br>FA*MS | Lab N<br>FA*MS | Lab O<br>FA*MS |
|------------------|----------------|----------------|----------------|------------|----------------|----------------|----------------|----------------|------------|----------------|----------------|-----------------|----------------|----------------|----------------|
| 1                | 71             | 61             | 56             | NR         | 66             | 58             | 59             | 71             | NR         | 89             | 58             | 57              | 54             | 51             | 59             |
| 2                | 75             | 68             | 66             | NR         | 69             | 56             | 57             | 51             | NR         | 94             | 51             | 56              | 54             | 55             | 57             |
| 3                | 72             | 66             | 63             | NR         | 73             | 58             | 57             | 77             | NR         | 81             | 45             | 63              | 52             | 52             | 53             |
| 4                | 71             | 64             | 58             | NR         | 68             | 55             | 61             | 68             | NR         | 126            | 57             | 60              | 56             | 54             | 66             |
| 5                | 75             | 64             | 67             | NR         | 43             | 57             | 61             | 66             | NR         | 88             | 55             | 58              | 56             | 52             | 72             |
| Mean             | 73             | 65             | 62             |            | 64             | 57             | 59             | 67             |            | 96             | 53             | 59              | 54             | 53             | 61             |
| Median           | 72             | 64             | 63             |            | 68             | 57             | 59             | 68             |            | 89             | 55             | 58              | 54             | 52             | 59             |
| Std.Dev.         | 2              | 3              | 5              |            | 12             | 1              | 2              | 10             |            | 18             | 5              | 3               | 2              | 2              | 8              |
| Rel.Std.Dev.     | 2.65%          | 4.04%          | 7.82%          |            | 18.7%          | 2.30%          | 3.39%          | 14.5%          |            | 18.4%          | 9.98%          | 4.60%           | 3.08%          | 3.11%          | 12.3%          |
| PDM <sup>3</sup> | 18.6%          | 5.41%          | 1.17%          |            | 4.11%          | -7.32%         | -3.73%         | 8.89%          |            | 56.0%          | -13.2%         | -3.99%          | -11.2%         | -13.8%         | 0.19%          |

Table A3. Analytical results for palladium in OREAS 77a (abbreviations as in Table A1; values in ppb).

| Replicate No.    | Lab A FA*MS | Lab B FA*MS | Lab C FA*MS | Lab D - | Lab E FA*MS | Lab F FA*MS | Lab G FA*MS | Lab H FA*MS | Lab I - | Lab J FA*MS | Lab K FA*MS | Lab L FA*OES | Lab M FA*MS | Lab N FA*MS | Lab O FA*MS |
|------------------|-------------|-------------|-------------|---------|-------------|-------------|-------------|-------------|---------|-------------|-------------|--------------|-------------|-------------|-------------|
| 1                | 564         | 600         | 577         | NR      | 640         | 555         | 559         | <b>721</b>  | NR      | 542         | 498         | 558          | 487         | 615         | 799         |
| 2                | 569         | 611         | 607         | NR      | 590         | 560         | 534         | <b>315</b>  | NR      | 597         | 499         | 548          | 479         | 625         | <b>765</b>  |
| 3                | 558         | 625         | 599         | NR      | 610         | 566         | 547         | 582         | NR      | 564         | 441         | 539          | 477         | 635         | 800         |
| 4                | 557         | <b>479</b>  | <b>561</b>  | NR      | 620         | 554         | 551         | 557         | NR      | 504         | 520         | 559          | <b>517</b>  | 625         | <b>865</b>  |
| 5                | 558         | 596         | 604         | NR      | <b>395</b>  | 570         | 576         | 594         | NR      | 581         | 531         | <b>506</b>   | 494         | 634         | 800         |
| Mean             | 561         | 582         | 590         |         | 571         | 561         | 553         | 554         |         | 558         | 498         | 542          | 491         | 627         | <b>806</b>  |
| Median           | 558         | 600         | 599         |         | 610         | 560         | 551         | 582         |         | 564         | 499         | 548          | 487         | 625         | 800         |
| Std.Dev.         | 5           | 59          | 20          |         | 100         | 7           | 16          | 148         |         | 36          | 35          | 22           | 16          | 8           | 36          |
| Rel.Std.Dev.     | 0.92%       | 10.1%       | 3.37%       |         | 17.5%       | 1.24%       | 2.81%       | 26.7%       |         | 6.50%       | 6.98%       | 4.01%        | 3.29%       | 1.30%       | 4.51%       |
| PDM <sup>3</sup> | -0.82%      | 2.89%       | 4.19%       |         | 0.91%       | -0.90%      | -2.20%      | -2.14%      |         | -1.46%      | -12.0%      | -4.22%       | -13.3%      | 10.8%       | 42.4%       |

Table A4. Analytical results for platinum in OREAS 77a (abbreviations as in Table A1; values in ppb).

| Replicate No.    | Lab A FA*MS | Lab B FA*MS | Lab C FA*MS | Lab D - | Lab E FA*MS | Lab F FA*MS | Lab G FA*MS | Lab H FA*MS | Lab I - | Lab J FA*MS | Lab K FA*MS | Lab L FA*OES | Lab M FA*MS | Lab N FA*MS | Lab O FA*MS |
|------------------|-------------|-------------|-------------|---------|-------------|-------------|-------------|-------------|---------|-------------|-------------|--------------|-------------|-------------|-------------|
| 1                | 1160        | 1153        | 1120        | NR      | 1180        | 1115        | 991         | 1310        | NR      | 1091        | 1041        | 1067         | 939         | 1059        | 1400        |
| 2                | 1120        | 1201        | <b>1180</b> | NR      | 1200        | 1106        | 930         | <b>617</b>  | NR      | 1207        | 837         | <b>1038</b>  | 917         | 1050        | 1300        |
| 3                | 1190        | 1187        | <b>1040</b> | NR      | 1150        | <b>1153</b> | 956         | 1140        | NR      | 1154        | <b>603</b>  | <b>1116</b>  | 921         | <b>1028</b> | 1430        |
| 4                | 1120        | 1169        | 1110        | NR      | 1220        | 1112        | 960         | 1090        | NR      | 1030        | 989         | 1077         | 982         | 1054        | 1300        |
| 5                | 1100        | 1145        | 1120        | NR      | <b>785</b>  | 1128        | 1030        | 1170        | NR      | 1168        | 1010        | 1083         | 954         | 1062        | 1370        |
| Mean             | 1138        | 1171        | 1114        |         | 1107        | 1123        | 973         | 1065        |         | 1130        | 896         | 1076         | 943         | 1051        | <b>1360</b> |
| Median           | 1120        | 1169        | 1120        |         | 1180        | 1115        | 960         | 1140        |         | 1154        | 989         | 1077         | 939         | 1054        | 1370        |
| Std.Dev.         | 36          | 23          | 50          |         | 182         | 18          | 38          | 264         |         | 70          | 182         | 28           | 27          | 13          | 59          |
| Rel.Std.Dev.     | 3.19%       | 1.98%       | 4.47%       |         | 16.4%       | 1.65%       | 3.94%       | 24.8%       |         | 6.17%       | 20.3%       | 2.62%        | 2.82%       | 1.28%       | 4.32%       |
| PDM <sup>3</sup> | 4.62%       | 7.65%       | 2.41%       |         | 1.77%       | 3.21%       | -10.5%      | -2.06%      |         | 3.88%       | -17.6%      | -1.06%       | -13.3%      | -3.42%      | 25.0%       |

Table A5. Analytical results for 4 acid aluminium oxide in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>- | Lab K<br>- | Lab L<br>- | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|------------|-----------------|-----------------|-----------------|
| 1                | 1.47            | 1.43            | 1.44            | 1.48           | 1.49            | 1.42            | 1.45            | 0.68            | 1.34            | NR         | NR         | NR         | 1.11            | 1.69            | 1.46            |
| 2                | 1.47            | 1.42            | 1.42            | 1.50           | 1.50            | 1.42            | 1.52            | 0.68            | 1.36            | NR         | NR         | NR         | 1.05            | 1.65            | 1.52            |
| 3                | 1.47            | <b>1.35</b>     | 1.42            | 1.46           | 1.54            | 1.38            | 1.49            | 0.68            | 1.32            | NR         | NR         | NR         | 1.08            | 1.68            | 1.51            |
| 4                | 1.49            | 1.42            | 1.42            | 1.46           | 1.56            | 1.40            | 1.53            | 0.70            | 1.34            | NR         | NR         | NR         | 1.12            | 1.64            | 1.47            |
| 5                | 1.50            | 1.38            | 1.42            | 1.50           | 1.52            | 1.40            | 1.51            | 0.69            | 1.33            | NR         | NR         | NR         | 1.08            | 1.67            | 1.48            |
| Mean             | 1.48            | 1.40            | 1.42            | 1.48           | 1.52            | 1.40            | 1.50            | <b>0.69</b>     | 1.34            |            |            |            | <b>1.09</b>     | <b>1.67</b>     | 1.49            |
| Median           | 1.47            | 1.42            | 1.42            | 1.48           | 1.52            | 1.40            | 1.51            | 0.68            | 1.34            |            |            |            | 1.08            | 1.67            | 1.48            |
| Std.Dev.         | 0.01            | 0.03            | 0.01            | 0.02           | 0.03            | 0.02            | 0.03            | 0.01            | 0.01            |            |            |            | 0.02            | 0.02            | 0.03            |
| Rel.Std.Dev.     | 0.96%           | 2.35%           | 0.59%           | 1.35%          | 1.88%           | 1.13%           | 2.11%           | 1.30%           | 1.11%           |            |            |            | 2.29%           | 1.24%           | 1.76%           |
| PDM <sup>3</sup> | 2.13%           | -3.46%          | -1.94%          | 2.13%          | 5.03%           | -3.25%          | 3.51%           | -52.7%          | -7.67%          |            |            |            | -24.9%          | 15.0%           | 2.67%           |

Table A6. Analytical results for 4 acid arsenic in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>HG*AAS | Lab K<br>- | Lab L<br>- | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|-----------------|-----------------|-----------------|
| 1                | 165             | 149             | 140             | <b>180</b>     | 160             | <200            | <b>159</b>      | 146             | 155             | 89              | NR         | NR         | 170             | 160             | 149             |
| 2                | 160             | 148             | 130             | 160            | 140             | 200             | 166             | 146             | 150             | 90              | NR         | NR         | 170             | 167             | 148             |
| 3                | 170             | <b>139</b>      | 140             | 140            | 140             | 200             | 166             | 148             | 160             | 91              | NR         | NR         | 170             | 160             | 143             |
| 4                | 170             | 148             | 150             | 130            | 150             | <200            | 164             | 146             | 155             | 87              | NR         | NR         | 170             | 160             | 148             |
| 5                | 165             | 148             | 140             | 140            | 160             | <200            | 167             | 144             | 155             | <b>109</b>      | NR         | NR         | 170             | 158             | 142             |
| Mean             | 166             | 146             | 140             | 150            | 150             | <b>200</b>      | 164             | 146             | 155             | <b>93</b>       |            |            | 170             | 161             | 146             |
| Median           | 165             | 148             | 140             | 140            | 150             | 200             | 166             | 146             | 155             | 90              |            |            | 170             | 160             | 148             |
| Std.Dev.         | 4               | 4               | 7               | 20             | 10              | 0               | 3               | 1               | 4               | 9               |            |            | 0               | 3               | 3               |
| Rel.Std.Dev.     | 2.52%           | 2.84%           | 5.05%           | 13.3%          | 6.67%           | 0.00%           | 1.95%           | 0.97%           | 2.28%           | 9.61%           |            |            | 0.00%           | 2.15%           | 2.22%           |
| PDM <sup>3</sup> | 8.02%           | -4.74%          | -8.90%          | -2.40%         | -2.40%          | 30.1%           | 6.97%           | -5.00%          | 0.86%           | -39.4%          |            |            | 10.6%           | 4.76%           | -5.00%          |

Table A7. Analytical results for 4 acid chromium in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>- | Lab I<br>4A*OES | Lab J<br>- | Lab K<br>- | Lab L<br>- | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>- |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|------------|-----------------|------------|------------|------------|-----------------|-----------------|------------|
| 1                | 495             | 745             | 690             | 600            | 750             | 490             | 690             | NR         | 750             | NR         | NR         | NR         | 685             | 716             | NR         |
| 2                | 435             | 743             | 690             | <b>490</b>     | 740             | 480             | <b>830</b>      | NR         | 780             | NR         | NR         | NR         | 685             | 716             | NR         |
| 3                | 455             | 688             | 680             | 600            | 810             | 490             | 680             | NR         | 790             | NR         | NR         | NR         | 560             | 698             | NR         |
| 4                | 440             | 727             | 680             | 630            | 800             | 520             | 740             | NR         | 780             | NR         | NR         | NR         | 745             | 758             | NR         |
| 5                | 465             | <b>560</b>      | 670             | 570            | 790             | 480             | 710             | NR         | 790             | NR         | NR         | NR         | 760             | 704             | NR         |
| Mean             | <b>458</b>      | 693             | 682             | 578            | 778             | <b>492</b>      | 730             |            | 778             |            |            |            | 687             | 718             |            |
| Median           | 455             | 727             | 680             | 600            | 790             | 490             | 710             |            | 780             |            |            |            | 685             | 716             |            |
| Std.Dev.         | 24              | 78              | 8               | 54             | 31              | 16              | 60              |            | 16              |            |            |            | 79              | 23              |            |
| Rel.Std.Dev.     | 5.21%           | 11.2%           | 1.23%           | 9.27%          | 4.00%           | 3.34%           | 8.28%           |            | 2.11%           |            |            |            | 11.5%           | 3.27%           |            |
| PDM <sup>3</sup> | -35.4%          | -2.35%          | -3.84%          | -18.5%         | 9.69%           | -30.6%          | 2.92%           |            | 9.69%           |            |            |            | -3.14%          | 1.29%           |            |

Table A8. Analytical results for 4 acid cobalt in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>4A*AAS | Lab K<br>- | Lab L<br>AR*OES | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 1700            | 1674            | 1740            | 1620           | 1640            | 1840            | 1550            | 1730            | 1740            | 1387            | NR         | 1794            | 1740            | 1820            | 1710            |
| 2                | 1700            | 1646            | 1740            | 1640           | 1630            | 1830            | 1630            | 1730            | 1760            | 1405            | NR         | 1780            | 1740            | 1801            | 1700            |
| 3                | 1690            | 1566            | 1730            | 1620           | 1690            | 1800            | 1580            | 1710            | 1760            | 1410            | NR         | 1770            | 1720            | 1825            | 1700            |
| 4                | 1670            | 1648            | 1740            | 1620           | 1700            | 1840            | 1520            | 1770            | 1790            | 1364            | NR         | 1791            | 1720            | 1802            | 1700            |
| 5                | 1675            | 1603            | 1720            | 1640           | 1670            | 1830            | 1600            | 1760            | 1780            | 1389            | NR         | 1785            | 1760            | 1816            | 1700            |
| Mean             | 1687            | 1627            | 1734            | 1628           | 1666            | 1828            | 1576            | 1740            | 1766            | <b>1391</b>     |            | 1784            | 1736            | 1813            | 1702            |
| Median           | 1690            | 1646            | 1740            | 1620           | 1670            | 1830            | 1580            | 1730            | 1760            | 1389            |            | 1785            | 1740            | 1816            | 1700            |
| Std.Dev.         | 14              | 43              | 9               | 11             | 30              | 16              | 43              | 24              | 19              | 18              |            | 10              | 17              | 11              | 4               |
| Rel.Std.Dev.     | 0.83%           | 2.63%           | 0.52%           | 0.67%          | 1.83%           | 0.90%           | 2.71%           | 1.41%           | 1.10%           | 1.30%           |            | 0.53%           | 0.96%           | 0.60%           | 0.26%           |
| PDM <sup>3</sup> | -1.60%          | -5.07%          | 1.14%           | -5.04%         | -2.82%          | 6.63%           | -8.07%          | 1.49%           | 3.01%           | -18.9%          |            | 4.06%           | 1.26%           | 5.74%           | -0.72%          |

Table A9. Analytical results for 4 acid copper in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>4A*AAS | Lab K<br>- | Lab L<br>AR*OES | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 4380            | 4239            | 4320            | 4250           | 4240            | 4400            | 4110            | 2970            | 4400            | 4201            | NR         | 4323            | <b>4440</b>     | 4508            | 4020            |
| 2                | 4290            | 4263            | 4280            | 4300           | 4250            | 4380            | 4240            | 2980            | 4450            | 4055            | NR         | 4345            | 4500            | 4506            | 4030            |
| 3                | 4290            | <b>4099</b>     | 4290            | 4230           | 4360            | <b>4310</b>     | 4280            | 2960            | 4430            | 4178            | NR         | 4309            | 4520            | 4540            | 4070            |
| 4                | 4310            | 4231            | 4290            | 4220           | 4370            | 4390            | 4170            | 3050            | 4450            | 4113            | NR         | <b>4436</b>     | 4560            | 4552            | 4050            |
| 5                | 4360            | 4204            | 4260            | 4320           | 4360            | 4390            | 4280            | 3040            | 4410            | 4110            | NR         | 4363            | 4530            | 4604            | 4050            |
| Mean             | 4326            | 4207            | 4288            | 4264           | 4316            | 4374            | 4216            | <b>3000</b>     | 4428            | 4131            |            | 4355            | 4510            | 4542            | 4044            |
| Median           | 4310            | 4231            | 4290            | 4250           | 4360            | 4390            | 4240            | 2980            | 4430            | 4113            |            | 4345            | 4520            | 4540            | 4050            |
| Std.Dev.         | 42              | 64              | 22              | 44             | 65              | 36              | 74              | 42              | 23              | 58              |            | 50              | 45              | 40              | 19              |
| Rel.Std.Dev.     | 0.96%           | 1.52%           | 0.51%           | 1.03%          | 1.51%           | 0.83%           | 1.76%           | 1.39%           | 0.51%           | 1.41%           |            | 1.14%           | 0.99%           | 0.88%           | 0.48%           |
| PDM <sup>3</sup> | 0.35%           | -2.41%          | -0.53%          | -1.09%         | 0.12%           | 1.46%           | -2.20%          | -30.4%          | 2.72%           | -4.16%          |            | 1.03%           | 4.62%           | 5.36%           | -6.19%          |

Table A10. Analytical results for 4 acid iron in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>- | Lab K<br>- | Lab L<br>- | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|------------|-----------------|-----------------|-----------------|
| 1                | 33.3            | 33.5            | >30.0           | 32.5           | 33.7            | 35.6            | 33.0            | 32.0            | 36.2            | NR         | NR         | NR         | 34.5            | 36.7            | <b>36.5</b>     |
| 2                | 32.7            | 33.6            | >30.0           | 33.2           | 33.9            | 35.7            | 34.3            | 32.1            | 36.1            | NR         | NR         | NR         | 34.8            | 36.3            | <b>35.2</b>     |
| 3                | 32.6            | <b>32.2</b>     | >30.0           | 32.3           | 34.8            | <b>34.4</b>     | 33.9            | 31.6            | <b>35.8</b>     | NR         | NR         | NR         | 34.4            | 36.2            | 35.9            |
| 4                | 32.9            | 33.5            | >30.0           | 32.2           | 34.4            | 35.4            | 32.9            | 32.5            | 36.4            | NR         | NR         | NR         | 34.6            | 36.5            | 36.1            |
| 5                | 33.2            | <b>32.7</b>     | >30.0           | 33.1           | 34.0            | 35.4            | 33.9            | 31.3            | 36.2            | NR         | NR         | NR         | 34.9            | 36.5            | 36.0            |
| Mean             | 32.9            | 33.1            | >30.0           | 32.7           | 34.2            | 35.3            | 33.6            | 31.9            | 36.1            |            |            |            | 34.6            | 36.4            | 35.9            |
| Median           | 32.9            | 33.5            | >30.0           | 32.5           | 34.0            | 35.4            | 33.9            | 32.0            | 36.2            |            |            |            | 34.6            | 36.5            | 36.0            |
| Std.Dev.         | 0.3             | 0.6             | -               | 0.5            | 0.4             | 0.5             | 0.6             | 0.5             | 0.2             |            |            |            | 0.2             | 0.2             | 0.5             |
| Rel.Std.Dev.     | 0.93%           | 1.95%           | -               | 1.41%          | 1.29%           | 1.50%           | 1.83%           | 1.45%           | 0.61%           |            |            |            | 0.61%           | 0.56%           | 1.31%           |
| PDM <sup>3</sup> | -4.04%          | -3.60%          | -               | -4.86%         | -0.49%          | 2.79%           | -2.12%          | -7.07%          | 5.28%           |            |            |            | 0.86%           | 6.15%           | 4.70%           |



Table A11. Analytical results for 4 acid magnesium oxide in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>- | Lab K<br>- | Lab L<br>- | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|------------|-----------------|-----------------|-----------------|
| 1                | 7.43            | 7.14            | 6.83            | 6.93           | 6.84            | 7.89            | 7.41            | 8.07            | 7.15            | NR         | NR         | NR         | 7.17            | 7.29            | 7.43            |
| 2                | 7.39            | 7.14            | 6.75            | 7.00           | 6.80            | 7.91            | 7.73            | 8.09            | 7.31            | NR         | NR         | NR         | 7.33            | 7.22            | 7.43            |
| 3                | 7.43            | 6.99            | 6.70            | 6.85           | 7.06            | 7.71            | 7.63            | 8.02            | 7.21            | NR         | NR         | NR         | 7.28            | 7.40            | 7.44            |
| 4                | 7.44            | 7.15            | 6.75            | 6.83           | 7.12            | 7.88            | 7.42            | 8.27            | 7.16            | NR         | NR         | NR         | 7.30            | 7.15            | 7.41            |
| 5                | 7.62            | 7.14            | 6.65            | 6.96           | 6.87            | 7.91            | 7.63            | 8.22            | 7.14            | NR         | NR         | NR         | 7.43            | 7.36            | 7.49            |
| Mean             | 7.46            | 7.11            | 6.74            | 6.91           | 6.94            | 7.86            | 7.56            | 8.13            | 7.19            |            |            |            | 7.30            | 7.28            | 7.44            |
| Median           | 7.43            | 7.14            | 6.75            | 6.93           | 6.87            | 7.89            | 7.63            | 8.09            | 7.16            |            |            |            | 7.30            | 7.29            | 7.43            |
| Std.Dev.         | 0.09            | 0.07            | 0.07            | 0.07           | 0.14            | 0.08            | 0.14            | 0.11            | 0.07            |            |            |            | 0.09            | 0.10            | 0.03            |
| Rel.Std.Dev.     | 1.21%           | 0.93%           | 1.01%           | 1.05%          | 2.05%           | 1.08%           | 1.88%           | 1.30%           | 0.98%           |            |            |            | 1.28%           | 1.40%           | 0.43%           |
| PDM <sup>3</sup> | 2.87%           | -1.94%          | -7.15%          | -4.69%         | -4.36%          | 8.35%           | 4.27%           | 12.1%           | -0.83%          |            |            |            | 0.66%           | 0.41%           | 2.59%           |

Table A12. Analytical results for 4 acid nickel in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>4A*OES | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>4A*AAS | Lab K<br>- | Lab L<br>AR*OES | Lab M<br>4A*OES | Lab N<br>4A*OES | Lab O<br>4A*OES |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 10.7            | 10.3            | 10.6            | 9.73           | 10.6            | 10.4            | 10.1            | 10.8            | 10.8            | 10.3            | NR         | 10.8            | 10.4            | 11.1            | 10.9            |
| 2                | 10.7            | 10.7            | 10.6            | 10.3           | 10.2            | 10.4            | 10.2            | 11.1            | 11.0            | 10.2            | NR         | 10.9            | 10.5            | 11.1            | 11.1            |
| 3                | 10.6            | 10.3            | 10.6            | 9.94           | 10.6            | 10.5            | 10.2            | 11.1            | 10.9            | 10.7            | NR         | 10.8            | 10.4            | 11.1            | 11.2            |
| 4                | 10.6            | 10.0            | 10.5            | 9.86           | 10.5            | 10.4            | 10.4            | 11.1            | 11.1            | 10.9            | NR         | 11.0            | 10.5            | 11.0            | 11.2            |
| 5                | 10.6            | 10.1            | 10.5            | 10.2           | 9.96            | 10.5            | 10.1            | 10.8            | 11.0            | 10.3            | NR         | 10.9            | 10.7            | 11.3            | 11.0            |
| Mean             | 10.6            | 10.3            | 10.5            | 10.0           | 10.4            | 10.4            | 10.2            | 11.0            | 11.0            | 10.5            |            | 10.9            | 10.5            | 11.1            | 11.1            |
| Median           | 10.6            | 10.3            | 10.6            | 9.9            | 10.5            | 10.4            | 10.2            | 11.1            | 11.0            | 10.3            |            | 10.9            | 10.5            | 11.1            | 11.1            |
| Std.Dev.         | 0.1             | 0.3             | 0.0             | 0.2            | 0.3             | 0.1             | 0.1             | 0.2             | 0.1             | 0.3             |            | 0.1             | 0.1             | 0.1             | 0.1             |
| Rel.Std.Dev.     | 0.63%           | 2.47%           | 0.43%           | 2.23%          | 2.64%           | 0.55%           | 1.20%           | 1.50%           | 1.01%           | 2.65%           |            | 0.49%           | 1.07%           | 0.99%           | 1.18%           |
| PDM <sup>3</sup> | 0.41%           | -2.80%          | -0.63%          | -5.57%         | -2.12%          | -1.51%          | -3.65%          | 3.72%           | 3.57%           | -1.17%          |            | 2.73%           | -0.87%          | 5.10%           | 4.66%           |

Table A13. Analytical results for 4 acid sulphur in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>4A*OES | Lab B<br>4A*OES | Lab C<br>4A*OES | Lab D<br>4A*MS | Lab E<br>4A*AAS | Lab F<br>4A*OES | Lab G<br>- | Lab H<br>4A*OES | Lab I<br>4A*OES | Lab J<br>- | Lab K<br>- | Lab L<br>AR*OES | Lab M<br>4A*OES | Lab N<br>- | Lab O<br>- |
|------------------|-----------------|-----------------|-----------------|----------------|-----------------|-----------------|------------|-----------------|-----------------|------------|------------|-----------------|-----------------|------------|------------|
| 1                | 25.3            | <b>24.0</b>     | <b>27.0</b>     | 22.2           | 26.4            | 22.7            | NR         | 17.9            | 23.8            | NR         | NR         | 26.4            | 30.3            | NR         | NR         |
| 2                | 25.3            | 22.7            | 26.5            | 22.9           | 26.6            | 22.8            | NR         | 18.7            | 23.6            | NR         | NR         | 26.5            | 28.9            | NR         | NR         |
| 3                | 25.4            | <b>21.2</b>     | 26.5            | 21.9           | 26.8            | 22.5            | NR         | 18.6            | 24.0            | NR         | NR         | 26.6            | 28.3            | NR         | NR         |
| 4                | 25.5            | 22.4            | 26.6            | 21.5           | <b>27.5</b>     | 22.7            | NR         | 19.2            | 23.6            | NR         | NR         | 27.0            | 28.0            | NR         | NR         |
| 5                | 25.4            | 22.2            | 26.3            | 22.5           | 26.5            | 22.9            | NR         | 18.2            | 23.6            | NR         | NR         | 26.9            | 29.0            | NR         | NR         |
| Mean             | 25.4            | 22.5            | 26.6            | 22.2           | 26.8            | 22.7            |            | 18.5            | 23.7            |            |            | 26.7            | 28.9            |            |            |
| Median           | 25.4            | 22.4            | 26.5            | 22.2           | 26.6            | 22.7            |            | 18.6            | 23.6            |            |            | 26.6            | 28.9            |            |            |
| Std.Dev.         | 0.1             | 1.0             | 0.3             | 0.5            | 0.4             | 0.1             |            | 0.5             | 0.2             |            |            | 0.3             | 0.9             |            |            |
| Rel.Std.Dev.     | 0.33%           | 4.46%           | 0.97%           | 2.43%          | 1.64%           | 0.60%           |            | 2.68%           | 0.75%           |            |            | 1.01%           | 3.07%           |            |            |
| PDM <sup>3</sup> | 4.18%           | -7.70%          | 9.10%           | -8.87%         | 9.84%           | -6.70%          |            | -24.0%          | -2.64%          |            |            | 9.52%           | 18.6%           |            |            |

Table A14. Analytical results for fusion aluminium oxide in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>BF*OES | Lab J<br>BF*XRF | Lab K<br>BF*OES | Lab L<br>PF*OES | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 1.60            | 1.44            | 1.48            | 1.52            | 1.41            | <b>1.34</b>     | 1.60            | 1.40            | 1.35            | 1.50            | 1.38            | 1.48            | 1.52            | 1.65            | 1.56            |
| 2                | 1.61            | <b>1.55</b>     | 1.52            | 1.60            | 1.41            | 1.47            | 1.40            | 1.40            | 1.32            | 1.40            | 1.36            | 1.47            | 1.53            | 1.64            | 1.68            |
| 3                | 1.60            | 1.45            | 1.45            | 1.60            | 1.37            | 1.49            | 1.50            | 1.33            | 1.29            | 1.50            | 1.42            | 1.48            | 1.50            | <b>1.59</b>     | 1.68            |
| 4                | 1.59            | 1.45            | 1.50            | 1.63            | 1.35            | 1.50            | 1.50            | 1.32            | 1.29            | 1.50            | 1.38            | 1.48            | 1.50            | 1.61            | 1.64            |
| 5                | 1.60            | 1.47            | 1.52            | 1.51            | 1.43            | 1.51            | 1.40            | 1.32            | 1.34            | 1.30            | 1.36            | 1.47            | 1.47            | 1.64            | 1.75            |
| Mean             | 1.60            | 1.47            | 1.49            | 1.57            | 1.39            | 1.46            | 1.48            | 1.35            | 1.32            | 1.44            | 1.38            | 1.47            | 1.50            | 1.63            | 1.66            |
| Median           | 1.60            | 1.45            | 1.50            | 1.60            | 1.41            | 1.49            | 1.50            | 1.33            | 1.32            | 1.50            | 1.38            | 1.48            | 1.50            | 1.64            | 1.68            |
| Std.Dev.         | 0.01            | 0.04            | 0.03            | 0.05            | 0.03            | 0.07            | 0.08            | 0.04            | 0.03            | 0.09            | 0.02            | 0.00            | 0.02            | 0.03            | 0.07            |
| Rel.Std.Dev.     | 0.44%           | 3.01%           | 1.99%           | 3.41%           | 2.36%           | 4.77%           | 5.65%           | 3.12%           | 2.11%           | 6.21%           | 1.68%           | 0.24%           | 1.53%           | 1.54%           | 4.18%           |
| PDM <sup>3</sup> | 7.85%           | -0.66%          | 0.70%           | 5.96%           | -6.04%          | -1.45%          | -0.24%          | -8.73%          | -11.2%          | -2.9%           | -7.03%          | -0.67%          | 1.38%           | 9.60%           | 12.0%           |

Table A15. Analytical results for fusion arsenic in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>- | Lab J<br>- | Lab K<br>BF*OES | Lab L<br>PF*MS | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|-----------------|----------------|-----------------|-----------------|-----------------|
| 1                | 180             | 200             | 200             | 300             | 170             | 23              | 150             | NR              | NR         | NR         | 144             | 176            | NR              | 144             | 151             |
| 2                | 190             | 200             | 200             | 200             | 170             | 20              | 150             | NR              | NR         | NR         | 146             | 174            | NR              | 148             | 134             |
| 3                | 190             | 200             | 200             | 300             | 170             | 61              | 130             | NR              | NR         | NR         | 146             | 176            | NR              | 140             | 156             |
| 4                | 180             | 200             | 100             | 300             | 170             | 93              | 130             | NR              | NR         | NR         | 139             | 177            | NR              | 140             | 142             |
| 5                | 185             | 200             | 100             | 300             | 170             | 94              | 120             | NR              | NR         | NR         | 142             | 178            | NR              | 144             | 156             |
| Mean             | 185             | 200             | 160             | <b>280</b>      | 170             | <b>58</b>       | 136             |                 |            |            | 143             | 176            |                 | 143             | 148             |
| Median           | 185             | 200             | 200             | 300             | 170             | 61              | 130             |                 |            |            | 144             | 176            |                 | 144             | 151             |
| Std.Dev.         | 5               | 0               | 55              | 45              | 0               | 36              | 13              |                 |            |            | 3               | 1              |                 | 3               | 10              |
| Rel.Std.Dev.     | 2.70%           | 0.00%           | 34.2%           | 16.0%           | 0.00%           | 62.0%           | 9.87%           |                 |            |            | 2.07%           | 0.74%          |                 | 2.34%           | 6.50%           |
| PDM <sup>3</sup> | 13.9%           | 23.2%           | -1.47%          | 72.4%           | 4.69%           | -64.1%          | -16.3%          |                 |            |            | -11.7%          | 8.44%          |                 | -11.8%          | -8.98%          |

Table A16. Analytical results for fusion chromium in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>BF*OES | Lab J<br>- | Lab K<br>BF*OES | Lab L<br>PF*OES | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 840             | 842             | 900             | 900             | 905             | 732             | 880             | 800             | 860             | NR         | 700             | 819             | 690             | 833             | 1800            |
| 2                | 850             | <b>957</b>      | 900             | 900             | 922             | 814             | 910             | 800             | 830             | NR         | 700             | 815             | 820             | 827             | 1600            |
| 3                | 860             | 867             | 800             | 800             | 905             | 780             | 890             | 800             | 840             | NR         | 700             | 831             | 780             | 835             | 1500            |
| 4                | 860             | 847             | 900             | 800             | 891             | 753             | 850             | 800             | 850             | NR         | 600             | 824             | 850             | 828             | 2000            |
| 5                | 855             | 882             | 900             | 800             | 951             | 732             | 930             | 800             | 840             | NR         | 700             | 821             | 790             | 827             | 2500            |
| Mean             | 853             | 879             | 880             | 840             | 915             | 762             | 892             | 800             | 844             |            | <b>680</b>      | 822             | 786             | 830             | <b>1880</b>     |
| Median           | 855             | 867             | 900             | 800             | 905             | 753             | 890             | 800             | 840             |            | 700             | 821             | 790             | 828             | 1800            |
| Std.Dev.         | 8               | 46              | 45              | 55              | 23              | 35              | 30              | 0               | 11              |            | 45              | 6               | 60              | 4               | 396             |
| Rel.Std.Dev.     | 0.98%           | 5.28%           | 5.08%           | 6.52%           | 2.52%           | 4.60%           | 3.40%           | 0.00%           | 1.35%           |            | 6.58%           | 0.73%           | 7.67%           | 0.45%           | 21.1%           |
| PDM <sup>3</sup> | 1.51%           | 4.61%           | 4.73%           | -0.03%          | 8.87%           | -9.30%          | 6.15%           | -4.79%          | 0.44%           |            | -19.1%          | -2.18%          | -6.46%          | -1.22%          | 124%            |

Table A17. Analytical results for fusion cobalt in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>- | Lab J<br>- | Lab K<br>BF*OES | Lab L<br>- | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|-----------------|------------|-----------------|-----------------|-----------------|
| 1                | 1690            | 1704            | 1700            | 1800            | 1370            | 1337            | 1720            | 1800            | NR         | NR         | 1662            | NR         | 1870            | 1827            | 1500            |
| 2                | 1690            | 1792            | 1730            | 1900            | 1370            | <b>1101</b>     | 1640            | 1800            | NR         | NR         | 1692            | NR         | 1850            | 1864            | 1600            |
| 3                | 1700            | 1735            | <b>1500</b>     | 1800            | 1350            | 1591            | 1710            | 1900            | NR         | NR         | 1624            | NR         | 1880            | 1824            | 1600            |
| 4                | 1710            | 1723            | 1720            | 1700            | 1350            | 1481            | 1660            | 1800            | NR         | NR         | 1556            | NR         | 1860            | 1838            | 1600            |
| 5                | 1715            | 1755            | 1670            | 1600            | 1340            | 1452            | 1630            | 1800            | NR         | NR         | 1579            | NR         | 1840            | 1852            | 1500            |
| Mean             | 1701            | 1742            | 1664            | 1760            | 1356            | 1392            | 1672            | 1820            |            |            | 1623            |            | 1860            | 1841            | 1560            |
| Median           | 1700            | 1735            | 1700            | 1800            | 1350            | 1452            | 1660            | 1800            |            |            | 1624            |            | 1860            | 1838            | 1600            |
| Std.Dev.         | 11              | 34              | 94              | 114             | 13              | 186             | 41              | 45              |            |            | 56              |            | 16              | 17              | 55              |
| Rel.Std.Dev.     | 0.67%           | 1.93%           | 5.68%           | 6.48%           | 0.99%           | 13.4%           | 2.44%           | 2.46%           |            |            | 3.47%           |            | 0.85%           | 0.92%           | 3.51%           |
| PDM <sup>3</sup> | 1.53%           | 3.96%           | -0.68%          | 5.05%           | -19.1%          | -16.9%          | -0.20%          | 8.63%           |            |            | -3.15%          |            | 11.0%           | 9.89%           | -6.89%          |

Table A18. Analytical results for fusion copper in OREAS 77a (abbreviations as in Table A1; values in ppm).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>- | Lab J<br>- | Lab K<br>BF*OES | Lab L<br>- | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>- |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|-----------------|------------|-----------------|-----------------|------------|
| 1                | 4130            | 4236            | 4340            | 4600            | 4190            | 2102            | 4930            | 4500            | NR         | NR         | 4521            | NR         | 2850            | 4346            | NR         |
| 2                | 4190            | 4357            | 4390            | 4900            | 4260            | 1556            | 4500            | 4400            | NR         | NR         | 4650            | NR         | 2690            | 4494            | NR         |
| 3                | 4160            | 4258            | 4180            | 4800            | 4070            | 1831            | 4740            | 4400            | NR         | NR         | 4479            | NR         | 2690            | 4553            | NR         |
| 4                | 4170            | 4191            | 4330            | 4800            | 4030            | 2258            | 4710            | 4400            | NR         | NR         | 4261            | NR         | 3130            | 4427            | NR         |
| 5                | 4140            | 4290            | 4410            | 4500            | 4180            | 2689            | 4350            | 4400            | NR         | NR         | 4350            | NR         | 2870            | 4470            | NR         |
| Mean             | 4158            | 4266            | 4330            | 4720            | 4146            | <b>2087</b>     | 4646            | 4420            |            |            | 4452            |            | <b>2846</b>     | 4458            |            |
| Median           | 4160            | 4258            | 4340            | 4800            | 4180            | 2102            | 4710            | 4400            |            |            | 4479            |            | 2850            | 4470            |            |
| Std.Dev.         | 24              | 62              | 90              | 164             | 94              | 430             | 225             | 45              |            |            | 151             |            | 180             | 77              |            |
| Rel.Std.Dev.     | 0.57%           | 1.46%           | 2.08%           | 3.48%           | 2.27%           | 20.6%           | 4.84%           | 1.01%           |            |            | 3.40%           |            | 6.33%           | 1.74%           |            |
| PDM <sup>3</sup> | -5.49%          | -3.03%          | -1.58%          | 7.28%           | -5.76%          | -52.6%          | 5.60%           | 0.46%           |            |            | 1.20%           |            | -35.3%          | 1.33%           |            |

Table A19. Analytical results for fusion iron in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>BF*XRF | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>BF*OES | Lab J<br>BF*XRF | Lab K<br>BF*OES | Lab L<br>PF*OES | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 32.2            | 33.6            | 33.0            | 37.6            | 32.0            | <b>34.7</b>     | 35.7            | 33.9            | 36.1            | <b>32.8</b>     | 33.2            | 32.5            | 33.0            | 36.3            | 34.7            |
| 2                | 32.5            | 34.9            | 33.9            | 38.6            | 32.2            | 33.9            | 34.0            | 33.4            | 36.2            | 32.5            | 32.7            | 32.5            | 32.6            | 36.4            | 34.8            |
| 3                | 32.4            | 33.9            | 32.4            | 36.7            | 31.6            | 33.7            | 34.3            | 34.0            | 35.8            | 32.5            | <b>34.8</b>     | 32.8            | 32.6            | 36.7            | 35.7            |
| 4                | 32.5            | 33.5            | 33.3            | 36.3            | 31.5            | 33.6            | 36.9            | 33.7            | 36.2            | 32.6            | 33.5            | 33.0            | 32.8            | 36.4            | 35.6            |
| 5                | 32.4            | 34.4            | 33.8            | 33.6            | 31.9            | 33.7            | 35.1            | 33.6            | 35.8            | 32.5            | 33.2            | 32.8            | 32.5            | 36.7            | 34.4            |
| Mean             | 32.4            | 34.0            | 33.3            | 36.6            | 31.8            | 34.0            | 35.2            | 33.7            | 36.0            | 32.6            | 33.5            | 32.7            | 32.7            | 36.5            | 35.0            |
| Median           | 32.4            | 33.9            | 33.3            | 36.7            | 31.9            | 33.7            | 35.1            | 33.7            | 36.1            | 32.5            | 33.2            | 32.8            | 32.6            | 36.4            | 34.8            |
| Std.Dev.         | 0.1             | 0.6             | 0.6             | 1.9             | 0.3             | 0.4             | 1.2             | 0.2             | 0.2             | 0.1             | 0.8             | 0.2             | 0.2             | 0.2             | 0.6             |
| Rel.Std.Dev.     | 0.38%           | 1.72%           | 1.84%           | 5.13%           | 0.90%           | 1.32%           | 3.30%           | 0.71%           | 0.57%           | 0.41%           | 2.35%           | 0.71%           | 0.61%           | 0.47%           | 1.65%           |
| PDM <sup>3</sup> | -4.60%          | 0.25%           | -2.01%          | 7.65%           | -6.25%          | -0.01%          | 3.65%           | -0.71%          | 6.06%           | -4.07%          | -1.45%          | -3.70%          | -3.71%          | 7.42%           | 3.18%           |

Table A20. Analytical results for fusion magnesium oxide in OREAS 77a (abbreviations as in Table A1; values wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>BF*OES | Lab J<br>BF*XRF | Lab K<br>BF*OES | Lab L<br>PF*OES | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 7.33            | 7.25            | 7.03            | 7.85            | 7.10            | 6.88            | 7.77            | 7.04            | 7.09            | 7.40            | 7.29            | 7.29            | 7.38            | 7.34            | 8.23            |
| 2                | 7.38            | 7.73            | 7.12            | 8.13            | 7.18            | 7.51            | 7.46            | 7.04            | 7.11            | 7.40            | <b>7.21</b>     | 7.26            | 7.27            | 7.42            | 8.31            |
| 3                | 7.37            | 7.43            | <b>6.84</b>     | 7.93            | 6.97            | 7.37            | 7.26            | 7.08            | 7.06            | 7.50            | <b>7.58</b>     | 7.31            | 7.32            | 7.37            | 8.49            |
| 4                | 7.37            | 7.40            | 7.13            | 7.98            | 6.90            | 7.19            | 7.35            | <b>6.97</b>     | 6.98            | 7.60            | 7.31            | 7.30            | 7.38            | 7.46            | 8.57            |
| 5                | <b>7.43</b>     | 7.53            | 7.08            | <b>7.31</b>     | 7.12            | 7.05            | 7.44            | 7.05            | 7.03            | 7.40            | 7.28            | 7.22            | 7.15            | 7.39            | 8.20            |
| Mean             | 7.38            | 7.46            | 7.04            | <b>7.84</b>     | 7.05            | 7.20            | 7.46            | 7.04            | 7.05            | 7.46            | 7.33            | 7.28            | 7.30            | 7.40            | <b>8.36</b>     |
| Median           | 7.37            | 7.43            | 7.08            | 7.93            | 7.10            | 7.19            | 7.44            | 7.04            | 7.06            | 7.40            | 7.29            | 7.29            | 7.32            | 7.39            | 8.31            |
| Std.Dev.         | 0.04            | 0.18            | 0.12            | 0.31            | 0.12            | 0.25            | 0.19            | 0.04            | 0.05            | 0.09            | 0.14            | 0.04            | 0.10            | 0.05            | 0.16            |
| Rel.Std.Dev.     | 0.49%           | 2.38%           | 1.68%           | 4.00%           | 1.63%           | 3.47%           | 2.58%           | 0.57%           | 0.73%           | 1.20%           | 1.94%           | 0.51%           | 1.31%           | 0.62%           | 1.95%           |
| PDM <sup>3</sup> | 1.51%           | 2.73%           | -3.11%          | 7.90%           | -2.92%          | -0.91%          | 2.61%           | -3.17%          | -2.92%          | 2.67%           | 0.93%           | 0.15%           | 0.47%           | 1.79%           | 15.1%           |

Table A21. Analytical results for fusion nickel in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>- | Lab J<br>- | Lab K<br>BF*OES | Lab L<br>- | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|-----------------|------------|-----------------|-----------------|-----------------|
| 1                | 10.7            | 10.6            | 10.8            | 9.73            | 10.2            | <b>11.3</b>     | NR              | 11.4            | NR         | NR         | 10.3            | NR         | 10.4            | 11.1            | 11.0            |
| 2                | 10.8            | 11.0            | 11.1            | 10.3            | 10.3            | 11.0            | NR              | 11.2            | NR         | NR         | 10.2            | NR         | 10.0            | 11.3            | 11.1            |
| 3                | 10.8            | 10.8            | 10.5            | 9.94            | 10.1            | 11.0            | NR              | 11.5            | NR         | NR         | <b>10.7</b>     | NR         | 10.2            | 11.2            | 11.3            |
| 4                | 10.8            | 10.6            | 11.0            | 9.86            | <b>9.99</b>     | 11.1            | NR              | 11.3            | NR         | NR         | 10.4            | NR         | 10.0            | 11.0            | 11.3            |
| 5                | 10.8            | 10.9            | 10.9            | 10.2            | 10.2            | 11.0            | NR              | 11.2            | NR         | NR         | 10.3            | NR         | 10.5            | 11.3            | 11.1            |
| Mean             | 10.8            | 10.8            | 10.8            | 10.0            | 10.1            | 11.1            |                 | 11.3            |            |            | 10.4            |            | 10.2            | 11.2            | 11.2            |
| Median           | 10.8            | 10.8            | 10.9            | 9.9             | 10.2            | 11.0            |                 | 11.3            |            |            | 10.3            |            | 10.2            | 11.2            | 11.1            |
| Std.Dev.         | 0.0             | 0.2             | 0.2             | 0.2             | 0.1             | 0.1             |                 | 0.1             |            |            | 0.2             |            | 0.2             | 0.1             | 0.1             |
| Rel.Std.Dev.     | 0.42%           | 1.71%           | 1.97%           | 2.23%           | 1.10%           | 1.35%           |                 | 1.15%           |            |            | 2.02%           |            | 2.26%           | 1.11%           | 1.20%           |
| PDM <sup>3</sup> | 0.60%           | 0.74%           | 1.16%           | -6.63%          | -5.30%          | 3.57%           |                 | 5.74%           |            |            | -3.02%          |            | -4.56%          | 4.54%           | 4.24%           |

Table A22. Analytical results for silicon dioxide in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>BF*OES | Lab G<br>BF*OES | Lab H<br>BF*OES | Lab I<br>BF*OES | Lab J<br>BF*XRF | Lab K<br>- | Lab L<br>PF*OES | Lab M<br>BF*OES | Lab N<br>BF*OES | Lab O<br>BF*OES |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|-----------------|-----------------|-----------------|-----------------|
| 1                | 13.1            | 13.3            | 13.6            | 14.2            | 12.7            | <b>12.0</b>     | 13.5            | 13.1            | 13.6            | 13.4            | NR         | 13.3            | 13.5            | <b>12.3</b>     | 13.7            |
| 2                | 13.1            | 14.1            | 13.8            | 15.0            | 12.8            | 13.0            | 11.9            | 13.1            | 13.8            | 13.4            | NR         | 13.2            | <b>14.1</b>     | 12.9            | 13.8            |
| 3                | 13.0            | 13.3            | <b>13.3</b>     | 14.1            | 12.4            | 13.1            | 12.5            | 13.2            | 13.8            | 13.6            | NR         | 13.3            | 13.4            | 12.8            | 14.1            |
| 4                | 13.1            | 13.5            | 13.7            | 14.7            | 12.4            | 13.3            | 12.6            | 13.1            | 13.8            | 13.5            | NR         | 13.3            | 13.4            | <b>12.7</b>     | 14.0            |
| 5                | 13.1            | 13.7            | 13.9            | 13.5            | 12.7            | 13.3            | <b>11.5</b>     | 13.2            | 13.8            | 13.4            | NR         | 13.2            | <b>13.1</b>     | 12.8            | 13.6            |
| Mean             | 13.1            | 13.6            | 13.6            | 14.3            | 12.6            | 12.9            | 12.4            | 13.2            | 13.8            | 13.5            |            | 13.3            | 13.5            | 12.7            | 13.8            |
| Median           | 13.1            | 13.5            | 13.7            | 14.2            | 12.7            | 13.1            | 12.5            | 13.1            | 13.8            | 13.4            |            | 13.3            | 13.4            | 12.8            | 13.8            |
| Std.Dev.         | 0.0             | 0.4             | 0.2             | 0.6             | 0.2             | 0.6             | 0.8             | 0.1             | 0.1             | 0.1             |            | 0.1             | 0.4             | 0.2             | 0.2             |
| Rel.Std.Dev.     | 0.34%           | 2.64%           | 1.79%           | 4.10%           | 1.55%           | 4.41%           | 6.14%           | 0.52%           | 0.65%           | 0.66%           |            | 0.40%           | 2.65%           | 1.83%           | 1.50%           |
| PDM <sup>3</sup> | -1.95%          | 1.67%           | 2.10%           | 7.05%           | -5.70%          | -3.01%          | -7.05%          | -1.43%          | 3.15%           | 0.90%           |            | -0.60%          | 1.11%           | -4.78%          | 3.75%           |

Table A23. Analytical results for fusion sulphur in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>BF*XRF | Lab B<br>PF*OES | Lab C<br>BF*OES | Lab D<br>BF*OES | Lab E<br>BF*XRF | Lab F<br>- | Lab G<br>- | Lab H<br>- | Lab I<br>- | Lab J<br>- | Lab K<br>- | Lab L<br>- | Lab M<br>- | Lab N<br>- | Lab O<br>- |
|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1                | 26.9            | <b>24.2</b>     | 25.1            | 29.9            | >6.0            | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         |
| 2                | 27.2            | 26.7            | 25.4            | 30.8            | >6.0            | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         |
| 3                | 26.9            | 26.4            | <b>24.4</b>     | 30.2            | >6.0            | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         |
| 4                | 27.0            | 25.8            | 25.4            | 30.5            | >6.0            | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         |
| 5                | 26.9            | 26.2            | 25.6            | <b>28.2</b>     | >6.0            | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         | NR         |
| Mean             | 27.0            | 25.9            | 25.2            | <b>29.9</b>     | >6.0            |            |            |            |            |            |            |            |            |            |            |
| Median           | 26.9            | 26.2            | 25.4            | 30.2            | >6.0            |            |            |            |            |            |            |            |            |            |            |
| Std.Dev.         | 0.1             | 1.0             | 0.5             | 1.0             | -               |            |            |            |            |            |            |            |            |            |            |
| Rel.Std.Dev.     | 0.48%           | 3.87%           | 1.87%           | 3.40%           | -               |            |            |            |            |            |            |            |            |            |            |
| PDM <sup>3</sup> | 2.94%           | -1.37%          | -3.93%          | 14.2%           | -               |            |            |            |            |            |            |            |            |            |            |

Table A24. Analytical results for sulphur by LECO in OREAS 77a (abbreviations as in Table A1; values in wt %).

| Replicate No.    | Lab A<br>LECO | Lab B<br>LECO | Lab C<br>LECO | Lab D<br>LECO | Lab E<br>LECO | Lab F<br>LECO | Lab G<br>LECO | Lab H<br>LECO | Lab I<br>LECO | Lab J<br>LECO | Lab K<br>LECO | Lab L<br>LECO | Lab M<br>LECO | Lab N<br>LECO | Lab O<br>LECO |
|------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1                | <b>26.0</b>   | 27.0          | 26.2          | 25.9          | 27.8          | 26.4          | 27.1          | 30.0          | NR            | 20.9          | 27.0          | <b>26.9</b>   | 27.9          | 25.4          | 26.8          |
| 2                | 26.7          | 26.9          | 25.8          | 26.2          | 28.0          | 26.6          | 26.4          | 30.0          | NR            | 22.8          | 26.8          | 27.1          | 28.1          | 25.6          | 26.7          |
| 3                | 26.6          | 27.1          | 27.5          | 26.1          | 28.0          | 27.0          | 26.6          | 30.7          | NR            | 22.6          | 27.2          | 27.3          | 28.6          | 25.6          | 26.7          |
| 4                | <b>27.2</b>   | 26.7          | 26.7          | 25.8          | 27.7          | 26.1          | 26.8          | 30.0          | NR            | 21.2          | 27.2          | 27.2          | 27.4          | 25.2          | 27.0          |
| 5                | 26.6          | 27.3          | <b>24.6</b>   | 25.8          | 27.7          | 26.5          | 27.3          | 30.5          | NR            | 21.8          | 26.8          | <b>27.5</b>   | 29.0          | 25.3          | 26.9          |
| Mean             | 26.6          | 27.0          | 26.2          | 26.0          | 27.8          | 26.5          | 26.8          | <b>30.2</b>   |               | <b>21.9</b>   | 27.0          | 27.2          | <b>28.2</b>   | <b>25.4</b>   | 26.8          |
| Median           | 26.6          | 27.0          | 26.2          | 25.9          | 27.8          | 26.5          | 26.8          | 30.0          |               | 21.8          | 27.0          | 27.2          | 28.1          | 25.4          | 26.8          |
| Std.Dev.         | 0.4           | 0.2           | 1.1           | 0.2           | 0.2           | 0.3           | 0.4           | 0.3           |               | 0.8           | 0.2           | 0.2           | 0.6           | 0.2           | 0.1           |
| Rel.Std.Dev.     | 1.61%         | 0.83%         | 4.12%         | 0.70%         | 0.54%         | 1.23%         | 1.36%         | 1.11%         |               | 3.82%         | 0.67%         | 0.87%         | 2.18%         | 0.73%         | 0.49%         |
| PDM <sup>3</sup> | -0.83%        | 0.63%         | -2.50%        | -3.25%        | 3.76%         | -1.22%        | 0.03%         | 12.7%         |               | -18.53%       | 0.61%         | 1.37%         | 5.02%         | -5.23%        | -0.04%        |