

## CERTIFICATE OF ANALYSIS FOR

# HIGH GRADE COPPER ORE REFERENCE MATERIAL

# OREAS 932

**Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 932**

| Constituent          | Certified Value | 1SD   | 95% Confidence Limits |       | 95% Tolerance Limits |       |
|----------------------|-----------------|-------|-----------------------|-------|----------------------|-------|
|                      |                 |       | Low                   | High  | Low                  | High  |
| 4-Acid Digestion     |                 |       |                       |       |                      |       |
| Ag, Silver (ppm)     | 22.41           | 2.75  | 21.32                 | 23.51 | 20.56                | 24.27 |
| Al, Aluminium (wt.%) | 5.32            | 0.273 | 4.99                  | 5.65  | 5.05                 | 5.59  |
| As, Arsenic (ppm)    | 13.1            | 0.97  | 12.8                  | 13.4  | 12.0                 | 14.2  |
| Be, Beryllium (ppm)  | 1.82            | 0.31  | 1.54                  | 2.09  | IND                  | IND   |
| Bi, Bismuth (ppm)    | 324             | 22.3  | 315                   | 333   | 305                  | 343   |
| Ca, Calcium (wt.%)   | 0.429           | 0.026 | 0.397                 | 0.461 | 0.400                | 0.458 |
| Cd, Cadmium (ppm)    | < 1.2           | IND   | IND                   | IND   | IND                  | IND   |
| Co, Cobalt (ppm)     | 60              | 2.1   | 59                    | 61    | 58                   | 62    |
| Cr, Chromium (ppm)   | 53              | 6     | 47                    | 59    | 49                   | 57    |
| Cu, Copper (wt.%)    | 6.13            | 0.181 | 6.06                  | 6.20  | 5.97                 | 6.29  |
| Fe, Iron (wt.%)      | 14.24           | 0.648 | 13.95                 | 14.52 | 13.86                | 14.61 |
| K, Potassium (wt.%)  | 1.77            | 0.135 | 1.59                  | 1.95  | 1.68                 | 1.86  |
| La, Lanthanum (ppm)  | 30.7            | 3.4   | 26.2                  | 35.3  | 29.5                 | 31.9  |
| Li, Lithium (ppm)    | 20.5            | 3.3   | 16.5                  | 24.4  | 19.4                 | 21.6  |
| Mg, Magnesium (wt.%) | 1.29            | 0.089 | 1.20                  | 1.39  | 1.22                 | 1.37  |
| Mn, Manganese (wt.%) | 0.088           | 0.005 | 0.083                 | 0.093 | 0.085                | 0.092 |
| Mo, Molybdenum (ppm) | < 2             | IND   | IND                   | IND   | IND                  | IND   |
| Na, Sodium (wt.%)    | 0.179           | 0.010 | 0.168                 | 0.191 | IND                  | IND   |
| Nb, Niobium (ppm)    | 9.50            | 0.865 | 8.41                  | 10.60 | 8.85                 | 10.16 |
| Ni, Nickel (ppm)     | 27.4            | 2.70  | 24.6                  | 30.2  | 24.7                 | 30.1  |
| P, Phosphorus (wt.%) | 0.045           | 0.004 | 0.042                 | 0.048 | 0.041                | 0.050 |
| Pb, Lead (ppm)       | 184             | 11.4  | 179                   | 189   | 179                  | 190   |
| S, Sulphur (wt.%)    | 6.13            | 0.79  | 5.71                  | 6.55  | 5.90                 | 6.35  |
| Sb, Antimony (ppm)   | 1.98            | 0.21  | 1.88                  | 2.08  | 1.88                 | 2.08  |
| Sc, Scandium (ppm)   | < 20            | IND   | IND                   | IND   | IND                  | IND   |
| Se, Selenium (ppm)   | 67              | 4.8   | 65                    | 69    | 63                   | 71    |
| Sn, Tin (ppm)        | 58              | 6     | 55                    | 61    | 56                   | 61    |
| Sr, Strontium (ppm)  | 33.7            | 3.5   | 29.1                  | 38.3  | 31.8                 | 35.6  |
| Th, Thorium (ppm)    | 11.0            | 1.1   | 9.8                   | 12.1  | 10.1                 | 11.9  |

Table 1 continued.

| Constituent                   | Certified Value | 1SD   | 95% Confidence Limits |       | 95% Tolerance Limits |       |
|-------------------------------|-----------------|-------|-----------------------|-------|----------------------|-------|
|                               |                 |       | Low                   | High  | Low                  | High  |
| 4-Acid Digestion continued    |                 |       |                       |       |                      |       |
| Ti, Titanium (wt.%)           | 0.261           | 0.021 | 0.239                 | 0.284 | 0.247                | 0.276 |
| V, Vanadium (ppm)             | 70              | 4.3   | 65                    | 75    | 67                   | 73    |
| W, Tungsten (ppm)             | 26.9            | 2.40  | 25.1                  | 28.6  | 22.0                 | 31.7  |
| Y, Yttrium (ppm)              | 17.5            | 1.8   | 16.2                  | 18.8  | IND                  | IND   |
| Zn, Zinc (ppm)                | 591             | 32.5  | 577                   | 605   | 570                  | 612   |
| Zr, Zirconium (ppm)           | 73              | 4.9   | 67                    | 79    | 69                   | 76    |
| Aqua Regia Digestion          |                 |       |                       |       |                      |       |
| Ag, Silver (ppm)              | 21.96           | 3.08  | 20.54                 | 23.37 | 19.81                | 24.10 |
| Al, Aluminium (wt.%)          | 2.42            | 0.169 | 2.20                  | 2.63  | 2.25                 | 2.58  |
| As, Arsenic (ppm)             | 12.3            | 1.7   | 11.6                  | 13.0  | 10.7                 | 13.9  |
| Ba, Barium (ppm)              | 42.8            | 2.20  | 40.0                  | 45.5  | 40.1                 | 45.4  |
| Bi, Bismuth (ppm)             | 322             | 21.2  | 311                   | 333   | 307                  | 336   |
| Ca, Calcium (wt.%)            | 0.333           | 0.012 | 0.322                 | 0.345 | 0.308                | 0.358 |
| Co, Cobalt (ppm)              | 61              | 5.1   | 58                    | 64    | 59                   | 63    |
| Cr, Chromium (ppm)            | 30.9            | 2.46  | 27.7                  | 34.0  | 29.9                 | 31.9  |
| Cu, Copper (wt.%)             | 6.11            | 0.225 | 6.02                  | 6.20  | 5.91                 | 6.32  |
| Fe, Iron (wt.%)               | 13.95           | 0.929 | 13.49                 | 14.41 | 13.58                | 14.31 |
| K, Potassium (wt.%)           | 0.258           | 0.021 | 0.230                 | 0.286 | 0.242                | 0.274 |
| Mg, Magnesium (wt.%)          | 1.15            | 0.086 | 1.04                  | 1.27  | 1.11                 | 1.19  |
| Mn, Manganese (wt.%)          | 0.083           | 0.004 | 0.079                 | 0.088 | 0.079                | 0.088 |
| Mo, Molybdenum (ppm)          | < 2             | IND   | IND                   | IND   | IND                  | IND   |
| Na, Sodium (wt.%)             | < 0.03          | IND   | IND                   | IND   | IND                  | IND   |
| Ni, Nickel (ppm)              | 28.2            | 3.5   | 23.5                  | 32.8  | 26.6                 | 29.7  |
| Pb, Lead (ppm)                | 182             | 12.7  | 176                   | 188   | 174                  | 190   |
| S, Sulphur (wt.%)             | 5.89            | 1.14  | 5.21                  | 6.57  | 5.65                 | 6.13  |
| Sb, Antimony (ppm)            | < 1.5           | IND   | IND                   | IND   | IND                  | IND   |
| Se, Selenium (ppm)            | 63              | 7     | 59                    | 67    | 60                   | 66    |
| Sn, Tin (ppm)                 | 51              | 5     | 48                    | 54    | 50                   | 52    |
| Sr, Strontium (ppm)           | 19.1            | 1.67  | 16.9                  | 21.2  | 17.6                 | 20.5  |
| Ti, Titanium (wt.%)           | 0.059           | 0.012 | 0.043                 | 0.075 | 0.049                | 0.068 |
| W, Tungsten (ppm)             | 21.8            | 3.2   | 18.0                  | 25.7  | IND                  | IND   |
| Zn, Zinc (ppm)                | 579             | 42.4  | 559                   | 599   | 564                  | 595   |
| Infrared Combustion           |                 |       |                       |       |                      |       |
| S, Sulphur (wt.%)             | 7.11            | 0.325 | 6.99                  | 7.23  | 6.87                 | 7.35  |
| Borate Fusion XRF             |                 |       |                       |       |                      |       |
| Co, Cobalt (ppm)              | < 100           | IND   | IND                   | IND   | IND                  | IND   |
| Cu, Copper (wt.%)             | 6.19            | 0.269 | 6.03                  | 6.35  | 6.02                 | 6.36  |
| Fe2O3, Iron(III) oxide (wt.%) | 20.93           | 0.636 | 20.52                 | 21.34 | 20.52                | 21.34 |
| Pb, Lead (ppm)                | 200             | 34    | 172                   | 228   | IND                  | IND   |
| S, Sulphur (wt.%)             | 7.17            | 0.122 | 7.10                  | 7.24  | 6.95                 | 7.38  |
| SiO2, Silicon dioxide (wt.%)  | 48.53           | 0.597 | 48.07                 | 49.00 | 47.64                | 49.43 |
| Zn, Zinc (ppm)                | 599             | 15.4  | 590                   | 608   | 561                  | 637   |

Table 1 continued.

| Constituent         | Certified Value | 1SD   | 95% Confidence Limits |       | 95% Tolerance Limits |       |
|---------------------|-----------------|-------|-----------------------|-------|----------------------|-------|
|                     |                 |       | Low                   | High  | Low                  | High  |
| Peroxide Fusion ICP |                 |       |                       |       |                      |       |
| Ag, Silver (ppm)    | 23.00           | 4.03  | 19.04                 | 26.95 | IND                  | IND   |
| As, Arsenic (ppm)   | < 20            | IND   | IND                   | IND   | IND                  | IND   |
| Bi, Bismuth (ppm)   | 337             | 22.7  | 324                   | 350   | 313                  | 361   |
| Co, Cobalt (ppm)    | 62              | 8     | 57                    | 67    | 60                   | 65    |
| Cu, Copper (wt.%)   | 6.17            | 0.199 | 6.08                  | 6.26  | 5.98                 | 6.36  |
| Fe, Iron (wt.%)     | 14.76           | 0.626 | 14.44                 | 15.07 | 14.43                | 15.08 |
| Pb, Lead (ppm)      | 195             | 12.0  | 187                   | 204   | 180                  | 210   |
| S, Sulphur (wt.%)   | 7.19            | 0.222 | 7.09                  | 7.30  | 6.93                 | 7.46  |
| Sb, Antimony (ppm)  | 2.11            | 0.38  | 1.85                  | 2.36  | IND                  | IND   |
| Se, Selenium (ppm)  | 73              | 7.3   | 68                    | 79    | 67                   | 80    |
| Si, Silicon (wt.%)  | 22.92           | 0.429 | 22.62                 | 23.21 | 21.60                | 24.23 |
| Sn, Tin (ppm)       | 67              | 5.7   | 63                    | 71    | 63                   | 71    |
| Zn, Zinc (ppm)      | 590             | 21.9  | 579                   | 601   | 565                  | 615   |

Note: intervals may appear asymmetric due to rounding

## INTRODUCTION

OREAS reference materials are intended to provide a low cost method of evaluating and improving the quality of analysis of geological samples. 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. To the analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures.

## SOURCE MATERIAL

OREAS 932 is one of a suite of sixteen copper CRMs (OREAS 920 to OREAS 935) prepared from material from the CSA mine located near the town of Cobar in central western New South Wales, Australia. The copper ore body is hosted by the Early Devonian CSA Siltstone, a thinly bedded turbiditic sequence of carbonaceous siltstones and mudstones with minor coarser units. The CSA Siltstone is part of the Cobar Supergroup, consisting of lower syn-rift sediments and upper post-rift sag phase sediments. The mineralisation is structurally controlled and confined to a number of steeply dipping bodies within a major shear zone on the eastern margin of the Early Devonian Cobar Basin. It is characterised by low-grade greenschist alteration and epigenetic low-grade mineralisation enveloping higher-grade shoots of vein complexes or sub-massive to massive sulphides. The sulphides include chalcopyrite, pyrrhotite, pyrite, sphalerite, galena, bornite and cubanite. Iron-rich chlorite and silica are prominent alterations in the siltstone host.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 932 was prepared in the following manner:

- drying to constant mass at 105°C;
- preliminary blending of copper ores and barren siltstone materials;
- multi-stage milling to approximately 99% less than 75 microns;
- final homogenisation;
- packaging in 10g units sealed under nitrogen, in laminated foil pouches.

## ANALYTICAL PROGRAM

Twenty two commercial analytical laboratories participated in the program to characterise the analytes reported in Table 1. The following methods were employed for method specific certification:

- Four acid (HCl-HNO<sub>3</sub>-HF-HClO<sub>4</sub>) digestion with ICP-OES, ICP-MS or AAS finish (21 laboratories);
- Aqua regia digestion with ICP-OES, ICP-MS or AAS finish (20 laboratories);
- Infrared combustion furnace for sulphur (19 laboratories);
- Borate or pyro-sulphate fusion with XRF (12 laboratories);
- Peroxide fusion with ICP-OES, ICP-MS or AAS finish (16 laboratories).

For the round robin program ten 300g test units were taken at predetermined intervals during the bagging stage, immediately following final homogenisation, and are considered representative of the entire batch. The six samples received by each laboratory were obtained by taking two 20g scoop splits from each of three separate 300g test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e. to ascertain whether between-unit variance is greater than within-unit variance. Table 1 presents the certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 shows indicative values. Table 3 provides performance gate intervals for the certified values of each analytical method group based on their pooled 1SD's. Tabulated results of all elements together with uncorrected means, medians, standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM<sup>3</sup>) are presented in the detailed certification data for this CRM (**Datapak for OREAS 932.xlsx**).

**Table 2. Indicative Values for OREAS 932**

| Constituent             | Unit | Value | Constituent | Unit | Value | Constituent | Unit | Value |
|-------------------------|------|-------|-------------|------|-------|-------------|------|-------|
| <b>4-Acid Digestion</b> |      |       |             |      |       |             |      |       |
| Au                      | ppm  | < 0.1 | Ge          | ppm  | 0.30  | Sm          | ppm  | 4.91  |
| Ba                      | ppm  | 91    | Hf          | ppm  | 2.12  | Ta          | ppm  | 0.86  |
| Ce                      | ppm  | 59    | Ho          | ppm  | 0.60  | Tb          | ppm  | 0.55  |
| Cs                      | ppm  | 5.96  | In          | ppm  | 4.96  | Te          | ppm  | 0.17  |
| Dy                      | ppm  | 3.02  | Lu          | ppm  | 0.25  | Tl          | ppm  | 0.62  |
| Er                      | ppm  | 1.70  | Nd          | ppm  | 26.8  | U           | ppm  | 2.23  |
| Eu                      | ppm  | 0.93  | Pr          | ppm  | 7.00  | Yb          | ppm  | 1.62  |
| Ga                      | ppm  | 15.8  | Rb          | ppm  | 112   |             |      |       |
| Gd                      | ppm  | 3.70  | Re          | ppb  | < 5   |             |      |       |

Table 2 continued.

| Constituent                    | Unit  | Value | Constituent                   | Unit  | Value | Constituent                   | Unit  | Value |
|--------------------------------|-------|-------|-------------------------------|-------|-------|-------------------------------|-------|-------|
| <b>Aqua Regia Digestion</b>    |       |       |                               |       |       |                               |       |       |
| Au                             | ppm   | 0.012 | In                            | ppm   | 4.71  | Ta                            | ppm   | 0.010 |
| B                              | ppm   | 63    | La                            | ppm   | 21.4  | Tb                            | ppm   | 0.39  |
| Be                             | ppm   | 0.51  | Li                            | ppm   | 18.3  | Te                            | ppm   | 0.15  |
| Cd                             | ppm   | 1.05  | Lu                            | ppm   | 0.14  | Th                            | ppm   | 11.6  |
| Ce                             | ppm   | 39.5  | Nb                            | ppm   | 0.45  | Tl                            | ppm   | 0.13  |
| Cs                             | ppm   | 2.46  | P                             | wt. % | 0.049 | U                             | ppm   | 1.57  |
| Ga                             | ppm   | 8.10  | Rb                            | ppm   | 16.2  | V                             | ppm   | 25.4  |
| Ge                             | ppm   | 0.24  | Re                            | ppb   | 1     | Y                             | ppm   | 9.42  |
| Hf                             | ppm   | 0.59  | Sc                            | ppm   | 3.15  | Yb                            | ppm   | 0.95  |
| Hg                             | ppm   | 0.13  | Si                            | wt. % | 10.54 | Zr                            | ppm   | 19.1  |
| <b>Infrared Combustion</b>     |       |       |                               |       |       |                               |       |       |
| C                              | wt. % | 0.028 |                               |       |       |                               |       |       |
| <b>Borate Fusion XRF</b>       |       |       |                               |       |       |                               |       |       |
| Al <sub>2</sub> O <sub>3</sub> | wt. % | 10.68 | MgO                           | wt. % | 2.29  | Sr                            | ppm   | 38.3  |
| BaO                            | ppm   | 372   | MnO                           | wt. % | 0.120 | TiO <sub>2</sub>              | wt. % | 0.447 |
| CaO                            | wt. % | 0.612 | Na <sub>2</sub> O             | wt. % | 0.247 | V <sub>2</sub> O <sub>5</sub> | ppm   | 122   |
| Cr <sub>2</sub> O <sub>3</sub> | ppm   | 113   | Ni                            | ppm   | 13.3  | Zr                            | ppm   | 93    |
| K <sub>2</sub> O               | wt. % | 2.13  | P <sub>2</sub> O <sub>5</sub> | wt. % | 0.108 |                               |       |       |
| LOI                            | wt. % | 5.31  | Sn                            | ppm   | 92    |                               |       |       |
| <b>Peroxide Fusion ICP</b>     |       |       |                               |       |       |                               |       |       |
| Al                             | wt. % | 5.70  | Ho                            | ppm   | 0.75  | Sc                            | ppm   | 9.59  |
| Ba                             | ppm   | 286   | In                            | ppm   | 5.69  | Sm                            | ppm   | 5.37  |
| Be                             | ppm   | < 5   | K                             | wt. % | 1.92  | Sr                            | ppm   | 32.6  |
| Ca                             | wt. % | 0.457 | La                            | ppm   | 33.1  | Ta                            | ppm   | 0.89  |
| Cd                             | ppm   | 1.02  | Li                            | ppm   | 21.3  | Tb                            | ppm   | 0.69  |
| Ce                             | ppm   | 68    | Lu                            | ppm   | 0.33  | Th                            | ppm   | 12.9  |
| Cr                             | ppm   | 66    | Mg                            | wt. % | 1.38  | Ti                            | wt. % | 0.296 |
| Cs                             | ppm   | 6.25  | Mn                            | wt. % | 0.097 | Tl                            | ppm   | 0.73  |
| Dy                             | ppm   | 3.97  | Mo                            | ppm   | < 2   | Tm                            | ppm   | 0.33  |
| Er                             | ppm   | 2.12  | Nb                            | ppm   | 10.5  | U                             | ppm   | 2.67  |
| Eu                             | ppm   | 1.12  | Nd                            | ppm   | 28.8  | V                             | ppm   | 67    |
| Ga                             | ppm   | 17.7  | Ni                            | ppm   | 30.3  | W                             | ppm   | 27.5  |
| Gd                             | ppm   | 4.56  | P                             | wt. % | 0.140 | Y                             | ppm   | 18.6  |
| Ge                             | ppm   | 2.61  | Pr                            | ppm   | 7.94  | Yb                            | ppm   | 1.97  |
| Hf                             | ppm   | 3.51  | Rb                            | ppm   | 122   | Zr                            | ppm   | 114   |

## STATISTICAL ANALYSIS

**Certified Values, Standard Deviations, Confidence and Tolerance Limits** have been determined for each analytical method following removal of individual and laboratory outliers (Table 1). Certified Values are the mean of means after outlier filtering. The 95% Confidence Limit is a measure of the reliability of the certified value, i.e. the narrower the Confidence Interval the greater the certainty in the Certified Value. It should not be used as a control limit for laboratory performance.

**Standard Deviation** values (1SDs) are reported in Table 1 and provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored

by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e. after removal of all individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e. the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.

**Performance Gates** (Table 3) are calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned.

A second method utilises a 5% window calculated directly from the certified value. Standard deviation is also shown in relative per cent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised 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.

**Table 3. Performance Gates for OREAS 932**

| Constituent      | Certified Value | Absolute Standard Deviations |         |          |         |          | Relative Standard Deviations |        |        | 5% window |       |
|------------------|-----------------|------------------------------|---------|----------|---------|----------|------------------------------|--------|--------|-----------|-------|
|                  |                 | 1SD                          | 2SD Low | 2SD High | 3SD Low | 3SD High | 1RSD                         | 2RSD   | 3RSD   | Low       | High  |
| 4-Acid Digestion |                 |                              |         |          |         |          |                              |        |        |           |       |
| Ag, ppm          | 22.41           | 2.75                         | 16.91   | 27.92    | 14.16   | 30.67    | 12.27%                       | 24.54% | 36.81% | 21.29     | 23.54 |
| Al, wt. %        | 5.32            | 0.273                        | 4.78    | 5.87     | 4.50    | 6.14     | 5.13%                        | 10.27% | 15.40% | 5.06      | 5.59  |
| As, ppm          | 13.1            | 0.97                         | 11.1    | 15.0     | 10.2    | 16.0     | 7.45%                        | 14.90% | 22.34% | 12.4      | 13.7  |
| Be, ppm          | 1.82            | 0.31                         | 1.20    | 2.43     | 0.90    | 2.74     | 16.87%                       | 33.74% | 50.61% | 1.73      | 1.91  |
| Bi, ppm          | 324             | 22                           | 279     | 369      | 257     | 391      | 6.89%                        | 13.77% | 20.66% | 308       | 340   |
| Ca, wt. %        | 0.429           | 0.026                        | 0.376   | 0.481    | 0.350   | 0.508    | 6.12%                        | 12.24% | 18.36% | 0.408     | 0.450 |
| Cd, ppm          | < 1.2           | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Co, ppm          | 60              | 2.1                          | 56      | 64       | 53      | 66       | 3.58%                        | 7.16%  | 10.73% | 57        | 63    |
| Cr, ppm          | 53              | 6                            | 41      | 65       | 35      | 71       | 11.25%                       | 22.50% | 33.75% | 50        | 55    |
| Cu, wt. %        | 6.13            | 0.181                        | 5.77    | 6.50     | 5.59    | 6.68     | 2.95%                        | 5.90%  | 8.84%  | 5.83      | 6.44  |
| Fe, wt. %        | 14.24           | 0.648                        | 12.94   | 15.53    | 12.29   | 16.18    | 4.55%                        | 9.10%  | 13.65% | 13.52     | 14.95 |
| K, wt. %         | 1.77            | 0.135                        | 1.50    | 2.04     | 1.37    | 2.17     | 7.60%                        | 15.20% | 22.79% | 1.68      | 1.86  |
| La, ppm          | 30.7            | 3.4                          | 23.8    | 37.6     | 20.4    | 41.1     | 11.22%                       | 22.44% | 33.66% | 29.2      | 32.3  |
| Li, ppm          | 20.5            | 3.3                          | 14.0    | 27.0     | 10.7    | 30.2     | 15.90%                       | 31.80% | 47.70% | 19.4      | 21.5  |

Table 3 continued.

| Constituent                | Certified Value | Absolute Standard Deviations |         |          |         |          | Relative Standard Deviations |        |        | 5% window |       |
|----------------------------|-----------------|------------------------------|---------|----------|---------|----------|------------------------------|--------|--------|-----------|-------|
|                            |                 | 1SD                          | 2SD Low | 2SD High | 3SD Low | 3SD High | 1RSD                         | 2RSD   | 3RSD   | Low       | High  |
| 4-Acid Digestion continued |                 |                              |         |          |         |          |                              |        |        |           |       |
| Mg, wt.%                   | 1.29            | 0.089                        | 1.11    | 1.47     | 1.03    | 1.56     | 6.87%                        | 13.74% | 20.61% | 1.23      | 1.36  |
| Mn, wt.%                   | 0.088           | 0.005                        | 0.078   | 0.098    | 0.073   | 0.103    | 5.66%                        | 11.31% | 16.97% | 0.084     | 0.093 |
| Mo, ppm                    | < 2             | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Na, wt.%                   | 0.179           | 0.010                        | 0.160   | 0.198    | 0.151   | 0.208    | 5.32%                        | 10.64% | 15.96% | 0.170     | 0.188 |
| Nb, ppm                    | 9.50            | 0.865                        | 7.77    | 11.23    | 6.91    | 12.10    | 9.10%                        | 18.20% | 27.30% | 9.03      | 9.98  |
| Ni, ppm                    | 27.4            | 2.70                         | 22.0    | 32.8     | 19.3    | 35.5     | 9.84%                        | 19.67% | 29.51% | 26.0      | 28.8  |
| P, wt.%                    | 0.045           | 0.004                        | 0.037   | 0.054    | 0.032   | 0.058    | 9.50%                        | 19.00% | 28.51% | 0.043     | 0.048 |
| Pb, ppm                    | 184             | 11                           | 162     | 207      | 150     | 218      | 6.18%                        | 12.36% | 18.53% | 175       | 194   |
| S, wt.%                    | 6.13            | 0.79                         | 4.54    | 7.71     | 3.75    | 8.51     | 12.93%                       | 25.86% | 38.79% | 5.82      | 6.43  |
| Sb, ppm                    | 1.98            | 0.21                         | 1.57    | 2.39     | 1.36    | 2.60     | 10.42%                       | 20.84% | 31.26% | 1.88      | 2.08  |
| Sc, ppm                    | < 20            | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Se, ppm                    | 67              | 4.8                          | 57      | 77       | 53      | 81       | 7.15%                        | 14.31% | 21.46% | 64        | 70    |
| Sn, ppm                    | 58              | 6                            | 46      | 70       | 40      | 76       | 10.37%                       | 20.75% | 31.12% | 55        | 61    |
| Sr, ppm                    | 33.7            | 3.5                          | 26.7    | 40.6     | 23.3    | 44.1     | 10.31%                       | 20.62% | 30.93% | 32.0      | 35.4  |
| Th, ppm                    | 11.0            | 1.1                          | 8.7     | 13.2     | 7.6     | 14.3     | 10.24%                       | 20.48% | 30.72% | 10.4      | 11.5  |
| Ti, wt.%                   | 0.261           | 0.021                        | 0.219   | 0.304    | 0.197   | 0.325    | 8.16%                        | 16.32% | 24.48% | 0.248     | 0.274 |
| V, ppm                     | 70              | 4.3                          | 62      | 79       | 57      | 83       | 6.11%                        | 12.21% | 18.32% | 67        | 74    |
| W, ppm                     | 26.9            | 2.40                         | 22.1    | 31.7     | 19.7    | 34.1     | 8.94%                        | 17.88% | 26.81% | 25.5      | 28.2  |
| Y, ppm                     | 17.5            | 1.8                          | 14.0    | 21.0     | 12.2    | 22.8     | 10.05%                       | 20.11% | 30.16% | 16.6      | 18.4  |
| Zn, ppm                    | 591             | 32                           | 526     | 656      | 493     | 688      | 5.50%                        | 11.00% | 16.50% | 561       | 620   |
| Zr, ppm                    | 73              | 4.9                          | 63      | 82       | 58      | 87       | 6.69%                        | 13.38% | 20.08% | 69        | 76    |
| Aqua Regia Digestion       |                 |                              |         |          |         |          |                              |        |        |           |       |
| Ag, ppm                    | 21.96           | 3.08                         | 15.81   | 28.11    | 12.73   | 31.18    | 14.01%                       | 28.01% | 42.02% | 20.86     | 23.05 |
| Al, wt.%                   | 2.42            | 0.169                        | 2.08    | 2.75     | 1.91    | 2.92     | 7.00%                        | 14.00% | 21.01% | 2.29      | 2.54  |
| As, ppm                    | 12.3            | 1.7                          | 8.9     | 15.7     | 7.2     | 17.4     | 13.82%                       | 27.63% | 41.45% | 11.7      | 12.9  |
| Ba, ppm                    | 42.8            | 2.20                         | 38.4    | 47.2     | 36.2    | 49.4     | 5.13%                        | 10.27% | 15.40% | 40.6      | 44.9  |
| Bi, ppm                    | 322             | 21                           | 280     | 364      | 258     | 385      | 6.57%                        | 13.14% | 19.71% | 306       | 338   |
| Ca, wt.%                   | 0.333           | 0.012                        | 0.310   | 0.357    | 0.298   | 0.368    | 3.50%                        | 7.00%  | 10.50% | 0.317     | 0.350 |
| Co, ppm                    | 61              | 5.1                          | 51      | 71       | 46      | 76       | 8.41%                        | 16.81% | 25.22% | 58        | 64    |
| Cr, ppm                    | 30.9            | 2.46                         | 26.0    | 35.8     | 23.5    | 38.2     | 7.96%                        | 15.92% | 23.88% | 29.3      | 32.4  |
| Cu, wt.%                   | 6.11            | 0.225                        | 5.66    | 6.56     | 5.44    | 6.79     | 3.68%                        | 7.37%  | 11.05% | 5.81      | 6.42  |
| Fe, wt.%                   | 13.95           | 0.929                        | 12.09   | 15.81    | 11.16   | 16.74    | 6.66%                        | 13.32% | 19.98% | 13.25     | 14.65 |



Table 3 continued.

| Constituent                           | Certified Value | Absolute Standard Deviations |         |          |         |          | Relative Standard Deviations |        |        | 5% window |       |
|---------------------------------------|-----------------|------------------------------|---------|----------|---------|----------|------------------------------|--------|--------|-----------|-------|
|                                       |                 | 1SD                          | 2SD Low | 2SD High | 3SD Low | 3SD High | 1RSD                         | 2RSD   | 3RSD   | Low       | High  |
| Aqua Regia Digestion continued        |                 |                              |         |          |         |          |                              |        |        |           |       |
| K, wt.%                               | 0.258           | 0.021                        | 0.216   | 0.300    | 0.196   | 0.321    | 8.08%                        | 16.17% | 24.25% | 0.245     | 0.271 |
| Mg, wt.%                              | 1.15            | 0.086                        | 0.98    | 1.32     | 0.89    | 1.41     | 7.48%                        | 14.97% | 22.45% | 1.09      | 1.21  |
| Mn, wt.%                              | 0.083           | 0.004                        | 0.075   | 0.092    | 0.071   | 0.096    | 4.98%                        | 9.97%  | 14.95% | 0.079     | 0.087 |
| Mo, ppm                               | < 2             | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Na, wt.%                              | < 0.03          | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Ni, ppm                               | 28.2            | 3.5                          | 21.2    | 35.2     | 17.6    | 38.7     | 12.45%                       | 24.89% | 37.34% | 26.8      | 29.6  |
| Pb, ppm                               | 182             | 13                           | 156     | 207      | 144     | 220      | 6.98%                        | 13.96% | 20.94% | 173       | 191   |
| S, wt.%                               | 5.89            | 1.14                         | 3.62    | 8.16     | 2.48    | 9.30     | 19.29%                       | 38.57% | 57.86% | 5.59      | 6.18  |
| Sb, ppm                               | < 1.5           | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Se, ppm                               | 63              | 7                            | 49      | 77       | 41      | 84       | 11.36%                       | 22.71% | 34.07% | 60        | 66    |
| Sn, ppm                               | 51              | 5                            | 41      | 61       | 36      | 67       | 10.07%                       | 20.15% | 30.22% | 49        | 54    |
| Sr, ppm                               | 19.1            | 1.67                         | 15.7    | 22.4     | 14.1    | 24.1     | 8.75%                        | 17.51% | 26.26% | 18.1      | 20.0  |
| Ti, wt.%                              | 0.059           | 0.012                        | 0.035   | 0.083    | 0.023   | 0.095    | 20.43%                       | 40.85% | 61.28% | 0.056     | 0.062 |
| W, ppm                                | 21.8            | 3.2                          | 15.4    | 28.2     | 12.2    | 31.4     | 14.63%                       | 29.27% | 43.90% | 20.7      | 22.9  |
| Zn, ppm                               | 579             | 42                           | 494     | 664      | 452     | 706      | 7.32%                        | 14.63% | 21.95% | 550       | 608   |
| Infrared Combustion                   |                 |                              |         |          |         |          |                              |        |        |           |       |
| S, wt.%                               | 7.11            | 0.325                        | 6.46    | 7.76     | 6.14    | 8.08     | 4.57%                        | 9.14%  | 13.70% | 6.75      | 7.47  |
| Borate Fusion XRF                     |                 |                              |         |          |         |          |                              |        |        |           |       |
| Co, ppm                               | < 100           | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Cu, wt.%                              | 6.19            | 0.269                        | 5.65    | 6.73     | 5.38    | 7.00     | 4.35%                        | 8.69%  | 13.04% | 5.88      | 6.50  |
| Fe <sub>2</sub> O <sub>3</sub> , wt.% | 20.93           | 0.636                        | 19.66   | 22.20    | 19.03   | 22.84    | 3.04%                        | 6.07%  | 9.11%  | 19.89     | 21.98 |
| Pb, ppm                               | 200             | 34                           | 133     | 268      | 99      | 301      | 16.86%                       | 33.72% | 50.58% | 190       | 210   |
| S, wt.%                               | 7.17            | 0.122                        | 6.92    | 7.41     | 6.80    | 7.53     | 1.70%                        | 3.39%  | 5.09%  | 6.81      | 7.53  |
| SiO <sub>2</sub> , wt.%               | 48.53           | 0.597                        | 47.34   | 49.73    | 46.74   | 50.33    | 1.23%                        | 2.46%  | 3.69%  | 46.11     | 50.96 |
| Zn, ppm                               | 599             | 15                           | 568     | 630      | 553     | 645      | 2.58%                        | 5.15%  | 7.73%  | 569       | 629   |
| Peroxide Fusion ICP                   |                 |                              |         |          |         |          |                              |        |        |           |       |
| Ag, ppm                               | 23.00           | 4.03                         | 14.93   | 31.06    | 10.90   | 35.10    | 17.54%                       | 35.08% | 52.61% | 21.85     | 24.15 |
| As, ppm                               | < 20            | IND                          | IND     | IND      | IND     | IND      | IND                          | IND    | IND    | IND       | IND   |
| Bi, ppm                               | 337             | 23                           | 292     | 383      | 269     | 405      | 6.73%                        | 13.47% | 20.20% | 320       | 354   |
| Co, ppm                               | 62              | 8                            | 46      | 79       | 37      | 87       | 13.33%                       | 26.65% | 39.98% | 59        | 65    |
| Cu, wt.%                              | 6.17            | 0.199                        | 5.77    | 6.57     | 5.57    | 6.76     | 3.22%                        | 6.44%  | 9.66%  | 5.86      | 6.48  |
| Fe, wt.%                              | 14.76           | 0.626                        | 13.51   | 16.01    | 12.88   | 16.63    | 4.24%                        | 8.48%  | 12.72% | 14.02     | 15.50 |



Table 3 continued.

| Constituent                   | Certified Value | Absolute Standard Deviations |         |          |         |          | Relative Standard Deviations |        |        | 5% window |       |
|-------------------------------|-----------------|------------------------------|---------|----------|---------|----------|------------------------------|--------|--------|-----------|-------|
|                               |                 | 1SD                          | 2SD Low | 2SD High | 3SD Low | 3SD High | 1RSD                         | 2RSD   | 3RSD   | Low       | High  |
| Peroxide Fusion ICP continued |                 |                              |         |          |         |          |                              |        |        |           |       |
| Pb, ppm                       | 195             | 12                           | 171     | 219      | 159     | 231      | 6.15%                        | 12.30% | 18.44% | 185       | 205   |
| S, wt.%                       | 7.19            | 0.222                        | 6.75    | 7.64     | 6.53    | 7.86     | 3.09%                        | 6.18%  | 9.27%  | 6.83      | 7.55  |
| Sb, ppm                       | 2.11            | 0.38                         | 1.34    | 2.87     | 0.96    | 3.26     | 18.17%                       | 36.33% | 54.50% | 2.00      | 2.21  |
| Se, ppm                       | 73              | 7.3                          | 59      | 88       | 52      | 95       | 9.96%                        | 19.93% | 29.89% | 70        | 77    |
| Si, wt.%                      | 22.92           | 0.429                        | 22.06   | 23.77    | 21.63   | 24.20    | 1.87%                        | 3.74%  | 5.61%  | 21.77     | 24.06 |
| Sn, ppm                       | 67              | 5.7                          | 55      | 78       | 50      | 84       | 8.52%                        | 17.03% | 25.55% | 64        | 70    |
| Zn, ppm                       | 590             | 22                           | 546     | 634      | 524     | 656      | 3.71%                        | 7.42%  | 11.13% | 560       | 619   |

Note: intervals may appear asymmetric due to rounding

**Tolerance Limits** (ISO Guide 3207) were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for copper by 4-acid digestion, where 99% of the time ( $1-\alpha=0.99$ ) at least 95% of subsamples ( $p=0.95$ ) will have concentrations lying between 5.97 and 6.29 wt.%. 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 homogeneity of OREAS 932 has also been evaluated in an ANOVA study for all certified analytes. This study tests the null hypothesis that no statistically significant difference exists between the *between-unit variance* and the *within-unit variance* (i.e. p-values  $<0.05$  indicate rejection of the null hypothesis). Of the 81 certified values, no failures were observed indicating no evidence to reject the null hypothesis.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 932 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

## PREPARER AND SUPPLIER OF THE REFERENCE MATERIAL

Reference material OREAS 932 has been prepared and certified by:

ORE Research & Exploration Pty Ltd  
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AUSTRALIA

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Web: [www.ore.com.au](http://www.ore.com.au)  
Email: [info@ore.com.au](mailto:info@ore.com.au)

It has been packaged in 10g units sealed under nitrogen in laminated foil pouches.

## **PARTICIPATING LABORATORIES**

Accurassay, Thunder Bay, ON, Canada  
Acme, Santiago, Chile  
Acme, Vancouver, BC, Canada  
Actlabs, Ancaster, Ontario, Canada  
Actlabs, Kamloops, BC, Canada  
Actlabs, Thunder Bay, Ontario, Canada  
ALS, Brisbane, QLD, Australia  
ALS, Burnie, TAS, Australia  
ALS, Loughrea, County Galway, Ireland  
ALS, Vancouver, BC, Canada  
Amdel (BV), Cardiff, NSW, Australia  
Intertek Genalysis, Perth, WA, Australia  
Intertek Testing Services, Adelaide, SA, Australia  
Intertek Testing Services, Beijing, China  
Intertek Testing Services, Jakarta Selatan, Indonesia  
Intertek Genalysis, Johannesburg, Sth Africa  
Intertek Testing Services, Muntinlupa, Philippines  
Labtium Oy, Rovaniemi, Finland  
MINTEK, Randburg, Sth Africa  
PT. Geoservices, Cikarang, Indonesia  
SGS, Booyssens, Gauteng, South Africa  
SGS Didipio, Makati City, Philippines  
SGS, Lakefield, Ontario, Canada  
SGS Nui Phao, Ha Noi, Vietnam  
SGS, Vancouver, BC, Canada  
SGS, Vespasiano, MG, Brazil  
Shiva Analyticals, Bangalore North, Karnataka, India  
Ultra Trace (BV), Perth, WA, Australia

## **INTENDED USE**

OREAS 932 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of geological samples for the analytes reported in Table 1;
- for the verification of analytical methods for analytes reported in Table 1;
- for the calibration of instruments used in the determination of the concentration of analytes reported in Table 1.

## **STABILITY AND STORAGE INSTRUCTIONS**

OREAS 932 has been prepared from mineralised and altered carbonaceous siltstones and mudstones from the CSA mine located near the town of Cobar in central western New South Wales, Australia. To prolong its shelf life it has been packaged under nitrogen in

robust foil laminate pouches. Under normal storage conditions it is considered to have long-term stability beyond 10 years.

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

The certified values for OREAS 932 refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

## **HANDLING INSTRUCTIONS**

Fine powders pose a risk to eyes and lungs and therefore standard precautions such as the use of safety glasses and dust masks are advised.

## **LEGAL NOTICE**

Ore Research & Exploration Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The Purchaser by receipt hereof releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

## **CERTIFYING OFFICER**

Craig Hamlyn (B.Sc. Hons - Geology), Technical Manager – (ORE P/L)

## **REFERENCES**

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

ISO Guide 35 (2006), Certification of reference materials - General and statistical principals.