**ORE RESEARCH & EXPLORATION P/L** ABN 28 006 859 856
37A Hosie Street · Bayswater North · VIC 3153 · AUSTRALIA
61 3 9729 0333 Fx 61 3 9729 8338
info@ore.com.au www.ore.com.au

**CERTIFICATE OF ANALYSIS FOR**

## LATERITIC NICKEL-COBALT ORE
## CERTIFIED REFERENCE MATERIAL
# OREAS 181

**Table 1. Certified Values, SDs, 95% Confidence and Tolerance Limits for OREAS 181.**

| Constituent | Certified Value | 1SD | 95% Confidence Limits | | 95% Tolerance Limits | |
|---|---|---|---|---|---|---|
| | | | Low | High | Low | High |
| **Borate Fusion XRF** | | | | | | |
| $Al_2O_3$, Aluminium(III) oxide (wt.%) | 11.56 | 0.118 | 11.49 | 11.62 | 11.50 | 11.61 |
| CaO, Calcium oxide (wt.%) | 2.37 | 0.020 | 2.36 | 2.38 | 2.35 | 2.39 |
| Co, Cobalt (ppm) | 451 | 11 | 446 | 456 | 435 | 466 |
| $Cr_2O_3$, Chromium(III) oxide (wt.%) | 1.24 | 0.016 | 1.23 | 1.25 | 1.23 | 1.25 |
| Cu, Copper (ppm) | 74 | 13 | 66 | 82 | IND | IND |
| $Fe_2O_3$, Iron(III) oxide (wt.%) | 35.94 | 0.205 | 35.85 | 36.04 | 35.79 | 36.09 |
| $K_2O$, Potassium oxide (wt.%) | 0.132 | 0.005 | 0.129 | 0.135 | 0.130 | 0.135 |
| MgO, Magnesium oxide (wt.%) | 2.05 | 0.041 | 2.03 | 2.08 | 2.03 | 2.08 |
| MnO, Manganese oxide (wt.%) | 0.168 | 0.005 | 0.166 | 0.171 | 0.166 | 0.171 |
| $Na_2O$, Sodium oxide (wt.%) | 0.448 | 0.020 | 0.436 | 0.459 | 0.431 | 0.465 |
| Ni, Nickel (ppm) | 5123 | 59 | 5091 | 5155 | 5071 | 5175 |
| $P_2O_5$, Phosphorus(V) oxide (wt.%) | 0.017 | 0.003 | 0.015 | 0.018 | IND | IND |
| $SiO_2$, Silicon dioxide (wt.%) | 33.79 | 0.114 | 33.74 | 33.83 | 33.60 | 33.97 |
| $SO_3$, Sulphur trioxide (wt.%) | 0.189 | 0.008 | 0.181 | 0.197 | 0.182 | 0.196 |
| $TiO_2$, Titanium dioxide (wt.%) | 0.339 | 0.008 | 0.335 | 0.343 | 0.331 | 0.347 |
| Zn, Zinc (ppm) | 96 | 7.8 | 91 | 102 | IND | IND |
| **Thermogravimetry** | | | | | | |
| $LOI^{1000}$, Loss On Ignition @1000°C (wt.%) | 11.26 | 0.339 | 11.06 | 11.46 | 11.20 | 11.32 |
| **Borate / Peroxide Fusion ICP** | | | | | | |
| $Al_2O_3$, Aluminium(III) oxide (wt.%) | 11.31 | 0.352 | 11.10 | 11.52 | 11.09 | 11.52 |
| Ba, Barium (ppm) | 135 | 9 | 130 | 139 | 129 | 141 |
| CaO, Calcium oxide (wt.%) | 2.37 | 0.106 | 2.31 | 2.43 | 2.32 | 2.42 |
| Cd, Cadmium (ppm) | < 10 | IND | IND | IND | IND | IND |
| Ce, Cerium (ppm) | 12.3 | 1.2 | 11.0 | 13.7 | 11.9 | 12.8 |
| Co, Cobalt (ppm) | 451 | 10 | 447 | 454 | 441 | 461 |
| $Cr_2O_3$, Chromium(III) oxide (wt.%) | 1.23 | 0.043 | 1.20 | 1.25 | 1.20 | 1.25 |
| Cs, Cesium (ppm) | 0.57 | 0.035 | 0.55 | 0.59 | 0.52 | 0.62 |
| Cu, Copper (ppm) | 77 | 4.4 | 74 | 80 | 73 | 81 |
| Eu, Europium (ppm) | 0.43 | 0.08 | 0.34 | 0.52 | IND | IND |
| $Fe_2O_3$, Iron(III) oxide (wt.%) | 35.34 | 0.895 | 34.83 | 35.86 | 34.71 | 35.97 |
| Ga, Gallium (ppm) | 10.5 | 0.79 | 9.7 | 11.2 | 9.7 | 11.2 |
| Gd, Gadolinium (ppm) | 1.35 | 0.21 | 1.12 | 1.57 | 1.20 | 1.49 |
| Hf, Hafnium (ppm) | 1.74 | 0.22 | 1.46 | 2.02 | IND | IND |
| Ho, Holmium (ppm) | 0.27 | 0.03 | 0.24 | 0.29 | IND | IND |
| $K_2O$, Potassium oxide (wt.%) | 0.125 | 0.015 | 0.116 | 0.133 | 0.109 | 0.141 |
| La, Lanthanum (ppm) | 4.04 | 0.58 | 3.42 | 4.66 | 3.73 | 4.35 |
| Li, Lithium (ppm) | 12.3 | 1.6 | 10.7 | 13.9 | IND | IND |
| MgO, Magnesium oxide (wt.%) | 2.01 | 0.062 | 1.97 | 2.05 | 1.97 | 2.05 |
| MnO, Manganese oxide (wt.%) | 0.166 | 0.007 | 0.162 | 0.169 | 0.160 | 0.172 |
| Mo, Molybdenum (ppm) | < 5 | IND | IND | IND | IND | IND |
| $Na_2O$, Sodium oxide (wt.%) | 0.420 | 0.036 | 0.380 | 0.460 | 0.404 | 0.436 |

Note: intervals may appear asymmetric due to rounding

**Table 1 continued.**

| Constituent | Certified Value | 1SD | 95% Confidence Limits | | 95% Tolerance Limits | |
|---|---|---|---|---|---|---|
| | | | Low | High | Low | High |
| **Borate / Peroxide Fusion ICP continued** | | | | | | |
| Nb, Niobium (ppm) | 1.96 | 0.38 | 1.63 | 2.30 | IND | IND |
| Nd, Neodymium (ppm) | 5.30 | 0.53 | 4.87 | 5.72 | 4.68 | 5.91 |
| Ni, Nickel (ppm) | 5048 | 126 | 5012 | 5084 | 4914 | 5182 |
| Pr, Praseodymium (ppm) | 1.29 | 0.17 | 1.15 | 1.43 | IND | IND |
| Rb, Rubidium (ppm) | 5.61 | 0.384 | 5.38 | 5.84 | 5.35 | 5.87 |
| S, Sulphur (wt.%) | 0.071 | 0.006 | 0.067 | 0.074 | IND | IND |
| Sb, Antimony (ppm) | 1.19 | 0.16 | 1.10 | 1.28 | IND | IND |
| Sc, Scandium (ppm) | 38.2 | 1.27 | 37.4 | 38.9 | 36.5 | 39.8 |
| $SiO_2$, Silicon dioxide (wt.%) | 33.32 | 1.050 | 32.64 | 34.01 | 32.63 | 34.02 |
| Sm, Samarium (ppm) | 1.36 | 0.22 | 1.15 | 1.57 | IND | IND |
| Sr, Strontium (ppm) | 87 | 5.1 | 84 | 90 | 85 | 89 |
| Tb, Terbium (ppm) | 0.22 | 0.04 | 0.20 | 0.25 | IND | IND |
| Th, Thorium (ppm) | 2.72 | 0.128 | 2.60 | 2.83 | 2.58 | 2.85 |
| $TiO_2$, Titanium dioxide (wt.%) | 0.333 | 0.015 | 0.325 | 0.341 | 0.322 | 0.344 |
| U, Uranium (ppm) | 0.98 | 0.073 | 0.93 | 1.03 | 0.82 | 1.14 |
| V, Vanadium (ppm) | 146 | 15 | 135 | 157 | 137 | 154 |
| W, Tungsten (ppm) | 3.22 | 0.38 | 2.95 | 3.50 | IND | IND |
| Y, Yttrium (ppm) | 5.73 | 0.64 | 5.39 | 6.07 | 5.47 | 6.00 |
| Yb, Ytterbium (ppm) | 0.89 | 0.080 | 0.84 | 0.94 | IND | IND |
| Zn, Zinc (ppm) | 100 | 10 | 91 | 108 | 92 | 107 |
| Zr, Zirconium (ppm) | 61 | 4.9 | 57 | 66 | 59 | 64 |
| **Infrared Combustion** | | | | | | |
| C, Carbon (wt.%) | 0.653 | 0.028 | 0.635 | 0.671 | 0.640 | 0.665 |
| S, Sulphur (wt.%) | 0.059 | 0.012 | 0.052 | 0.067 | 0.055 | 0.064 |
| **Gas / Liquid Pycnometry** | | | | | | |
| SG, Specific Gravity (Unity) | 2.87 | 0.155 | 2.74 | 3.00 | 2.82 | 2.91 |

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 MATERIALS

OREAS 181 has been prepared from a blend of low and high grade Ni-Co lateritic ores sourced from the Bulong deposit located 35km east of Kalgoorlie in Western Australia. This ore formed from prolonged lateritic weathering of Archaean (Yilgarn Craton) olivine rich ultramafic/komatiite flows. Grades of >1% Ni were generated in zones of more intense weathering associated with faulting and bedrock alteration. The Ni-Co nontronitic (Fe-Ni smectite clays) siliceous ores at Bulong formed with a goethitic overprint in the upper laterite profile.

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 181 was prepared in the following manner:

- drying to constant mass at 105°C;
- crushing and milling to 100% minus 35 microns;
- preliminary homogenisation and check assaying of low and high grade source materials;
- final homogenisation by blending the source materials in specific ratios to achieve target grades;
- packaging in 10g units sealed in laminated foil pouches and 1kg units in plastic jars.

## ANALYTICAL PROGRAM

Seventeen commercial analytical laboratories participated in the program to certify the analytes reported in Table 1. The following methods were employed:

- Borate fusion with XRF for common nickel laterite assemblage (up to 14 laboratories depening on the analyte);
- Thermogravimetric analysis of LOI at 1000°C (15 labs);
- Borate or peroxide fusion for full elemental suite ICP-OES and ICP-MS finishes (up to 15 laboratories depending on the element);
- C and S by IR combustion furnace (14 labs);
- Specific gravity by gas (6 labs) or liquid (3 labs) pycnometry.

For the round robin program ten 250g test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire 270kg batch. The six samples received by each laboratory were obtained by taking one 20g scoop split from each of six different test units. This format maximised representivity of the parent batch at each lab. Table 1 presents the 63 certified values together with their associated 1SD's, 95% confidence and tolerance limits and Table 2 below shows 26 indicative values. Table 3 provides performance gate intervals for the certified values based on their associated pooled standard deviations. Tabulated results of all elements together with analytical method codes, uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 181 DataPack.xlsx**).

**Table 2. Indicative Values for OREAS 181.**

| Constituent | Unit | Value | Constituent | Unit | Value | Constituent | Unit | Value |
|---|---|---|---|---|---|---|---|---|
| **Borate Fusion XRF** | | | | | | | | |
| As | ppm | *27.8* | Pb | ppm | *< 50* | Zr | ppm | *78* |
| BaO | ppm | *157* | Sc | ppm | *38.7* | | | |
| Cl | ppm | *699* | $V_2O_5$ | ppm | *247* | | | |
| **Borate / Peroxide Fusion ICP** | | | | | | | | |
| Ag | ppm | *< 5* | Ge | ppm | *1.85* | Sn | ppm | *1.67* |
| As | ppm | *23.9* | In | ppm | *< 0.1* | Ta | ppm | *0.16* |
| B | ppm | *75* | Lu | ppm | *0.14* | Te | ppm | *< 1* |
| Be | ppm | *< 1* | $P_2O_5$ | wt.% | *0.019* | Tl | ppm | *< 0.5* |
| Bi | ppm | *0.075* | Pb | ppm | *9.23* | Tm | ppm | *0.13* |
| Dy | ppm | *1.22* | Re | ppm | *< 0.1* | | | |
| Er | ppm | *0.78* | Se | ppm | *< 20* | | | |

Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

## STATISTICAL ANALYSIS

**Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits** (Table 1) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. In certain instances statistician's prerogative has been employed in discriminating outliers. Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status. The Certified Values are the means of accepted laboratory means after outlier filtering.

The 95% Confidence Limits are inversely proportional to the number of participating laboratories and inter-laboratory agreement. It is a measure of the reliability of the certified value. A 95% confidence interval indicates a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits. *95% Confidence Limits should not be used as control limits 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. The SD's 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 SD values thus include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability. OREAS prepared reference materials have a level of homogeneity such that the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself.

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 any 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.**

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical process and this SD is not directly related to the round robin program.

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include inter-lab bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

Table 3 shows **Performance Gates** 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 percent 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.

**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 nickel (Ni) by fusion XRF, where 99% of the time ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 5071 and 5175 ppm. 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). *Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.*

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 181 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

**Table 3. Performance Gates for OREAS 181.**

| 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 |
| **Borate Fusion XRF** | | | | | | | | | | | |
| $Al_2O_3$, wt.% | 11.56 | 0.118 | 11.32 | 11.79 | 11.20 | 11.91 | 1.02% | 2.04% | 3.06% | 10.98 | 12.13 |
| CaO, wt.% | 2.37 | 0.020 | 2.33 | 2.41 | 2.31 | 2.43 | 0.84% | 1.68% | 2.51% | 2.25 | 2.49 |
| Co, ppm | 451 | 11 | 429 | 472 | 418 | 483 | 2.41% | 4.81% | 7.22% | 428 | 473 |
| $Cr_2O_3$, wt.% | 1.24 | 0.016 | 1.21 | 1.27 | 1.19 | 1.29 | 1.32% | 2.64% | 3.95% | 1.18 | 1.30 |
| Cu, ppm | 74 | 13 | 47 | 100 | 34 | 113 | 17.89% | 35.79% | 53.68% | 70 | 77 |
| $Fe_2O_3$, wt.% | 35.94 | 0.205 | 35.53 | 36.35 | 35.33 | 36.56 | 0.57% | 1.14% | 1.71% | 34.15 | 37.74 |
| $K_2O$, wt.% | 0.132 | 0.005 | 0.122 | 0.143 | 0.116 | 0.148 | 4.00% | 8.00% | 12.01% | 0.126 | 0.139 |
| MgO, wt.% | 2.05 | 0.041 | 1.97 | 2.14 | 1.93 | 2.18 | 1.98% | 3.97% | 5.95% | 1.95 | 2.16 |
| MnO, wt.% | 0.168 | 0.005 | 0.158 | 0.179 | 0.153 | 0.184 | 3.02% | 6.04% | 9.07% | 0.160 | 0.177 |
| $Na_2O$, wt.% | 0.448 | 0.020 | 0.407 | 0.488 | 0.387 | 0.509 | 4.53% | 9.06% | 13.59% | 0.425 | 0.470 |
| Ni, ppm | 5123 | 59 | 5004 | 5242 | 4945 | 5301 | 1.16% | 2.32% | 3.48% | 4867 | 5379 |
| $P_2O_5$, wt.% | 0.017 | 0.003 | 0.011 | 0.022 | 0.008 | 0.025 | 16.77% | 33.53% | 50.30% | 0.016 | 0.018 |
| $SiO_2$, wt.% | 33.79 | 0.114 | 33.56 | 34.01 | 33.44 | 34.13 | 0.34% | 0.68% | 1.02% | 32.10 | 35.47 |
| $SO_3$, wt.% | 0.189 | 0.008 | 0.174 | 0.204 | 0.166 | 0.212 | 4.04% | 8.08% | 12.12% | 0.179 | 0.198 |
| $TiO_2$, wt.% | 0.339 | 0.008 | 0.323 | 0.354 | 0.315 | 0.362 | 2.31% | 4.62% | 6.93% | 0.322 | 0.356 |
| Zn, ppm | 96 | 7.8 | 81 | 112 | 73 | 120 | 8.07% | 16.15% | 24.22% | 92 | 101 |
| **Thermogravimetry** | | | | | | | | | | | |
| $LOI^{1000}$, wt.% | 11.26 | 0.339 | 10.59 | 11.94 | 10.25 | 12.28 | 3.01% | 6.02% | 9.02% | 10.70 | 11.83 |
| **Borate / Peroxide Fusion ICP** | | | | | | | | | | | |
| $Al_2O_3$, wt.% | 11.31 | 0.352 | 10.60 | 12.01 | 10.25 | 12.37 | 3.11% | 6.23% | 9.34% | 10.74 | 11.87 |
| Ba, ppm | 135 | 9 | 117 | 152 | 108 | 161 | 6.52% | 13.05% | 19.57% | 128 | 141 |
| CaO, wt.% | 2.37 | 0.106 | 2.16 | 2.58 | 2.05 | 2.69 | 4.47% | 8.94% | 13.41% | 2.25 | 2.49 |
| Cd, ppm | < 10 | IND | IND | IND | IND | IND | IND | IND | IND | IND | IND |
| Ce, ppm | 12.3 | 1.2 | 9.9 | 14.8 | 8.6 | 16.1 | 10.10% | 20.20% | 30.30% | 11.7 | 13.0 |
| Co, ppm | 451 | 10 | 430 | 472 | 420 | 482 | 2.32% | 4.63% | 6.95% | 428 | 473 |
| $Cr_2O_3$, wt.% | 1.23 | 0.043 | 1.14 | 1.31 | 1.10 | 1.35 | 3.47% | 6.94% | 10.42% | 1.16 | 1.29 |
| Cs, ppm | 0.57 | 0.035 | 0.50 | 0.64 | 0.46 | 0.67 | 6.20% | 12.40% | 18.60% | 0.54 | 0.60 |
| Cu, ppm | 77 | 4.4 | 68 | 86 | 64 | 90 | 5.66% | 11.32% | 16.98% | 73 | 81 |
| Eu, ppm | 0.43 | 0.08 | 0.27 | 0.59 | 0.19 | 0.67 | 18.80% | 37.61% | 56.41% | 0.41 | 0.45 |
| $Fe_2O_3$, wt.% | 35.34 | 0.895 | 33.55 | 37.13 | 32.66 | 38.03 | 2.53% | 5.06% | 7.59% | 33.57 | 37.11 |
| Ga, ppm | 10.5 | 0.79 | 8.9 | 12.0 | 8.1 | 12.8 | 7.58% | 15.16% | 22.74% | 9.9 | 11.0 |
| Gd, ppm | 1.35 | 0.21 | 0.93 | 1.76 | 0.72 | 1.97 | 15.54% | 31.07% | 46.61% | 1.28 | 1.41 |
| Hf, ppm | 1.74 | 0.22 | 1.30 | 2.18 | 1.07 | 2.41 | 12.77% | 25.54% | 38.31% | 1.65 | 1.83 |
| Ho, ppm | 0.27 | 0.03 | 0.21 | 0.33 | 0.18 | 0.35 | 10.92% | 21.85% | 32.77% | 0.25 | 0.28 |
| $K_2O$, wt.% | 0.125 | 0.015 | 0.095 | 0.155 | 0.080 | 0.170 | 12.04% | 24.08% | 36.12% | 0.119 | 0.131 |
| La, ppm | 4.04 | 0.58 | 2.88 | 5.20 | 2.30 | 5.78 | 14.36% | 28.71% | 43.07% | 3.84 | 4.24 |
| Li, ppm | 12.3 | 1.6 | 9.2 | 15.5 | 7.6 | 17.0 | 12.80% | 25.60% | 38.39% | 11.7 | 12.9 |
| MgO, wt.% | 2.01 | 0.062 | 1.89 | 2.13 | 1.82 | 2.19 | 3.07% | 6.14% | 9.21% | 1.91 | 2.11 |
| MnO, wt.% | 0.166 | 0.007 | 0.153 | 0.179 | 0.146 | 0.186 | 3.99% | 7.98% | 11.98% | 0.158 | 0.174 |
| Mo, ppm | < 5 | IND | IND | IND | IND | IND | IND | IND | IND | IND | IND |
| $Na_2O$, wt.% | 0.420 | 0.036 | 0.348 | 0.492 | 0.312 | 0.528 | 8.59% | 17.19% | 25.78% | 0.399 | 0.441 |
| Nb, ppm | 1.96 | 0.38 | 1.19 | 2.73 | 0.81 | 3.11 | 19.59% | 39.18% | 58.76% | 1.86 | 2.06 |
| Nd, ppm | 5.30 | 0.53 | 4.23 | 6.36 | 3.70 | 6.89 | 10.06% | 20.12% | 30.18% | 5.03 | 5.56 |

Note: intervals may appear asymmetric due to rounding.

**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 |
| **Borate / Peroxide Fusion ICP continued** | | | | | | | | | | | |
| Ni, ppm | 5048 | 126 | 4796 | 5300 | 4670 | 5426 | 2.50% | 5.00% | 7.50% | 4796 | 5300 |
| Pr, ppm | 1.29 | 0.17 | 0.96 | 1.62 | 0.80 | 1.79 | 12.77% | 25.54% | 38.31% | 1.23 | 1.36 |
| Rb, ppm | 5.61 | 0.384 | 4.84 | 6.38 | 4.46 | 6.76 | 6.84% | 13.68% | 20.51% | 5.33 | 5.89 |
| S, wt.% | 0.071 | 0.006 | 0.059 | 0.082 | 0.053 | 0.088 | 8.42% | 16.85% | 25.27% | 0.067 | 0.074 |
| Sb, ppm | 1.19 | 0.16 | 0.87 | 1.50 | 0.72 | 1.66 | 13.24% | 26.49% | 39.73% | 1.13 | 1.25 |
| Sc, ppm | 38.2 | 1.27 | 35.6 | 40.7 | 34.4 | 42.0 | 3.32% | 6.64% | 9.96% | 36.3 | 40.1 |
| $SiO_2$, wt.% | 33.32 | 1.050 | 31.22 | 35.42 | 30.17 | 36.47 | 3.15% | 6.30% | 9.45% | 31.66 | 34.99 |
| Sm, ppm | 1.36 | 0.22 | 0.93 | 1.79 | 0.71 | 2.01 | 15.92% | 31.85% | 47.77% | 1.29 | 1.43 |
| Sr, ppm | 87 | 5.1 | 77 | 98 | 72 | 103 | 5.87% | 11.74% | 17.61% | 83 | 92 |
| Tb, ppm | 0.22 | 0.04 | 0.14 | 0.31 | 0.09 | 0.36 | 19.67% | 39.34% | 59.01% | 0.21 | 0.24 |
| Th, ppm | 2.72 | 0.128 | 2.46 | 2.97 | 2.33 | 3.10 | 4.71% | 9.42% | 14.13% | 2.58 | 2.85 |
| $TiO_2$, wt.% | 0.333 | 0.015 | 0.304 | 0.363 | 0.289 | 0.378 | 4.44% | 8.89% | 13.33% | 0.317 | 0.350 |
| U, ppm | 0.98 | 0.073 | 0.83 | 1.13 | 0.76 | 1.20 | 7.48% | 14.95% | 22.43% | 0.93 | 1.03 |
| V, ppm | 146 | 15 | 116 | 175 | 102 | 190 | 10.12% | 20.24% | 30.36% | 139 | 153 |
| W, ppm | 3.22 | 0.38 | 2.46 | 3.99 | 2.08 | 4.37 | 11.83% | 23.67% | 35.50% | 3.06 | 3.38 |
| Y, ppm | 5.73 | 0.64 | 4.44 | 7.02 | 3.80 | 7.67 | 11.24% | 22.48% | 33.72% | 5.45 | 6.02 |
| Yb, ppm | 0.89 | 0.080 | 0.73 | 1.05 | 0.65 | 1.13 | 8.98% | 17.96% | 26.94% | 0.84 | 0.93 |
| Zn, ppm | 100 | 10 | 79 | 120 | 69 | 130 | 10.18% | 20.36% | 30.54% | 95 | 105 |
| Zr, ppm | 61 | 4.9 | 51 | 71 | 46 | 76 | 8.04% | 16.08% | 24.11% | 58 | 64 |
| **Infrared Combustion** | | | | | | | | | | | |
| C, wt.% | 0.653 | 0.028 | 0.597 | 0.708 | 0.570 | 0.736 | 4.25% | 8.50% | 12.76% | 0.620 | 0.685 |
| S, wt.% | 0.059 | 0.012 | 0.035 | 0.084 | 0.022 | 0.097 | 20.94% | 41.89% | 62.83% | 0.057 | 0.062 |
| **Gas / Liquid Pycnometry** | | | | | | | | | | | |
| SG, Unity | 2.87 | 0.155 | 2.56 | 3.18 | 2.40 | 3.33 | 5.40% | 10.80% | 16.20% | 2.73 | 3.01 |

Note: intervals may appear asymmetric due to rounding.

## PARTICIPATING LABORATORIES

1. ALS, Brisbane, QLD, Australia
2. ALS, Lima, Peru
3. ALS, Vancouver, BC, Canada
4. Argile Analytica, Calgary, Alberta, Canada
5. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
6. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
7. Bureau Veritas Geoanalytical, Perth, WA, Australia
8. Inspectorate (BV), Lima, Peru
9. Intertek Genalysis, Perth, WA, Australia
10. Intertek Testing Services, Cupang, Muntinlupa, Philippines
11. Intertek Testing Services, Townsville, QLD, Australia
12. Nagrom, Perth, WA, Australia
13. Ni Lab, Pouembout, New Caledonia
14. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
15. SGS Australia Mineral Services, Perth, WA, Australia
16. SGS Geosol Laboratorios Ltda, Vespasiano, Minas Gerais, Brazil
17. SGS Mineral Services, Townsville, QLD, Australia

## PREPARER AND SUPPLIER

Certified reference material OREAS 181 is prepared, certified and supplied by:


| | | | |
|---|---|---|---|
| ORE RESEARCH & EXPLORATION | ORE Research & Exploration Pty Ltd | Tel: | +613-9729 0333 |
| | 37A Hosie Street | Fax: | +613-9729 8338 |
| | Bayswater North VIC 3153 | Web: | www.ore.com.au |
| | AUSTRALIA | Email: | info@ore.com.au |


It is available in unit sizes of 10g (single-use laminated foil pouches) and 1kg (plastic jars).

## INTENDED USE

OREAS 181 is intended for the following uses:

- for the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- 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 181 is an oxidised reference material and is stable in the laminated foil pouches. Under normal conditions of storage it has a shelf life beyond ten years.

## INSTRUCTIONS FOR CORRECT USE

The certified values determined via fusion ICP, C and S by infrared combustion furnace and SG by pycnometry refer to the concentration levels in the packaged state. There is no need for drying prior to weighing and analysis.

In contrast the certified values determined via borate fusion XRF and for LOI at 1000° C are on a dry basis. This requires the removal of hygroscopic moisture by drying in air to constant mass at 105° C. If the reference material is not dried prior to analysis, the certified values should be corrected to the moisture-bearing basis.

## 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.

## TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared CRM. This ‘representivity’ was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis. The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment as detailed in this report.

## 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.

## QMS ACCREDITED

ORE Pty Ltd is accredited to ISO 9001:2008 by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.

## CERTIFYING OFFICER

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

## REFERENCES


ISO Guide 30 (1992), Terms and definitions used in connection with reference materials.

ISO Guide 31 (2000), Reference materials – Contents of certificates and labels.

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.