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## CERTIFICATE OF ANALYSIS FOR

# CERTIFIED REFERENCE MATERIAL

# OREAS 504d

## PORPHYRY COPPER-GOLD-MOLYBDENUM

## (Cadia Valley Operations, New South Wales, Australia)

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| 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 |
| **Pb Fire Assay** | | | | | | | | | | | |
| Au, ppm | 1.46 | 0.035 | 1.39 | 1.53 | 1.35 | 1.56 | 2.41% | 4.83% | 7.24% | 1.38 | 1.53 |
| **Aqua Regia Digestion (sample weights 10-50g)** | | | | | | | | | | | |
| Au, ppm | 1.46 | 0.075 | 1.31 | 1.61 | 1.23 | 1.68 | 5.11% | 10.23% | 15.34% | 1.38 | 1.53 |
| **4-Acid Digestion** | | | | | | | | | | | |
| Ag, ppm | 2.69 | 0.114 | 2.46 | 2.92 | 2.35 | 3.03 | 4.25% | 8.51% | 12.76% | 2.55 | 2.82 |
| Al, wt.% | 7.36 | 0.283 | 6.80 | 7.93 | 6.52 | 8.21 | 3.84% | 7.69% | 11.53% | 7.00 | 7.73 |
| As, ppm | 49.6 | 3.16 | 43.3 | 55.9 | 40.1 | 59.1 | 6.37% | 12.73% | 19.10% | 47.1 | 52.1 |
| Ba, ppm | 816 | 39 | 738 | 893 | 700 | 932 | 4.75% | 9.51% | 14.26% | 775 | 857 |
| Be, ppm | 2.07 | 0.171 | 1.72 | 2.41 | 1.55 | 2.58 | 8.26% | 16.51% | 24.77% | 1.96 | 2.17 |
| Bi, ppm | 3.16 | 0.225 | 2.71 | 3.61 | 2.49 | 3.84 | 7.11% | 14.22% | 21.33% | 3.01 | 3.32 |
| Ca, wt.% | 2.01 | 0.078 | 1.86 | 2.17 | 1.78 | 2.24 | 3.85% | 7.71% | 11.56% | 1.91 | 2.11 |
| Cd, ppm | 1.30 | 0.130 | 1.04 | 1.56 | 0.91 | 1.69 | 9.98% | 19.97% | 29.95% | 1.24 | 1.37 |
| Ce, ppm | 55 | 6 | 44 | 67 | 38 | 73 | 10.42% | 20.84% | 31.26% | 53 | 58 |
| Co, ppm | 21.5 | 1.14 | 19.3 | 23.8 | 18.1 | 25.0 | 5.29% | 10.59% | 15.88% | 20.5 | 22.6 |
| Cr, ppm | 41.1 | 3.65 | 33.8 | 48.4 | 30.1 | 52.0 | 8.89% | 17.78% | 26.67% | 39.0 | 43.1 |
| Cs, ppm | 7.59 | 0.293 | 7.00 | 8.18 | 6.71 | 8.47 | 3.86% | 7.72% | 11.58% | 7.21 | 7.97 |
| Cu, wt.% | 1.10 | 0.024 | 1.05 | 1.15 | 1.03 | 1.17 | 2.19% | 4.38% | 6.57% | 1.04 | 1.15 |
| Dy, ppm | 3.23 | 0.232 | 2.77 | 3.69 | 2.53 | 3.93 | 7.18% | 14.37% | 21.55% | 3.07 | 3.39 |
| Er, ppm | 1.45 | 0.15 | 1.16 | 1.75 | 1.01 | 1.89 | 10.13% | 20.26% | 30.39% | 1.38 | 1.52 |
| Eu, ppm | 1.16 | 0.072 | 1.01 | 1.30 | 0.94 | 1.37 | 6.22% | 12.44% | 18.67% | 1.10 | 1.22 |
| Fe, wt.% | 4.57 | 0.177 | 4.21 | 4.92 | 4.03 | 5.10 | 3.88% | 7.77% | 11.65% | 4.34 | 4.79 |
| Ga, ppm | 18.1 | 0.70 | 16.7 | 19.5 | 16.0 | 20.2 | 3.87% | 7.74% | 11.60% | 17.2 | 19.0 |
| Gd, ppm | 4.77 | 0.376 | 4.02 | 5.52 | 3.64 | 5.90 | 7.88% | 15.77% | 23.65% | 4.53 | 5.01 |
| Hf, ppm | 1.86 | 0.101 | 1.65 | 2.06 | 1.55 | 2.16 | 5.43% | 10.87% | 16.30% | 1.76 | 1.95 |
| Ho, ppm | 0.55 | 0.042 | 0.46 | 0.63 | 0.42 | 0.67 | 7.75% | 15.49% | 23.24% | 0.52 | 0.57 |
| In, ppm | 0.73 | 0.031 | 0.67 | 0.79 | 0.64 | 0.82 | 4.22% | 8.44% | 12.65% | 0.69 | 0.76 |
| K, wt.% | 2.97 | 0.078 | 2.82 | 3.13 | 2.74 | 3.21 | 2.63% | 5.26% | 7.89% | 2.82 | 3.12 |
| La, ppm | 27.6 | 2.10 | 23.4 | 31.9 | 21.3 | 34.0 | 7.61% | 15.22% | 22.83% | 26.3 | 29.0 |
| Li, ppm | 39.5 | 1.84 | 35.8 | 43.2 | 34.0 | 45.0 | 4.65% | 9.31% | 13.96% | 37.5 | 41.5 |
| Lu, ppm | 0.20 | 0.009 | 0.18 | 0.21 | 0.17 | 0.22 | 4.46% | 8.92% | 13.38% | 0.19 | 0.20 |
| Mg, wt.% | 0.980 | 0.035 | 0.910 | 1.051 | 0.875 | 1.086 | 3.59% | 7.18% | 10.77% | 0.931 | 1.029 |
| Mn, wt.% | 0.038 | 0.001 | 0.036 | 0.040 | 0.034 | 0.041 | 2.99% | 5.98% | 8.97% | 0.036 | 0.040 |
| Mo, ppm | 507 | 21 | 464 | 550 | 442 | 571 | 4.24% | 8.47% | 12.71% | 482 | 532 |
| Na, wt.% | 2.05 | 0.067 | 1.91 | 2.18 | 1.85 | 2.25 | 3.25% | 6.50% | 9.76% | 1.94 | 2.15 |
| Nb, ppm | 9.77 | 0.463 | 8.85 | 10.70 | 8.38 | 11.16 | 4.74% | 9.48% | 14.23% | 9.28 | 10.26 |
| Nd, ppm | 26.8 | 2.62 | 21.5 | 32.0 | 18.9 | 34.6 | 9.81% | 19.61% | 29.42% | 25.4 | 28.1 |
| Ni, ppm | 35.3 | 1.56 | 32.2 | 38.4 | 30.6 | 40.0 | 4.43% | 8.86% | 13.29% | 33.5 | 37.1 |
| P, wt.% | 0.087 | 0.003 | 0.080 | 0.093 | 0.077 | 0.096 | 3.76% | 7.53% | 11.29% | 0.082 | 0.091 |
| Pb, ppm | 116 | 4 | 108 | 124 | 105 | 128 | 3.34% | 6.68% | 10.02% | 110 | 122 |
| Pr, ppm | 6.63 | 0.557 | 5.51 | 7.74 | 4.96 | 8.30 | 8.40% | 16.80% | 25.21% | 6.30 | 6.96 |
| Rb, ppm | 127 | 8 | 110 | 143 | 102 | 152 | 6.57% | 13.13% | 19.70% | 120 | 133 |
| Re, ppm | 0.11 | 0.005 | 0.10 | 0.12 | 0.09 | 0.13 | 4.90% | 9.79% | 14.69% | 0.11 | 0.12 |
| S, wt.% | 1.72 | 0.079 | 1.56 | 1.87 | 1.48 | 1.95 | 4.59% | 9.18% | 13.77% | 1.63 | 1.80 |

SI unit equivalents: ppm (parts per million; 1 x 10$^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

## Table 1 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** | | | | | | | | | | | |
| Sb, ppm | 5.52 | 0.253 | 5.01 | 6.03 | 4.76 | 6.28 | 4.59% | 9.18% | 13.77% | 5.24 | 5.79 |
| Sc, ppm | 9.74 | 0.752 | 8.24 | 11.25 | 7.48 | 12.00 | 7.72% | 15.45% | 23.17% | 9.25 | 10.23 |
| Se, ppm | 11.8 | 0.77 | 10.3 | 13.3 | 9.5 | 14.1 | 6.53% | 13.06% | 19.59% | 11.2 | 12.4 |
| Sm, ppm | 5.38 | 0.450 | 4.48 | 6.28 | 4.03 | 6.73 | 8.37% | 16.73% | 25.10% | 5.11 | 5.64 |
| Sn, ppm | 4.22 | 0.203 | 3.81 | 4.62 | 3.61 | 4.83 | 4.82% | 9.63% | 14.45% | 4.01 | 4.43 |
| Sr, ppm | 279 | 13 | 252 | 306 | 239 | 319 | 4.77% | 9.53% | 14.30% | 265 | 293 |
| Ta, ppm | 0.84 | 0.054 | 0.73 | 0.95 | 0.68 | 1.00 | 6.45% | 12.89% | 19.34% | 0.80 | 0.88 |
| Tb, ppm | 0.62 | 0.060 | 0.50 | 0.74 | 0.44 | 0.80 | 9.71% | 19.42% | 29.13% | 0.59 | 0.65 |
| Te, ppm | 1.61 | 0.089 | 1.43 | 1.78 | 1.34 | 1.87 | 5.52% | 11.05% | 16.57% | 1.53 | 1.69 |
| Th, ppm | 10.0 | 1.00 | 8.0 | 12.0 | 7.0 | 13.0 | 9.96% | 19.92% | 29.88% | 9.5 | 10.5 |
| Ti, wt.% | 0.326 | 0.011 | 0.305 | 0.348 | 0.294 | 0.359 | 3.32% | 6.64% | 9.96% | 0.310 | 0.343 |
| Tl, ppm | 0.72 | 0.039 | 0.64 | 0.80 | 0.60 | 0.83 | 5.45% | 10.90% | 16.35% | 0.68 | 0.75 |
| Tm, ppm | 0.20 | 0.007 | 0.19 | 0.22 | 0.18 | 0.22 | 3.36% | 6.71% | 10.07% | 0.19 | 0.21 |
| U, ppm | 2.94 | 0.264 | 2.41 | 3.46 | 2.14 | 3.73 | 9.00% | 18.00% | 26.99% | 2.79 | 3.08 |
| V, ppm | 88 | 3.8 | 81 | 96 | 77 | 100 | 4.25% | 8.51% | 12.76% | 84 | 93 |
| W, ppm | 8.79 | 0.812 | 7.17 | 10.42 | 6.36 | 11.23 | 9.23% | 18.47% | 27.70% | 8.35 | 9.23 |
| Y, ppm | 14.2 | 1.08 | 12.1 | 16.4 | 11.0 | 17.5 | 7.59% | 15.18% | 22.77% | 13.5 | 15.0 |
| Yb, ppm | 1.23 | 0.119 | 0.99 | 1.47 | 0.87 | 1.59 | 9.69% | 19.39% | 29.08% | 1.17 | 1.29 |
| Zn, ppm | 446 | 16 | 414 | 479 | 397 | 496 | 3.66% | 7.32% | 10.98% | 424 | 469 |
| Zr, ppm | 59 | 4.5 | 50 | 68 | 46 | 73 | 7.58% | 15.17% | 22.75% | 56 | 62 |
| **Aqua Regia Digestion** | | | | | | | | | | | |
| Ag, ppm | 2.64 | 0.134 | 2.37 | 2.90 | 2.23 | 3.04 | 5.10% | 10.20% | 15.31% | 2.50 | 2.77 |
| Al, wt.% | 1.85 | 0.069 | 1.71 | 1.99 | 1.64 | 2.06 | 3.73% | 7.46% | 11.20% | 1.76 | 1.94 |
| As, ppm | 48.8 | 2.93 | 42.9 | 54.7 | 40.0 | 57.6 | 6.01% | 12.03% | 18.04% | 46.3 | 51.2 |
| B, ppm | < 10 | IND | IND | IND | IND | IND | IND | IND | IND | IND | IND |
| Be, ppm | 1.17 | 0.069 | 1.03 | 1.31 | 0.96 | 1.37 | 5.92% | 11.84% | 17.76% | 1.11 | 1.23 |
| Bi, ppm | 3.33 | 0.243 | 2.84 | 3.81 | 2.60 | 4.05 | 7.29% | 14.59% | 21.88% | 3.16 | 3.49 |
| Ca, wt.% | 1.01 | 0.032 | 0.95 | 1.07 | 0.92 | 1.10 | 3.13% | 6.27% | 9.40% | 0.96 | 1.06 |
| Cd, ppm | 1.28 | 0.16 | 0.96 | 1.60 | 0.81 | 1.76 | 12.39% | 24.78% | 37.17% | 1.22 | 1.35 |
| Ce, ppm | 24.6 | 3.8 | 17.1 | 32.2 | 13.3 | 36.0 | 15.31% | 30.62% | 45.93% | 23.4 | 25.9 |
| Co, ppm | 21.2 | 0.56 | 20.1 | 22.3 | 19.5 | 22.9 | 2.65% | 5.30% | 7.96% | 20.2 | 22.3 |
| Cr, ppm | 43.3 | 2.34 | 38.7 | 48.0 | 36.3 | 50.4 | 5.41% | 10.81% | 16.22% | 41.2 | 45.5 |
| Cs, ppm | 6.22 | 0.268 | 5.68 | 6.75 | 5.41 | 7.02 | 4.31% | 8.62% | 12.93% | 5.91 | 6.53 |
| Cu, wt.% | 1.10 | 0.021 | 1.05 | 1.14 | 1.03 | 1.16 | 1.95% | 3.91% | 5.86% | 1.04 | 1.15 |
| Fe, wt.% | 4.38 | 0.126 | 4.13 | 4.63 | 4.00 | 4.76 | 2.87% | 5.74% | 8.61% | 4.16 | 4.60 |
| Ga, ppm | 8.66 | 0.667 | 7.32 | 9.99 | 6.65 | 10.66 | 7.71% | 15.42% | 23.13% | 8.22 | 9.09 |
| Ge, ppm | 0.13 | 0.02 | 0.09 | 0.16 | 0.08 | 0.18 | 13.17% | 26.33% | 39.50% | 0.12 | 0.13 |
| Hf, ppm | 0.35 | 0.04 | 0.28 | 0.42 | 0.24 | 0.45 | 10.15% | 20.29% | 30.44% | 0.33 | 0.36 |
| Hg, ppm | 0.096 | 0.008 | 0.079 | 0.113 | 0.071 | 0.122 | 8.76% | 17.52% | 26.28% | 0.091 | 0.101 |
| In, ppm | 0.73 | 0.026 | 0.68 | 0.78 | 0.65 | 0.81 | 3.53% | 7.06% | 10.60% | 0.70 | 0.77 |
| K, wt.% | 0.756 | 0.027 | 0.702 | 0.810 | 0.675 | 0.837 | 3.57% | 7.15% | 10.72% | 0.718 | 0.794 |
| La, ppm | 11.5 | 1.2 | 9.1 | 13.9 | 7.9 | 15.2 | 10.48% | 20.96% | 31.44% | 11.0 | 12.1 |
| Li, ppm | 31.4 | 1.29 | 28.8 | 34.0 | 27.5 | 35.3 | 4.09% | 8.19% | 12.28% | 29.8 | 33.0 |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding; IND = indeterminate.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

### Table 1 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** | | | | | | | | | | | |
| Mg, wt.% | 0.873 | 0.027 | 0.819 | 0.926 | 0.793 | 0.953 | 3.05% | 6.11% | 9.16% | 0.829 | 0.916 |
| Mn, wt.% | 0.032 | 0.001 | 0.029 | 0.034 | 0.028 | 0.036 | 4.08% | 8.17% | 12.25% | 0.030 | 0.033 |
| Mo, ppm | 489 | 19 | 451 | 527 | 432 | 546 | 3.88% | 7.75% | 11.63% | 465 | 514 |
| Na, wt.% | 0.138 | 0.013 | 0.112 | 0.165 | 0.098 | 0.179 | 9.67% | 19.33% | 29.00% | 0.132 | 0.145 |
| Nb, ppm | 0.79 | 0.13 | 0.54 | 1.05 | 0.41 | 1.18 | 16.13% | 32.27% | 48.40% | 0.75 | 0.83 |
| Ni, ppm | 34.2 | 1.11 | 32.0 | 36.4 | 30.9 | 37.5 | 3.25% | 6.49% | 9.74% | 32.5 | 35.9 |
| P, wt.% | 0.072 | 0.004 | 0.064 | 0.080 | 0.059 | 0.085 | 5.85% | 11.69% | 17.54% | 0.068 | 0.076 |
| Pb, ppm | 104 | 4 | 96 | 113 | 91 | 117 | 4.13% | 8.26% | 12.39% | 99 | 110 |
| Rb, ppm | 70 | 4.3 | 62 | 79 | 58 | 83 | 6.09% | 12.18% | 18.28% | 67 | 74 |
| Re, ppm | 0.12 | 0.009 | 0.10 | 0.13 | 0.09 | 0.14 | 7.90% | 15.80% | 23.70% | 0.11 | 0.12 |
| S, wt.% | 1.68 | 0.080 | 1.52 | 1.84 | 1.44 | 1.93 | 4.76% | 9.53% | 14.29% | 1.60 | 1.77 |
| Sb, ppm | 4.10 | 0.56 | 2.98 | 5.21 | 2.43 | 5.77 | 13.58% | 27.17% | 40.75% | 3.89 | 4.30 |
| Sc, ppm | 7.54 | 0.356 | 6.83 | 8.26 | 6.48 | 8.61 | 4.72% | 9.44% | 14.17% | 7.17 | 7.92 |
| Se, ppm | 12.0 | 0.60 | 10.8 | 13.2 | 10.2 | 13.8 | 4.99% | 9.99% | 14.98% | 11.4 | 12.6 |
| Sn, ppm | 3.14 | 0.245 | 2.65 | 3.63 | 2.40 | 3.87 | 7.81% | 15.62% | 23.43% | 2.98 | 3.29 |
| Sr, ppm | 73 | 3.0 | 67 | 79 | 64 | 82 | 4.13% | 8.27% | 12.40% | 69 | 77 |
| Ta, ppm | < 0.01 | IND | IND | IND | IND | IND | IND | IND | IND | IND | IND |
| Tb, ppm | 0.40 | 0.020 | 0.36 | 0.44 | 0.34 | 0.46 | 5.09% | 10.17% | 15.26% | 0.38 | 0.42 |
| Te, ppm | 1.60 | 0.110 | 1.38 | 1.82 | 1.27 | 1.93 | 6.88% | 13.75% | 20.63% | 1.52 | 1.68 |
| Th, ppm | 4.28 | 0.377 | 3.52 | 5.03 | 3.14 | 5.41 | 8.82% | 17.65% | 26.47% | 4.06 | 4.49 |
| Ti, wt.% | 0.215 | 0.007 | 0.200 | 0.230 | 0.193 | 0.237 | 3.41% | 6.82% | 10.23% | 0.204 | 0.226 |
| Tl, ppm | 0.47 | 0.028 | 0.41 | 0.52 | 0.38 | 0.55 | 6.02% | 12.03% | 18.05% | 0.44 | 0.49 |
| U, ppm | 2.49 | 0.217 | 2.06 | 2.92 | 1.84 | 3.14 | 8.69% | 17.39% | 26.08% | 2.37 | 2.62 |
| V, ppm | 73 | 3.5 | 66 | 80 | 63 | 84 | 4.73% | 9.47% | 14.20% | 69 | 77 |
| W, ppm | 4.97 | 0.76 | 3.45 | 6.49 | 2.69 | 7.25 | 15.29% | 30.58% | 45.86% | 4.72 | 5.22 |
| Y, ppm | 9.97 | 0.437 | 9.10 | 10.85 | 8.66 | 11.28 | 4.38% | 8.76% | 13.14% | 9.47 | 10.47 |
| Yb, ppm | 0.80 | 0.048 | 0.70 | 0.90 | 0.66 | 0.94 | 6.01% | 12.01% | 18.02% | 0.76 | 0.84 |
| Zn, ppm | 445 | 17 | 411 | 479 | 394 | 496 | 3.82% | 7.63% | 11.45% | 423 | 467 |
| Zr, ppm | 9.43 | 1.06 | 7.30 | 11.56 | 6.24 | 12.62 | 11.28% | 22.56% | 33.84% | 8.96 | 9.90 |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding; IND = indeterminate.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

### Table 2. Indicative Values for OREAS 504d.

| Constituent | Unit | Value | Constituent | Unit | Value | Constituent | Unit | Value |
|---|---|---|---|---|---|---|---|---|
| **4-Acid Digestion** | | | | | | | | |
| B | ppm | *38.1* | Ge | ppm | *0.27* | Hg | ppm | *< 2* |
| **Aqua Regia Digestion** | | | | | | | | |
| Ba | ppm | *190* | Ho | ppm | *0.40* | Pt | ppb | *8.25* |
| Dy | ppm | *2.14* | Lu | ppm | *0.11* | Sm | ppm | *2.63* |
| Er | ppm | *0.99* | Nd | ppm | *11.0* | Tm | ppm | *0.12* |
| Eu | ppm | *0.40* | Pd | ppb | *109* | | | |
| Gd | ppm | *2.67* | Pr | ppm | *2.72* | | | |
| **Borate Fusion XRF** | | | | | | | | |
| $Al_2O_3$ | wt.% | *14.23* | MgO | wt.% | *1.75* | $SiO_2$ | wt.% | *62.61* |
| CaO | wt.% | *2.83* | MnO | wt.% | *0.050* | $SO_3$ | wt.% | *4.25* |
| $Fe_2O_3$ | wt.% | *6.64* | $Na_2O$ | wt.% | *2.86* | $TiO_2$ | wt.% | *0.570* |
| $K_2O$ | wt.% | *3.60* | $P_2O_5$ | wt.% | *0.198* | | | |
| **Thermogravimetry** | | | | | | | | |
| $LOI^{1000}$ | wt.% | *2.78* | | | | | | |
| **Infrared Combustion** | | | | | | | | |
| C | wt.% | *0.150* | S | wt.% | *1.65* | | | |
| **Laser Ablation ICP-MS** | | | | | | | | |
| Ag | ppm | *2.80* | Hf | ppm | *5.40* | Sm | ppm | *5.90* |
| As | ppm | *50* | Ho | ppm | *0.93* | Sn | ppm | *5.70* |
| Ba | ppm | *836* | In | ppm | *0.68* | Sr | ppm | *273* |
| Be | ppm | *2.30* | La | ppm | *30.0* | Ta | ppm | *0.87* |
| Bi | ppm | *3.43* | Lu | ppm | *0.34* | Tb | ppm | *0.82* |
| Cd | ppm | *1.35* | Mn | wt.% | *0.039* | Te | ppm | *1.70* |
| Ce | ppm | *60* | Mo | ppm | *505* | Th | ppm | *10.8* |
| Co | ppm | *22.0* | Nb | ppm | *10.8* | Ti | wt.% | *0.350* |
| Cr | ppm | *45.5* | Nd | ppm | *28.2* | Tl | ppm | *0.60* |
| Cs | ppm | *7.96* | Ni | ppm | *39.0* | Tm | ppm | *0.36* |
| Cu | ppm | *10750* | Pb | ppm | *123* | U | ppm | *3.53* |
| Dy | ppm | *4.70* | Pr | ppm | *7.23* | V | ppm | *94* |
| Er | ppm | *2.52* | Rb | ppm | *133* | W | ppm | *10.0* |
| Eu | ppm | *1.23* | Re | ppm | *0.16* | Y | ppm | *29.3* |
| Ga | ppm | *17.7* | Sb | ppm | *5.65* | Yb | ppm | *2.44* |
| Gd | ppm | *5.36* | Sc | ppm | *9.45* | Zn | ppm | *450* |
| Ge | ppm | *1.53* | Se | ppm | *< 5* | Zr | ppm | *189* |

SI unit equivalents: ppb (parts per billion; 1 x $10^{-9}$) ≡ µg/kg; ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

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.

# 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. OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself. In evaluating laboratory performance with this CRM, the section headed 'Instructions for correct use' should be read carefully.

Table 1 provides performance gate intervals (based on multiples of the SD) for the certified values, Table 2 shows indicative values including major and trace element characterisation, Table 3 provides some indicative physical properties, Table 4 provides indicative mineralogy based on semi-quantitative XRD analysis, Table 5 presents the 95% expanded uncertainty and tolerance limits for all certified values and Table 6 shows gold homogeneity data determined by INAA. Tabulated results of all analytes together with 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 504d-DataPack.1.0.230214_143443.xlsx**).

Results are also presented in scatter plots for gold by fire assay, gold by aqua regia digestion, copper by 4-acid digestion and molybdenum by 4-acid digestion (Figures 1 to 4, respectively) together with ±3SD (magenta) and ±5% (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

# SOURCE MATERIAL

OREAS 504d was prepared from a blend of porphyry copper-gold ores, barren granodiorite and a minor quantity of Cu-Mo concentrate. The ores were sourced from both the Cadia Mine and Northparkes Mine. Both mines are located in the Central West of New South Wales, Australia. The barren granodiorite was sourced from the mafic, S-Type, Late Devonian Bulla Granodiorite complex located in northern Melbourne, Australia.

Mineralisation in the CVO region is hosted by a sequence of late Ordovician to Early Silurian volcanics, intrusives and sediments that occur within the Bogan Gate Synclinorial Zone of the Lachlan Fold Belt. The western portion of this zone is dominated by volcanics and host to the Late Ordovician Goonumbla porphyry copper-gold deposits. These volcanics are interpreted to have erupted from shallow water to partly emergent volcanic centres and show a broad range in composition from shoshonite through to latite to trachyte. Coeval sub-volcanic quartz monzonite porphyries (and attendant mineralisation) have intruded the volcanics. They are generally small, sub-vertical, pipe-like intrusives. Typically, the mineralised porphyries contain plagioclase and quartz phenocrysts in a matrix of fine-grained potassium feldspar and quartz with minor biotite and hornblende.

Copper-gold mineralisation occurs as stockwork quartz veins and disseminations associated with potassic alteration. This alteration is intimately associated spatially and temporally with the small finger-like quartz monzonite porphyries that intrude the Goonumbla

Volcanics. Sulphides are zoned laterally from the centres of mineralisation. The central portions are bornite-rich with minor chalcopyrite, zoning outward through equal concentrations of bornite and chalcopyrite, to an outermost chalcopyrite-rich zone. Pyrite increases outward at the expense of bornite.

## PERFORMANCE GATES

Table 1 above shows intervals 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 (also see 'Intended Use' section below). Westgard Rules extend the basics of single-rule QC monitoring using multi-rules (for more information visit www.westgard.com/mltirule.htm). 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. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL) ± 10%.

*I.e., Certified Value ± 10% ± 2DL* [1].

## COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 504d was prepared in the following manner:

- Drying of ore and barren granodiorite to constant mass at 105°C;
- Drying of Cu-Mo concentrate to constant mass at 85°C;
- Multi-stage milling of ore and concentrate to 100% minus 30 microns;
- Milling of barren granodiorite to 98% minus 75 microns;
- Combining ores, granodiorite and concentrate in appropriate proportions to achieve target grades;
- Homogenisation using OREAS' novel processing technologies;
- Packaging into 10 and 60g units in laminated foil pouches and 500g units in plastic jars.

## PHYSICAL PROPERTIES

OREAS 504d was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 3 presents these findings that should be used for informational purposes only.

**Table 3. Physical properties of OREAS 504d.**

| Bulk Density (g/L) | Moisture% | Munsell Notation‡ | Munsell Color‡ |
|---|---|---|---|
| 688 | 0.83 | N7 | Light Gray |

‡The Munsell Rock Color Chart helps geologists and archeologists communicate with colour more effectively by cross-referencing ISCC-NBS colour names with unique Munsell alpha-numeric colour notations for rock colour samples.

## MINERALOGY

The semi-quantitative XRD results shown in Table 4 below have been normalised to 100 % and represent the relative proportion of crystalline material. Totals greater or less than 100 % are due to rounding errors. Some amorphous material is likely present.

**Table 4. Indicative mineralogy of OREAS 504d based on semi-quantitative XRD analysis.**

| Mineral / Mineral Group | % (mass ratio) |
|---|---|
| Zeolite | 0 |
| *Clay minerals | 1 |
| Kaolinite | 0 |
| Chlorite | 2 |
| Annite - biotite - phlogopite | 34 |
| Muscovite | 2 |
| Calcic amphibole | 1 |
| Cordierite | 0 |
| Plagioclase | 26 |
| K-feldspar | 13 |
| Quartz | 20 |
| Gypsum | < 1 |
| Calcite | 1 |
| Pyrite | 1 |
| **Molybdenite | < 1 |

*Most likely smectite and vermiculite.

**This phase is associated with a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it may also indicate an uncertainty in regard to the presence of the phase itself.

## ANALYTICAL PROGRAM

Twenty-two commercial analytical laboratories participated in the program to certify the elements reported in Table 1. The following methods were employed:

- Gold by 15-50g fire assay with AAS (17 laboratories) or ICP-OES (4 laboratories) finish;
- Gold by 10-50g aqua regia digestion with ICP-MS finish (10 laboratories) and AAS (5 laboratories) finish;
- 4-acid digestion for full elemental suite ICP-OES/MS finish (up to 19 laboratories depending on the element)
- Aqua regia digestion for full elemental suite ICP-OES/MS and AAS finish (up to 21 laboratories depending on the element);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (undertaken at ANSTO, Lucas Heights, Australia).

Table 2 shows indicative values including major and trace element characterisation by Bureau Veritas in Perth, Western Australia which includes:

- Major oxides by lithium borate fusion with X-ray fluorescence;
- LOI at 1000°C by thermogravimetric analyser;

- Total Carbon and Sulphur by infrared combustion furnace;
- Trace elements by laser ablation (on the fused bead) with ICP-MS finish.

For the round robin program twenty 2kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 110g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 110g samples from each of three separate 2kg 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.

## STATISTICAL ANALYSIS

**Standard Deviation intervals** (see Table 1) 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.***

**Indicative (uncertified) values** (Table 2) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

**Certified Values and their uncertainty intervals** (Table 5) 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.

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value. The INAA data (see Table 6) is omitted from determination of the certified value for Au and is used solely for the calculation of Tolerance Limits and homogeneity evaluation (see 'Homogeneity Evaluation' section below).

95% Expanded Uncertainty provides a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits and is calculated according to the method in the ISO Guides [6,16]. All known or suspected sources of bias have been investigated or taken into account.

***The 95% Expanded Uncertainty should not be used as control limits for laboratory performance.***

**Table 5. 95% Uncertainty & Tolerance Limits for OREAS 504d.**

| Constituent | Certified | 95% Expanded Uncertainty | | 95% Tolerance Limits | |
|---|---|---|---|---|---|
| | Value | Low | High | Low | High |
| **Pb Fire Assay** | | | | | |
| Au, Gold (ppm) | 1.46 | 1.44 | 1.47 | 1.45 | 1.47 |
| **Aqua Regia Digestion (sample weights 10-50g)** | | | | | |
| Au, Gold (ppm) | 1.46 | 1.42 | 1.50 | 1.45 | 1.47 |
| **4-Acid Digestion** | | | | | |
| Ag, Silver (ppm) | 2.69 | 2.57 | 2.81 | 2.60 | 2.78 |
| Al, Aluminium (wt.%) | 7.36 | 7.04 | 7.69 | 7.21 | 7.52 |
| As, Arsenic (ppm) | 49.6 | 46.5 | 52.7 | 47.4 | 51.7 |
| Ba, Barium (ppm) | 816 | 782 | 849 | 796 | 836 |
| Be, Beryllium (ppm) | 2.07 | 1.92 | 2.21 | 2.00 | 2.13 |
| Bi, Bismuth (ppm) | 3.16 | 2.85 | 3.47 | 2.92 | 3.40 |
| Ca, Calcium (wt.%) | 2.01 | 1.94 | 2.08 | 1.97 | 2.06 |
| Cd, Cadmium (ppm) | 1.30 | 1.19 | 1.42 | 1.26 | 1.35 |
| Ce, Cerium (ppm) | 55 | 50 | 60 | 52 | 59 |
| Co, Cobalt (ppm) | 21.5 | 20.5 | 22.6 | 21.0 | 22.0 |
| Cr, Chromium (ppm) | 41.1 | 38.1 | 44.0 | 39.7 | 42.4 |
| Cs, Caesium (ppm) | 7.59 | 7.20 | 7.98 | 7.32 | 7.86 |
| Cu, Copper (wt.%) | 1.10 | 1.07 | 1.13 | 1.08 | 1.12 |
| Dy, Dysprosium (ppm) | 3.23 | 2.90 | 3.56 | 2.97 | 3.49 |
| Er, Erbium (ppm) | 1.45 | 1.27 | 1.63 | IND | IND |
| Eu, Europium (ppm) | 1.16 | 1.08 | 1.24 | 1.12 | 1.20 |
| Fe, Iron (wt.%) | 4.57 | 4.42 | 4.71 | 4.48 | 4.65 |
| Ga, Gallium (ppm) | 18.1 | 17.2 | 19.0 | 17.5 | 18.6 |
| Gd, Gadolinium (ppm) | 4.77 | 4.25 | 5.29 | 4.40 | 5.13 |
| Hf, Hafnium (ppm) | 1.86 | 1.73 | 1.98 | 1.76 | 1.95 |
| Ho, Holmium (ppm) | 0.55 | 0.50 | 0.59 | IND | IND |
| In, Indium (ppm) | 0.73 | 0.69 | 0.76 | 0.70 | 0.75 |
| K, Potassium (wt.%) | 2.97 | 2.89 | 3.05 | 2.90 | 3.04 |
| La, Lanthanum (ppm) | 27.6 | 25.3 | 30.0 | 26.4 | 28.9 |
| Li, Lithium (ppm) | 39.5 | 37.9 | 41.2 | 38.5 | 40.6 |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

*Gold Tolerance Limits for typical 30g fire assay and 25g aqua regia digestion methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973). IND = indeterminate (due to limited reading resolution of the methods employed). Note: intervals may appear asymmetric due to rounding.

**Table 5 continued.**

| Constituent | Certified Value | 95% Expanded Uncertainty |  | 95% Tolerance Limits |  |
|---|---|---|---|---|---|
|  |  | Low | High | Low | High |
| **4-Acid Digestion continued** |  |  |  |  |  |
| Lu, Lutetium (ppm) | 0.20 | 0.18 | 0.21 | IND | IND |
| Mg, Magnesium (wt.%) | 0.980 | 0.945 | 1.016 | 0.958 | 1.003 |
| Mn, Manganese (wt.%) | 0.038 | 0.037 | 0.039 | 0.037 | 0.039 |
| Mo, Molybdenum (ppm) | 507 | 489 | 524 | 498 | 516 |
| Na, Sodium (wt.%) | 2.05 | 1.98 | 2.11 | 1.99 | 2.10 |
| Nb, Niobium (ppm) | 9.77 | 9.39 | 10.16 | 9.45 | 10.09 |
| Nd, Neodymium (ppm) | 26.8 | 23.6 | 29.9 | 25.0 | 28.5 |
| Ni, Nickel (ppm) | 35.3 | 33.7 | 37.0 | 34.2 | 36.4 |
| P, Phosphorus (wt.%) | 0.087 | 0.084 | 0.090 | 0.085 | 0.089 |
| Pb, Lead (ppm) | 116 | 111 | 121 | 114 | 119 |
| Pr, Praseodymium (ppm) | 6.63 | 5.91 | 7.35 | 6.21 | 7.05 |
| Rb, Rubidium (ppm) | 127 | 120 | 133 | 122 | 131 |
| Re, Rhenium (ppm) | 0.11 | 0.10 | 0.12 | 0.11 | 0.12 |
| S, Sulphur (wt.%) | 1.72 | 1.65 | 1.78 | 1.68 | 1.75 |
| Sb, Antimony (ppm) | 5.52 | 5.17 | 5.87 | 5.31 | 5.73 |
| Sc, Scandium (ppm) | 9.74 | 9.22 | 10.26 | 9.53 | 9.95 |
| Se, Selenium (ppm) | 11.8 | 10.9 | 12.7 | 11.3 | 12.3 |
| Sm, Samarium (ppm) | 5.38 | 4.78 | 5.97 | 4.90 | 5.86 |
| Sn, Tin (ppm) | 4.22 | 3.99 | 4.45 | 4.06 | 4.38 |
| Sr, Strontium (ppm) | 279 | 267 | 291 | 273 | 285 |
| Ta, Tantalum (ppm) | 0.84 | 0.78 | 0.90 | 0.81 | 0.87 |
| Tb, Terbium (ppm) | 0.62 | 0.53 | 0.72 | 0.58 | 0.67 |
| Te, Tellurium (ppm) | 1.61 | 1.50 | 1.71 | 1.53 | 1.68 |
| Th, Thorium (ppm) | 10.0 | 9.2 | 10.8 | 9.4 | 10.6 |
| Ti, Titanium (wt.%) | 0.326 | 0.316 | 0.337 | 0.319 | 0.333 |
| Tl, Thallium (ppm) | 0.72 | 0.67 | 0.76 | 0.69 | 0.74 |
| Tm, Thulium (ppm) | 0.20 | 0.19 | 0.22 | IND | IND |
| U, Uranium (ppm) | 2.94 | 2.55 | 3.32 | 2.73 | 3.14 |
| V, Vanadium (ppm) | 88 | 85 | 91 | 87 | 90 |
| W, Tungsten (ppm) | 8.79 | 7.58 | 10.01 | 8.36 | 9.22 |
| Y, Yttrium (ppm) | 14.2 | 13.4 | 15.1 | 13.7 | 14.8 |
| Yb, Ytterbium (ppm) | 1.23 | 1.09 | 1.38 | IND | IND |
| Zn, Zinc (ppm) | 446 | 432 | 461 | 437 | 456 |
| Zr, Zirconium (ppm) | 59 | 55 | 63 | 57 | 61 |
| **Aqua Regia Digestion** |  |  |  |  |  |
| Ag, Silver (ppm) | 2.64 | 2.51 | 2.76 | 2.56 | 2.71 |
| Al, Aluminium (wt.%) | 1.85 | 1.80 | 1.90 | 1.82 | 1.89 |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
Note: intervals may appear asymmetric due to rounding.
IND = indeterminate (due to limited reading resolution of the methods employed).

**Table 5 continued.**

| Constituent | Certified Value | 95% Expanded Uncertainty | | 95% Tolerance Limits | |
|---|---|---|---|---|---|
| | | Low | High | Low | High |
| **Aqua Regia Digestion** | | | | | |
| As, Arsenic (ppm) | 48.8 | 46.4 | 51.2 | 47.4 | 50.2 |
| B, Boron (ppm) | < 10 | IND | IND | IND | IND |
| Be, Beryllium (ppm) | 1.17 | 1.07 | 1.27 | 1.14 | 1.20 |
| Bi, Bismuth (ppm) | 3.33 | 3.10 | 3.55 | 3.17 | 3.48 |
| Ca, Calcium (wt.%) | 1.01 | 0.98 | 1.04 | 0.99 | 1.03 |
| Cd, Cadmium (ppm) | 1.28 | 1.15 | 1.42 | 1.23 | 1.34 |
| Ce, Cerium (ppm) | 24.6 | 22.1 | 27.2 | 24.1 | 25.2 |
| Co, Cobalt (ppm) | 21.2 | 20.5 | 22.0 | 20.9 | 21.6 |
| Cr, Chromium (ppm) | 43.3 | 41.5 | 45.2 | 42.3 | 44.4 |
| Cs, Caesium (ppm) | 6.22 | 5.92 | 6.51 | 6.06 | 6.37 |
| Cu, Copper (wt.%) | 1.10 | 1.07 | 1.12 | 1.08 | 1.11 |
| Fe, Iron (wt.%) | 4.38 | 4.28 | 4.48 | 4.33 | 4.44 |
| Ga, Gallium (ppm) | 8.66 | 8.17 | 9.14 | 8.44 | 8.87 |
| Ge, Germanium (ppm) | 0.13 | 0.10 | 0.15 | IND | IND |
| Hf, Hafnium (ppm) | 0.35 | 0.31 | 0.38 | 0.33 | 0.37 |
| Hg, Mercury (ppm) | 0.096 | 0.081 | 0.112 | IND | IND |
| In, Indium (ppm) | 0.73 | 0.70 | 0.77 | 0.71 | 0.75 |
| K, Potassium (wt.%) | 0.756 | 0.734 | 0.778 | 0.742 | 0.770 |
| La, Lanthanum (ppm) | 11.5 | 10.6 | 12.5 | 11.1 | 11.9 |
| Li, Lithium (ppm) | 31.4 | 30.0 | 32.8 | 30.8 | 32.0 |
| Mg, Magnesium (wt.%) | 0.873 | 0.847 | 0.898 | 0.858 | 0.888 |
| Mn, Manganese (wt.%) | 0.032 | 0.031 | 0.033 | 0.031 | 0.032 |
| Mo, Molybdenum (ppm) | 489 | 474 | 504 | 482 | 496 |
| Na, Sodium (wt.%) | 0.138 | 0.129 | 0.148 | 0.134 | 0.143 |
| Nb, Niobium (ppm) | 0.79 | 0.67 | 0.91 | 0.75 | 0.83 |
| Ni, Nickel (ppm) | 34.2 | 32.9 | 35.4 | 33.4 | 34.9 |
| P, Phosphorus (wt.%) | 0.072 | 0.069 | 0.075 | 0.070 | 0.074 |
| Pb, Lead (ppm) | 104 | 101 | 108 | 103 | 106 |
| Rb, Rubidium (ppm) | 70 | 67 | 74 | 69 | 72 |
| Re, Rhenium (ppm) | 0.12 | 0.11 | 0.13 | 0.11 | 0.12 |
| S, Sulphur (wt.%) | 1.68 | 1.63 | 1.73 | 1.65 | 1.71 |
| Sb, Antimony (ppm) | 4.10 | 3.75 | 4.45 | 3.93 | 4.26 |
| Sc, Scandium (ppm) | 7.54 | 7.20 | 7.88 | 7.37 | 7.71 |
| Se, Selenium (ppm) | 12.0 | 11.0 | 12.9 | 11.2 | 12.7 |
| Sn, Tin (ppm) | 3.14 | 2.92 | 3.35 | 3.00 | 3.27 |
| Sr, Strontium (ppm) | 73 | 70 | 76 | 72 | 75 |
| Ta, Tantalum (ppm) | < 0.01 | IND | IND | IND | IND |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).

Note: intervals may appear asymmetric due to rounding.

IND = indeterminate (due to limited reading resolution of the methods employed. For practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of the upper bound/non-detect limit value).

**Table 5 continued.**

| Constituent | Certified | 95% Expanded Uncertainty | | 95% Tolerance Limits | |
|---|---|---|---|---|---|
| | Value | Low | High | Low | High |
| **Aqua Regia Digestion continued** | | | | | |
| Tb, Terbium (ppm) | 0.40 | 0.36 | 0.44 | IND | IND |
| Te, Tellurium (ppm) | 1.60 | 1.48 | 1.72 | 1.53 | 1.67 |
| Th, Thorium (ppm) | 4.28 | 3.93 | 4.62 | 4.12 | 4.44 |
| Ti, Titanium (wt.%) | 0.215 | 0.207 | 0.223 | 0.211 | 0.219 |
| Tl, Thallium (ppm) | 0.47 | 0.44 | 0.49 | 0.45 | 0.48 |
| U, Uranium (ppm) | 2.49 | 2.13 | 2.85 | 2.31 | 2.67 |
| V, Vanadium (ppm) | 73 | 71 | 75 | 72 | 74 |
| W, Tungsten (ppm) | 4.97 | 4.42 | 5.53 | 4.68 | 5.26 |
| Y, Yttrium (ppm) | 9.97 | 9.60 | 10.34 | 9.74 | 10.21 |
| Yb, Ytterbium (ppm) | 0.80 | 0.75 | 0.85 | IND | IND |
| Zn, Zinc (ppm) | 445 | 430 | 459 | 439 | 450 |
| Zr, Zirconium (ppm) | 9.43 | 8.72 | 10.14 | 9.17 | 9.68 |

SI unit equivalents: ppm (parts per million; 1 x $10^{-6}$) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
Note: intervals may appear asymmetric due to rounding.
IND = indeterminate (due to limited reading resolution of the methods employed).

## Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Table 5 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-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 1.08 and 1.12 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).

***Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.***

Table 6 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 504d. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 30g fire assays were undertaken without the normal measurement error associated with this methodology. In this instance, the 1RSD of 0.23% calculated for a 30g fire assay sample (4.28% at 85mg weights) confirms the high level of gold homogeneity in OREAS 504d.

The homogeneity of gold has been determined by INAA at ANSTO using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material and measurement error becomes negligible.

**Table 6. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples and showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.**

| Replicate No | Au 85mg actual | Au 30g equivalent* |
|---|---|---|
| 1 | 1.327 | 1.481 |
| 2 | 1.473 | 1.488 |
| 3 | 1.422 | 1.486 |
| 4 | 1.413 | 1.485 |
| 5 | 1.482 | 1.489 |
| 6 | 1.527 | 1.491 |
| 7 | 1.491 | 1.489 |
| 8 | 1.483 | 1.489 |
| 9 | 1.473 | 1.488 |
| 10 | 1.469 | 1.488 |
| 11 | 1.432 | 1.486 |
| 12 | 1.521 | 1.491 |
| 13 | 1.508 | 1.490 |
| 14 | 1.467 | 1.488 |
| 15 | 1.491 | 1.489 |
| 16 | 1.532 | 1.492 |
| 17 | 1.516 | 1.491 |
| 18 | 1.568 | 1.494 |
| 19 | 1.623 | 1.496 |
| 20 | 1.569 | 1.494 |
| Mean | 1.489 | 1.489 |
| Median | 1.487 | 1.489 |
| Std Dev. | 0.064 | 0.003 |
| **Rel.Std.Dev.** | **4.28%** | **0.228%** |

*Results calculated for a 30g equivalent sample mass using the formula: $x^{30g\ Eq} = \frac{(x^{INAA} - \bar{X}) \times RSD@30g}{RSD@85mg} + \bar{X}$

where $x^{30g\ Eq}$ = equivalent result calculated for a 30g sample mass
$(x^{INAA})$ = raw INAA result at 85mg
$\bar{X}$ = mean of 85mg INAA results

The homogeneity of gold in OREAS 504d has also been evaluated in a nested Analysis of Variance (**ANOVA**) of the round robin program. Twenty-one round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation is to test that no statistically significant difference exists in the variance between units to that of the variance within units. This allows an assessment of homogeneity across the entire prepared batch of OREAS 504d. The test was performed using the following parameters:

- Gold fire assay – 126 samples (21 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 90 samples (15 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, $H_0$: Between-unit variance is no greater than within-unit variance (reject $H_0$ if *p*-value < 0.05);
- Alternative Hypothesis, $H_1$: Between-unit variance is greater than within-unit variance.

*P*-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of the *p*-value.

This process derived *p*-values of 0.59 for Au by fire assay and 0.44 for Au by aqua regia digestion. Both *p*-values are insignificant and the Null Hypothesis is retained. Additionally, none of the other certified values showed significant *p*-values except for W by 4-acid digestion (*p*-value = 0.005). This isolated case is most likely a false positive (a significant difference is detected where, in reality, none exists). There is no other supporting evidence to suspect greater between-unit variance compared with within-unit variance. The null hypothesis is therefore retained.

Please note that only results for constituents present in concentrations well above the detection levels (i.e., >20 x Lower Limit of Detection) for the various methods undertaken were considered for the objective of evaluating homogeneity

It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not the analytes are distributed in a similar manner throughout the packaging run of OREAS 504d and whether the variance between two subsamples from the same unit is statistically distinguishable from the variance of two subsamples taken from any two separate units. A reference material therefore can possess poor absolute homogeneity yet still pass a relative homogeneity (ANOVA) test if the within-unit heterogeneity is large and similar across all units.

Based on the statistical analysis of ANOVA and the results of the interlaboratory certification program, it can be concluded that OREAS 504d is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

## PREPARER AND SUPPLIER

Certified reference material OREAS 504d was prepared and certified by:

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3. ALS, Johannesburg, South Africa
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Ulaanbaatar, Khan-Uul District, Mongolia
8. ALS, Vancouver, BC, Canada

9. ANSTO, Lucas Heights, NSW, Australia
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. CERTIMIN, Lima, Peru
12. ESAN Istanbul, Istanbul, Turkey
13. Inspectorate (BV), Lima, Peru
14. Intertek Genalysis, Perth, WA, Australia
15. Intertek Testing Services, Townsville, QLD, Australia
16. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
17. Laboratorio Tecnológico de Metalurgia LTM SA de CV, Hermosillo, Sonora, Mexico
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20. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
21. SGS, Ankara, Anatolia, Turkey
22. SGS Mongolia, Ulaanbaatar, Bayangol District, Mongolia

***Please note: To preserve anonymity, the above numbered alphabetical list of participating laboratories does not correspond with the Lab ID numbering on the scatter plots below.***

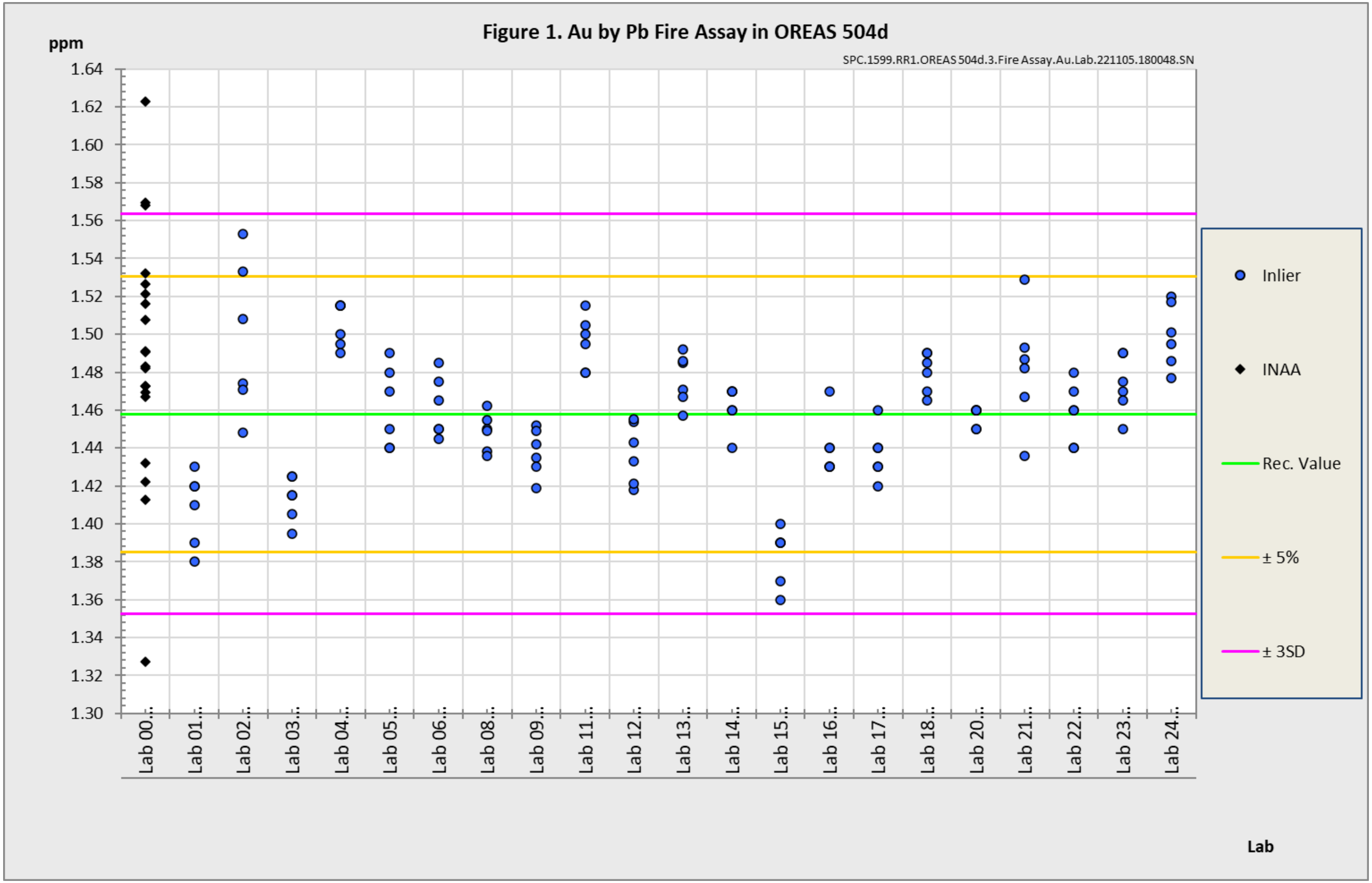
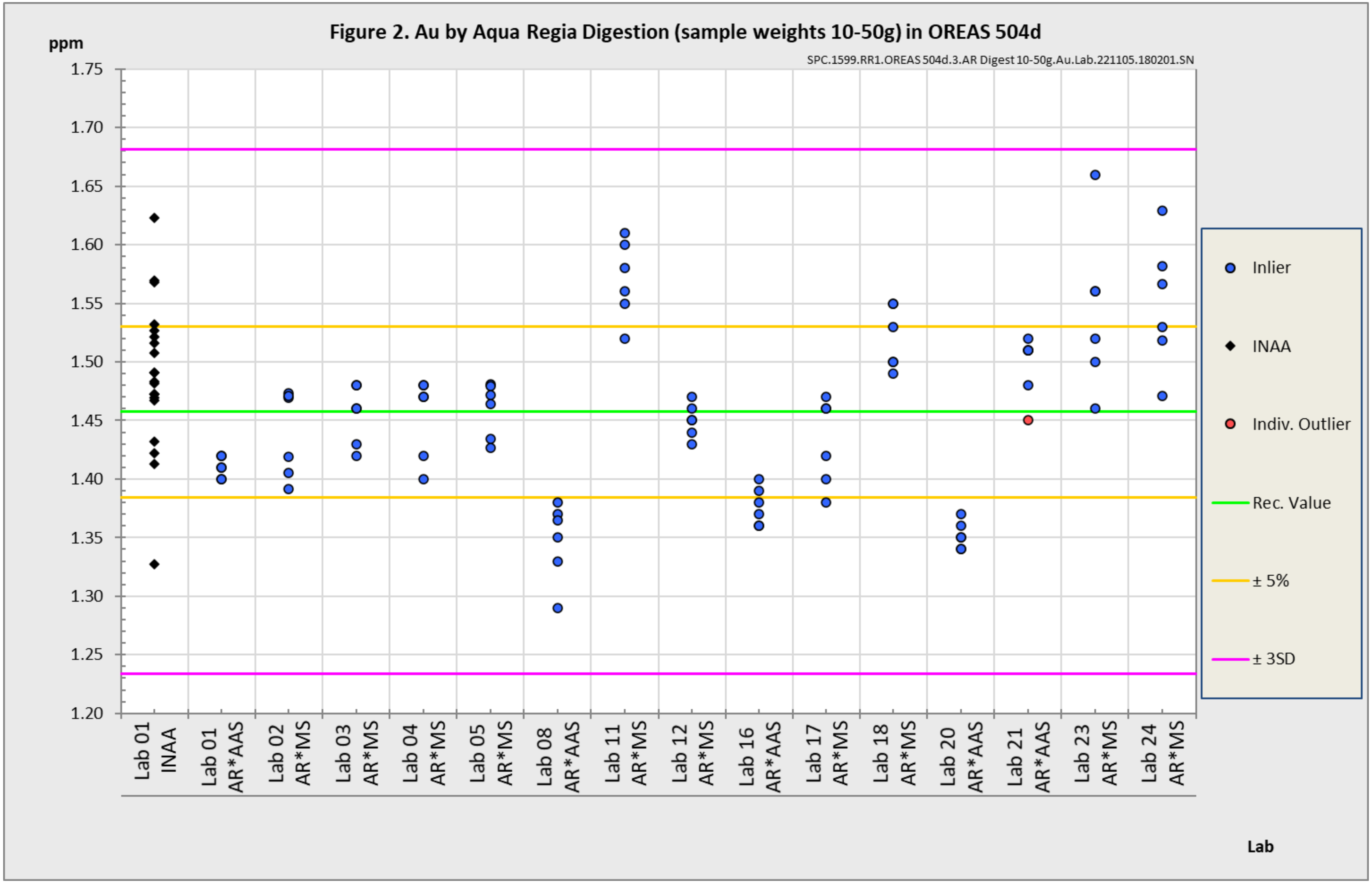


Figure 1. Au by Pb Fire Assay in OREAS 504d


ppm
Figure 2. Au by Aqua Regia Digestion (sample weights 10-50g) in OREAS 504d
SPC.1599.RR1.OREAS 504d.3.AR Digest 10-50g.Au.Lab.221105.180201.SN
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
Lab 01 INAA
Lab 01 AR*AAS
Lab 02 AR*MS
Lab 03 AR*MS
Lab 04 AR*MS
Lab 05 AR*MS
Lab 08 AR*AAS
Lab 11 AR*MS
Lab 12 AR*MS
Lab 16 AR*AAS
Lab 17 AR*MS
Lab 18 AR*MS
Lab 20 AR*AAS
Lab 21 AR*AAS
Lab 23 AR*MS
Lab 24 AR*MS
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD
Lab

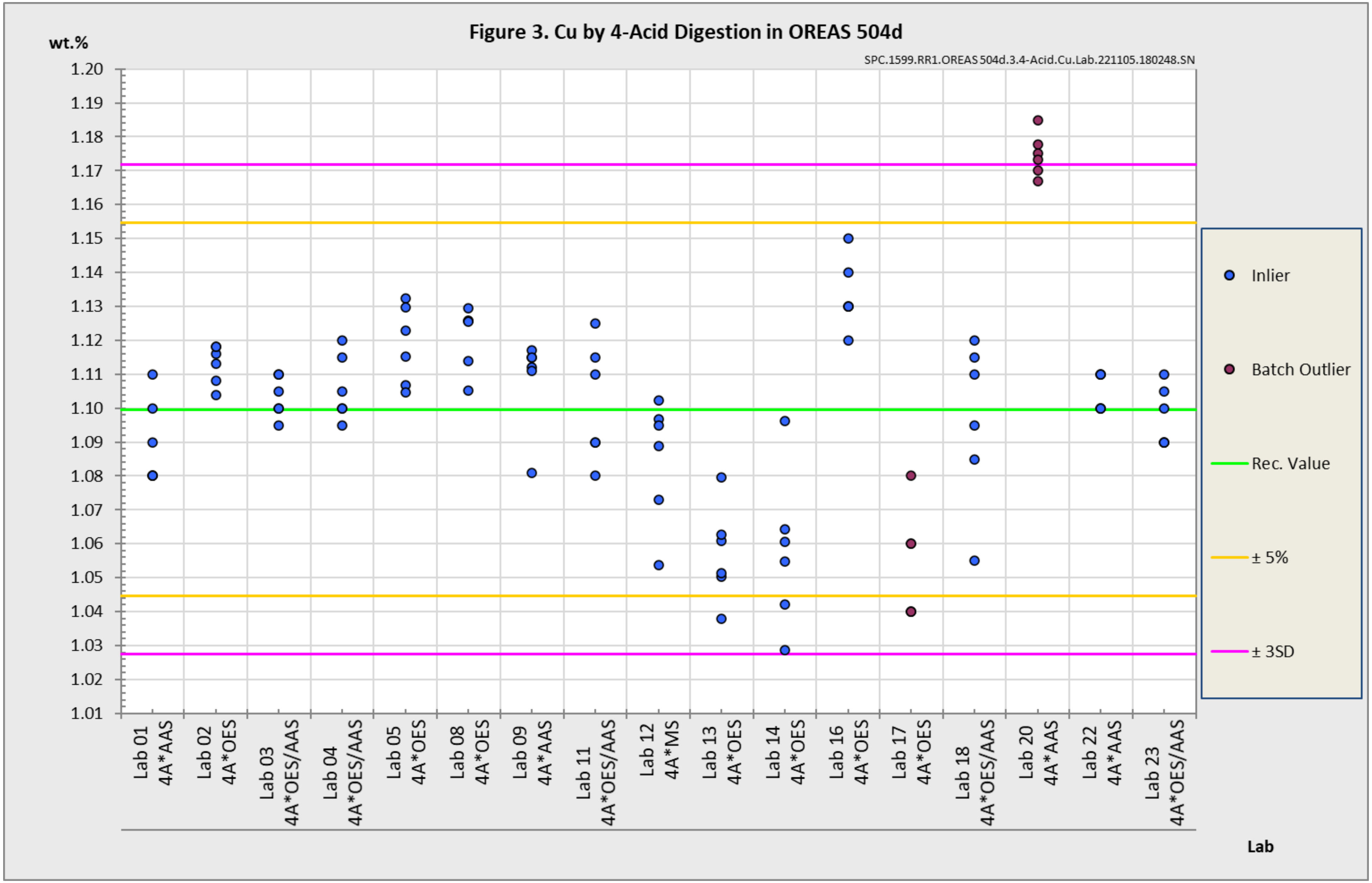


Figure 3. Cu by 4-Acid Digestion in OREAS 504d
wt.%
SPC.1599.RR1.OREAS 504d.3.4-Acid.Cu.Lab.221105.180248.SN
1.20
1.19
1.18
1.17
1.16
1.15
1.14
1.13
1.12
1.11
1.10
1.09
1.08
1.07
1.06
1.05
1.04
1.03
1.02
1.01
Lab 01 4A*AAS
Lab 02 4A*OES
Lab 03 4A*OES/AAS
Lab 04 4A*OES/AAS
Lab 05 4A*OES
Lab 08 4A*OES
Lab 09 4A*AAS
Lab 11 4A*OES/AAS
Lab 12 4A*MS
Lab 13 4A*OES
Lab 14 4A*OES
Lab 16 4A*OES
Lab 17 4A*OES
Lab 18 4A*OES/AAS
Lab 20 4A*AAS
Lab 22 4A*AAS
Lab 23 4A*OES/AAS
Lab
Inlier
Batch Outlier
Rec. Value
± 5%
± 3SD

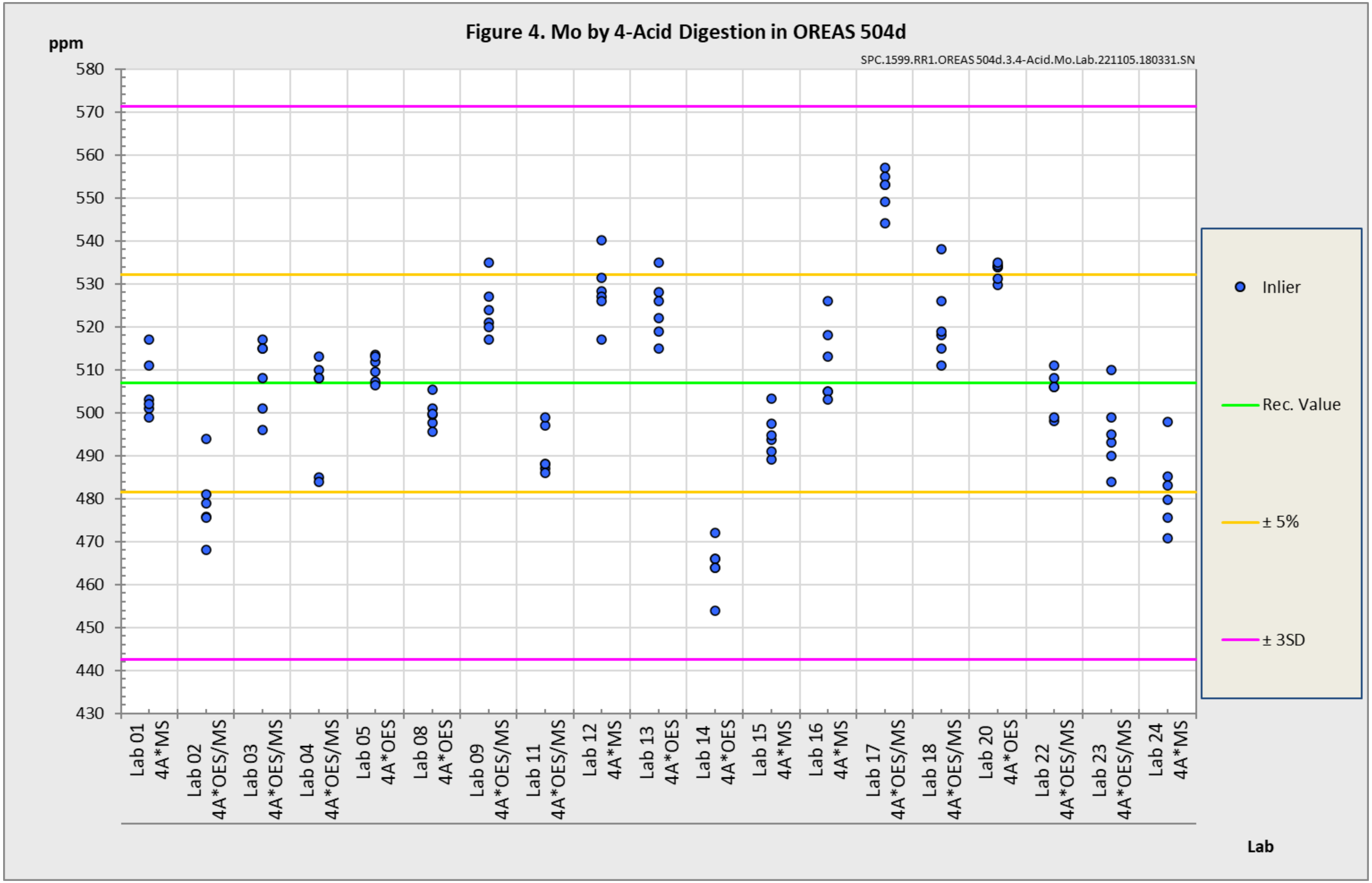


Figure 4. Mo by 4-Acid Digestion in OREAS 504d
ppm
SPC.1599.RR1.OREAS 504d.3.4-Acid.Mo.Lab.221105.180331.SN
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
Lab 01 4A*MS
Lab 02 4A*OES/MS
Lab 03 4A*OES/MS
Lab 04 4A*OES/MS
Lab 05 4A*OES
Lab 08 4A*OES
Lab 09 4A*OES/MS
Lab 11 4A*OES/MS
Lab 12 4A*MS
Lab 13 4A*OES
Lab 14 4A*OES
Lab 15 4A*MS
Lab 16 4A*MS
Lab 17 4A*OES/MS
Lab 18 4A*OES/MS
Lab 20 4A*OES
Lab 22 4A*OES/MS
Lab 23 4A*OES/MS
Lab 24 4A*MS
Lab
Inlier
Rec. Value
± 5%
± 3SD

# METROLOGICAL TRACEABILITY

The interlaboratory results that underpin the certified values are metrologically traceable to the international measurement scale (SI) of mass (either as a % mass fraction, as milligrams per kilogram (mg/kg) or micrograms per kilogram (µg/kg). In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%) or parts per million (ppm).

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 undertaken by ORE Pty Ltd) 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.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation.* ***In other cases, only a comparison among different laboratories using the same procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand*** *(ISO Guide 35:2017, 9.2.4c)."* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

# COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. Being matrix-matched, OREAS 504d will display similar behaviour in the relevant measurement process to the routine 'process' samples for which OREAS 504d is designated to monitor. To maintain commutability, care should be taken to always ensure 'matrix matching' as close as practically achievable. The matrix of the CRM is described in the 'Source Material' section and users should select appropriate CRMs matching these attributes to their field samples.

# INTENDED USE

OREAS 504d is intended to cover all activities needed to produce a measurement result. This includes extraction, possible separation steps and the actual measurement process (the signal producing step). OREAS 504d may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution. OREAS 504d 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.

# MINIMUM SAMPLE SIZE

To relate analytical determinations to the values in this certificate, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory (round robin) certification program. This means that different minimum sample masses should be used depending on the operationally defined methodology as follows:

- Au by fire assay: ≥10g;
- Au by aqua regia digestion ICP finish: ≥1g.;
- 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥0.5g.

# PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 504d remains valid, within the specified measurement uncertainties, until October 2037, provided the CRM is handled and stored in accordance with the instructions given below. This certification is nullified if the CRM is any way changed or contaminated.

Store in a clean and cool dry place away from direct sunlight.

Long-term stability will be monitored at appropriate intervals and purchasers notified if any changes are observed. The period of validity may well be indefinite and will be reassessed prior to expiry with the aim of extending the validity if possible.

### Single-use sachets

OREAS 504d has been prepared from a blend of porphyry copper-gold ore, barren granodiorite and a minor quantity of Cu-Mo concentrate. It is low in reactive sulphide (1.1 wt.% S). In its unopened state and under normal conditions of storage it has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

### Repeat-use packaging (e.g., 500g plastic jars)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 504d contains a non-hygroscopic* matrix with an indicative value for moisture provided to enable users to check for changes to stored material by determining moisture in the user's laboratory and comparing the result to the value in Table 3 in this certificate.

The stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is negligible given its low sulphur concentration (1.1 wt.% S).

*A non-hygroscopic matrix means exposure to atmospheres significantly different, in terms of temperature and humidity, from the climate during manufacturing should have negligible impact on the precision of results. Hygroscopic moisture is the amount of adsorped moisture (weakly held $H_2O$- molecules on the surface of exposed material) following exposure to the local atmosphere. Usually, equilibration of material to the local atmosphere will only occur if the material is spread into a thin (~2mm thick) layer and left exposed for a period of 2 hours.

## INSTRUCTIONS FOR HANDLING & CORRECT USE

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [13].

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

### QC monitoring using multiples of the Standard Deviation (SD)

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 interlaboratory 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.

The performance gates shown in Table 1 are intended only to be used as a preliminary guide as to what a laboratory may be able to achieve. Over a period of time monitoring your own laboratory's data for this CRM, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the 95% expanded uncertainty then generally there is no cause for concern in regard to bias.

### For use with the aqua regia digestion method

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. This method is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions and can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements.

The approach applied here is to report certified values in those instances where reasonable agreement exists amongst a majority of participating laboratories. The results of specific laboratories may differ significantly from the certified values, but will, nonetheless, be valid and reproducible in the context of the specifics of the aqua regia method in use. Users of this reference material should, therefore, be mindful of this limitation when applying the certified values in a quality control program.

## 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.

## DOCUMENT HISTORY

| Revision No. | Date | Changes applied |
|---|---|---|
| 1 | 1st September, 2023 | Added M&T and Minerology data. |
| 0 | 7th November, 2022 | First publication. |

## QMS ACCREDITATION

vORE Pty Ltd is accredited for compliance with ISO 17034.

ORE Pty Ltd is accredited to ISO 9001:2015 by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.

## CERTIFYING OFFICER

1st September, 2023

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

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