African Mineral Standards
MATRIX REFERENCE MATERIALS

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# AMIS0192

## *Certified Reference Material*

## Platinum (PGM), Merensky Ore
## Bushveld Complex, South Africa

## *Certificate of Analysis*

## Recommended Concentrations and Limits[1.]
### *(at two Standard Deviations)*

### *Certified Concentrations[2]*

| | | | | |
|---|---|---|---|---|
| Pt Pb Collection | 7.93 | ± | 0.40 | g/t |
| Pd Pb Collection | 4.04 | ± | 0.18 | g/t |
| Au Pb Collection | 1.68 | ± | 0.12 | g/t |
| Pt NIS | 7.86 | ± | 0.52 | g/t |
| Pd NIS | 4.04 | ± | 0.16 | g/t |
| Au NIS | 1.61 | ± | 0.12 | g/t |
| Rh NiS | 1.01 | ± | 0.08 | g/t |
| Co M/ICP | 179 | ± | 14 | ppm |
| Co P | 131 | ± | 15 | ppm |
| Cu M/ICP | 1562 | ± | 112 | ppm |
| Cu P | 1550 | ± | 104 | ppm |
| Ni M/ICP | 2776 | ± | 258 | ppm |
| Ni P | 2556 | ± | 236 | ppm |
| Ni XRF | 2909 | ± | 264 | ppm |
| Specific Gravity | 3.10 | ± | 0.16 | |

### *Provisional Concentrations*

| | | | | |
|---|---|---|---|---|
| Ir NiS | 0.40 | ± | 0.08 | g/t |
| Ru NiS | 1.78 | ± | 0.30 | g/t |

*4E (Pt, Pd, Au (all NiS) & Rh) = 14.51 g/t*

1. *Manufacturers recommended limits for use of the material as control samples, based on two standard deviations, calculated using "Between Laboratory" statistics for treatment of the data for trivial, non-trivial and technically invalid results. See sections 1, 9 and 12.*
2. *There is additional certified major element data presented on p2 and uncertified trace element data presented as an appendix.*

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# Major Element Recommended Concentrations and two "Between Laboratory" Standard Deviations

## *Certified Concentrations*

| | | | | |
|---|---|---|---|---|
| $Al_2O_3$ | 12.22 | ± | 0.16 | % |
| CaO | 6.58 | ± | 0.14 | % |
| $Cr_2O_3$ | 2.99 | ± | 0.10 | % |
| $Fe_2O_3$ | 11.92 | ± | 0.22 | % |
| $K_2O$ | 0.15 | ± | 0.01 | % |
| MgO | 15.13 | ± | 0.30 | % |
| MnO | 0.17 | ± | 0.014 | % |
| $Na_2O$ | 0.90 | ± | 0.03 | % |
| $SiO_2$ | 48.23 | ± | 0.50 | % |
| $TiO_2$ | 0.24 | ± | 0.01 | % |
| S LECO | 0.63 | ± | 0.08 | % |

## *Informational Concentration*

| | | |
|---|---|---|
| LOI | 0.86 | % |

**1. Intended Use:** AMIS0192 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of PGE, Cu and Ni ores; derived from the Merensky Reef, or from other mafic rocks with a similar grade and matrix.

It is a matrix matched Certified Reference Material, fit for use as control samples in routine assay laboratory quality control when inserted within runs of samples and measured in parallel to the unknown. Its purpose is to monitor inter-laboratory or instrument bias and within lab precision. It can be used, indirectly, to establish the traceability of results to an SI system of units.

The recommended concentrations and limits for this material are property values based on a measurement campaign (round robin) and reflect consensus results from the laboratories that participated in the round robin.

Slight variations in analytical procedures between laboratories will reflect as slight biases to the recommended concentrations (see Section 19). Good laboratories will report results within the two standard deviation levels with a failure rate of <10 %.

The material can also be used for method development and for the calibration of equipment.

**2. Origin of Material:** AMIS0192 is a commissioned CRM made from material supplied by SGS Minerals Services, using Anglo Platinum - Merensky Reef underground sample material, from the Western Limb of the Bushveld complex.

**3. Mineral and Chemical Composition:** The Merensky Reef comprises components of feldspathic pyroxenite, pyroxenite and anorthosite. Peak PGE values are associated with a thin chromitite stringer. Mineralization in this Merensky Reef comprises 2-5% disseminated or net textured magmatic sulphides, predominantly pyrrhotite, pentlandite, chalcopyrite and pyrite. The PGE's occur as micron-sized satellite grains around but rarely within the sulphides.

Major element chemistry data from 18 of the labs has been compiled and certified. Uncertified summary statistics for trace element data are set out in the appendix.

**4. Appearance:** The material is a very fine powder. It is colored a Medium Dark Grey (Corstor).

**5. Handling instructions:** The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

**6. Method of Preparation**: The material was crushed, dry-milled and air-classified to <54um. Wet sieve partic**l**e size analysis of random samples confirmed the material was 98.5% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and the consensus test results were carried out by independent statisticians.

**7. Methods of Analysis requested:**

1. Pt, Pd and Au. ICP-OES or ICP-MS, Pb collection with Ag as a co-collector.
2. Au, Pt, Pd, Rh, Ru and Ir. ICP-MS, nickel sulphide collection.
3. Cu and Ni. Multi-acid total digestion, including HF, with ICP-OES finish.
4. Cu and Ni. Aqua regia digestion with ICP-OES finish.
5. Cr, Co, Cu and Ni. Pressed pellet XRF.
6. Cr, Co, Cu and Ni. Fusion, ICP-OES or ICP-MS
7. Specific Gravity. Gas pycnometer.
8. XRF (major elements).
9. Multi acid digest ICP scan – trace elements.

**8. Information requested:**

1. Aliquots used for all determinations.
2. Results for individual PGM's reported in ppb.
3. Results for base metals reported in ppm.
4. QC data, to include replicates blanks and certified reference materials used.
5. Analytical techniques used.

**9. Method of Certification:** Twenty six laboratories were each given eight randomly selected packages of sample. Twenty one of the laboratories submitted results.

The final limits were calculated after a three step examination of the data, first removing incompatible data outside a spread normally expected for similar analytical methods done by reputable laboratories. Then, data from any one laboratory was removed from further calculations, if the mean of all analyses from that laboratory failed a t-test of the global means of the other laboratories. Next, data that fell outside of the 2 standard deviations were removed. The mean and standard deviations were then re-calculated.

Analytes with an RSD of near or less than 5 % are reported as “Certified Concentrations” with limits at two “Between Laboratory” standard deviations. Those with RSD’s of between near 5 % and 15 % are reported as “Provisional Concentrations” with limits at two “Between Laboratory” standard deviations. Those with RSD’s over 15 % are reported as “Informational Values”.

This method is different from that used by Government agencies in that the actual “between-laboratory” standard deviation is used in the calculations. This produces upper and lower limits that reflect actual individual analyses rather than a grouped set of analyses. The limits can therefore be used to monitor accuracy from individual analyses, unlike the Confidence Limits published on other standards**.**

**10. Participating Laboratories:** The 21 out of 26 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Activation Laboratories Pty Ltd (ActLabs) CA
2. ALS Chemex Laboratory Group Johannesburg SA
3. ALS Chemex Laboratory Group Lima Peru
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. Anglo Platinum - Eastern Bushveld Regional Laboratory
7. Anglo Research (South Africa)
8. Genalysis Laboratory Services (South Africa) Pty
9. Genalysis Laboratory Services WA
10. Northam Platinum LTD
11. Performance Laboratories SA
12. Rappa Research Laboratory SA
13. Set Point Laboratories (Isando) SA
14. SGS Australia Pty Ltd (Newburn) WA
15. SGS Geosol Laboratories Ltda (Brazil)
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booysens JHB
19. SGS Toronto (Canada)
20. SGS Townsville (Australia)
21. Ultra Trace (Pty) Ltd WA

**11. Assay Data:** Data as received from the laboratories for the important certified elements are set out below.

**Economic element data**

| Lab Order | Pt PbColl g/t | Pd PbColl g/t | Au PbColl g/t | Pt NiS g/t | Pd NiS g/t | Au NiS g/t | Ir NiS g/t | Rh NiS g/t | Ru NiS g/t | Co M/ICP ppm | Co P ppm | Co XRF ppm | Cu M/ICP ppm | Cu P ppm | Cu XRF ppm | Ni M/ICP ppm | Ni P ppm | Ni XRF ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 6.78 | 3.98 | 1.71 | | | | | | | 178 | 126 | | 1665 | 1670 | | 2820 | 2520 | |
| A | 8.07 | 3.78 | 1.67 | | | | | | | 181 | 129 | | 1680 | 1700 | | 2860 | 2560 | |
| A | 7.99 | 4.01 | 1.72 | | | | | | | 179 | 129 | | 1665 | 1680 | | 2830 | 2510 | |
| A | 8.03 | 4.14 | 1.86 | | | | | | | 179 | 129 | | 1685 | 1660 | | 2890 | 2540 | |
| A | 7.71 | 4.04 | 1.80 | | | | | | | 180 | 127 | | 1695 | 1670 | | 2870 | 2510 | |
| A | 7.89 | 4.12 | 1.80 | | | | | | | 185 | 129 | | 1705 | 1710 | | 2930 | 2520 | |
| A | 8.01 | 4.00 | 1.72 | | | | | | | 180 | 128 | | 1680 | 1670 | | 2830 | 2520 | |
| A | 7.91 | 3.97 | 1.82 | | | | | | | 185 | 130 | | 1710 | 1690 | | 2900 | 2550 | |
| B | | | | | | | | | | | | | | | | | | |
| B | 8.33 | 4.09 | 1.61 | | | | | | | 186 | 125 | | 1635 | 1590 | | 2780 | 2440 | |
| B | 8.29 | 4.09 | 1.63 | | | | | | | 186 | 127 | | 1630 | 1620 | | 2800 | 2440 | |
| B | 8.21 | 4.05 | 1.64 | | | | | | | 188 | 125 | | 1640 | 1605 | | 2780 | 2440 | |
| B | 8.14 | 4.00 | 1.69 | | | | | | | 176 | 127 | | 1525 | 1605 | | 2650 | 2480 | |
| B | 8.23 | 4.10 | 1.66 | | | | | | | 175 | 122 | | 1520 | 1580 | | 2600 | 2410 | |
| B | 8.37 | 4.11 | 1.69 | | | | | | | 186 | 126 | | 1630 | 1610 | | 2750 | 2450 | |
| B | 7.37 | 3.62 | 1.45 | | | | | | | 185 | 126 | | 1605 | 1600 | | 2760 | 2430 | |
| C | 8.33 | 4.28 | 1.62 | | | | | | | 169 | 132 | | 1540 | 1535 | | 2690 | 2400 | |
| C | 8.21 | 4.25 | 1.64 | | | | | | | 169 | 133 | | 1530 | 1525 | | 2700 | 2430 | |
| C | 8.53 | 4.34 | 1.68 | | | | | | | 167 | 135 | | 1525 | 1565 | | 2650 | 2470 | |
| C | 8.52 | 4.37 | 1.65 | | | | | | | 165 | 134 | | 1510 | 1525 | | 2600 | 2420 | |
| C | 8.51 | 4.37 | 1.63 | | | | | | | 172 | 137 | | 1545 | 1590 | | 2660 | 2470 | |
| C | 8.18 | 4.21 | 1.63 | | | | | | | 168 | 134 | | 1510 | 1570 | | 2660 | 2470 | |
| C | 8.34 | 4.32 | 1.64 | | | | | | | 168 | 134 | | 1525 | 1555 | | 2660 | 2470 | |
| C | 8.56 | 4.35 | 1.72 | | | | | | | 167 | 132 | | 1520 | 1550 | | 2630 | 2380 | |
| D | 8.03 | 4.03 | 1.78 | | | | | | | 168 | 132 | | 1605 | 1980 | | 2790 | 2730 | |
| D | 8.03 | 4.02 | 1.77 | | | | | | | 173 | 131 | | 1635 | 1910 | | 2850 | 2670 | |
| D | 8.18 | 4.09 | 1.80 | | | | | | | 172 | 136 | | 1670 | 2020 | | 2880 | 2790 | |
| D | 8.32 | 4.14 | 1.78 | | | | | | | 175 | 134 | | 1660 | 1910 | | 2910 | 2690 | |
| D | 8.06 | 4.00 | 1.68 | | | | | | | 176 | 131 | | 1695 | 1930 | | 2910 | 2710 | |
| D | 8.22 | 4.09 | 1.74 | | | | | | | 173 | 130 | | 1675 | 1900 | | 2890 | 2650 | |
| D | 8.06 | 4.06 | 1.69 | | | | | | | 172 | 135 | | 1665 | 2010 | | 2890 | 2750 | |
| D | 8.16 | 4.06 | 1.72 | | | | | | | 175 | 133 | | 1600 | 1940 | | 2870 | 2700 | |
| E | 7.82 | 3.72 | 1.78 | | | | | | | 178 | 124 | 200 | 1376 | 1385 | 1900.00 | 2701 | 2388 | 3000 |
| E | 7.74 | 3.68 | 1.65 | | | | | | | 178 | 121 | 300 | 1396 | 1414 | 1400.00 | 2685 | 2445 | 3100 |
| E | 7.97 | 3.86 | 1.82 | | | | | | | 173 | 120 | 300 | 1314 | 1393 | 1500.00 | 2692 | 2347 | 3100 |
| E | 7.75 | 3.33 | 1.66 | | | | | | | 177 | 122 | 200 | 1340 | 1396 | 1600.00 | 2585 | 2392 | 2900 |
| E | 7.83 | 3.60 | 1.76 | | | | | | | 158 | 120 | 300 | 1320 | 1402 | 1400.00 | 2596 | 2379 | 2800 |
| E | 7.78 | 3.50 | 1.67 | | | | | | | 169 | 120 | 300 | 1395 | 1397 | 1700.00 | 2614 | 2313 | 2900 |
| E | 7.87 | 3.63 | 1.70 | | | | | | | 178 | 122 | 300 | 1359 | 1390 | 1500.00 | 2595 | 2395 | 2900 |
| E | 7.27 | 3.30 | 1.59 | | | | | | | 176 | 118 | 300 | 1343 | 1371 | 1600.00 | 2571 | 2361 | 2800 |
| F | 5.63 | 2.47 | 1.22 | | | | | | | 171 | 124 | | 1470 | 1460 | | 2660 | 2400 | |
| F | 6.89 | 2.92 | 1.40 | | | | | | | 180 | 127 | | 1530 | 1470 | | 2710 | 2460 | |
| F | 5.44 | 2.62 | 1.35 | | | | | | | 175 | 127 | | 1580 | 1520 | | 2680 | 2430 | |
| F | 6.53 | 2.85 | 1.38 | | | | | | | 175 | 131 | | 1520 | 1490 | | 2730 | 2500 | |
| F | 7.03 | 3.15 | 1.46 | | | | | | | 174 | 134 | | 1500 | 1500 | | 2690 | 2550 | |
| F | 7.31 | 3.16 | 1.53 | | | | | | | 178 | 129 | | 1530 | 1450 | | 2770 | 2470 | |
| F | 7.00 | 2.91 | 1.53 | | | | | | | 175 | 128 | | 1560 | 1510 | | 2780 | 2460 | |
| F | 7.65 | 3.43 | 1.61 | | | | | | | 179 | 131 | | 1530 | 1490 | | 2770 | 2480 | |

## Economic element data (cont)

| Lab Order | Pt PbColl g/t | Pd PbColl g/t | Au PbColl g/t | Pt NiS g/t | Pd NiS g/t | Au NiS g/t | Ir NiS g/t | Rh NiS g/t | Ru NiS g/t | Co M/ICP ppm | Co P ppm | Co XRF ppm | Cu M/ICP ppm | Cu P ppm | Cu XRF ppm | Ni M/ICP ppm | Ni P ppm | Ni XRF ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G | 7.70 | 4.20 | 1.58 | | | | | | | 182 | 144 | | 1550 | 1550 | | 2620 | 2460 | |
| G | 7.56 | 4.09 | 1.57 | | | | | | | 183 | 144 | | 1500 | 1570 | | 2550 | 2450 | |
| G | 7.77 | 4.21 | 1.62 | | | | | | | 182 | 145 | | 1530 | 1570 | | 2630 | 2470 | |
| G | 7.85 | 4.18 | 1.61 | | | | | | | 185 | 145 | | 1580 | 1580 | | 2660 | 2470 | |
| G | 7.53 | 4.12 | 1.62 | | | | | | | 186 | 144 | | 1680 | 1580 | | 2760 | 2450 | |
| G | 7.77 | 4.19 | 1.80 | | | | | | | 185 | 150 | | 1550 | 1590 | | 2670 | 2500 | |
| G | 7.68 | 4.25 | 1.65 | | | | | | | 188 | 145 | | 1580 | 1580 | | 2690 | 2470 | |
| G | 7.69 | 4.18 | 1.75 | | | | | | | 183 | 144 | | 1650 | 1550 | | 2820 | 2430 | |
| H | 7.78 | 4.05 | 1.64 | | | | | | | 175 | 138 | | 1536 | 1588 | | 2808 | 2589 | |
| H | 7.64 | 4.03 | 1.61 | | | | | | | 176 | 133 | | 1602 | 1569 | | 2843 | 2583 | |
| H | 7.68 | 3.91 | 1.58 | | | | | | | 176 | 135 | | 1617 | 1594 | | 2885 | 2616 | |
| H | 7.69 | 4.05 | 1.54 | | | | | | | 175 | 142 | | 1636 | 1608 | | 2853 | 2629 | |
| H | 7.73 | 4.02 | 1.58 | | | | | | | 168 | 141 | | 1564 | 1637 | | 2787 | 2669 | |
| H | 7.63 | 4.02 | 1.57 | | | | | | | 172 | 142 | | 1552 | 1648 | | 2765 | 2692 | |
| H | 7.86 | 4.07 | 1.56 | | | | | | | 171 | 141 | | 1588 | 1633 | | 2850 | 2685 | |
| H | 7.84 | 4.16 | 1.60 | | | | | | | 166 | 140 | | 1548 | 1582 | | 2748 | 2624 | |
| I | 7.96 | 4.01 | 1.63 | | | | | | | | 140 | 200 | | 1400 | 1800.00 | | 2200 | 3000 |
| I | 7.76 | 4.01 | 1.68 | | | | | | | | 130 | 200 | | 1400 | 1600.00 | | 2100 | 2900 |
| I | 7.69 | 3.90 | 1.67 | | | | | | | | 130 | 200 | | 1300 | 1700.00 | | 2000 | 3000 |
| I | 7.72 | 3.92 | 1.61 | | | | | | | | 130 | 200 | | 1400 | 1700.00 | | 2100 | 3000 |
| I | 7.84 | 3.97 | 1.66 | | | | | | | | 120 | 100 | | 1200 | 1700.00 | | 1800 | 3000 |
| I | 7.79 | 3.97 | 1.67 | | | | | | | | 120 | 200 | | 1200 | 1700.00 | | 1900 | 3000 |
| I | 7.87 | 4.04 | 1.73 | | | | | | | | 130 | 200 | | 1400 | 1700.00 | | 2200 | 3000 |
| I | 7.82 | 3.99 | 1.61 | | | | | | | | 120 | 200 | | 1300 | 1500.00 | | 2000 | 3000 |
| J | 7.99 | 3.99 | 1.74 | | | | | | | 150 | 114 | | 1554 | 1536 | | 2558 | 2143 | 3003 |
| J | 8.04 | 4.12 | 1.68 | | | | | | | 148 | 111 | | 1555 | 1543 | | 2544 | 2167 | 2989 |
| J | 8.01 | 3.99 | 1.78 | | | | | | | 149 | 112 | | 1554 | 1549 | | 2518 | 2231 | 3006 |
| J | 8.14 | 4.13 | 1.76 | | | | | | | 147 | 113 | | 1534 | 1540 | | 2534 | 2209 | 2991 |
| J | 8.12 | 4.13 | 1.77 | | | | | | | 149 | 115 | | 1527 | 1547 | | 2562 | 2164 | 2960 |
| J | 7.97 | 4.03 | 1.65 | | | | | | | 145 | 113 | | 1511 | 1534 | | 2595 | 2135 | 2990 |
| J | 8.05 | 4.03 | 1.65 | | | | | | | 148 | 112 | | 1537 | 1545 | | 2529 | 2129 | 2959 |
| J | 7.95 | 4.08 | 1.68 | | | | | | | 149 | 114 | | 1525 | 1535 | | 2570 | 2198 | 3005 |
| K | 8.04 | 4.17 | 1.67 | 7.97 | 4.12 | 1.72 | 0.33 | 0.94 | 1.65 | 159 | 140 | 174 | 1730 | 1520 | 1448.00 | 2550 | 2620 | 2711 |
| K | 8.00 | 4.18 | 1.71 | 7.97 | 4.09 | 1.64 | 0.34 | 0.97 | 1.67 | 156 | 130 | 178 | 1720 | 1510 | 1464.00 | 2520 | 2640 | 2736 |
| K | 8.06 | 4.08 | 1.67 | 7.86 | 4.09 | 1.69 | 0.29 | 0.94 | 1.65 | 154 | 130 | 180 | 1770 | 1510 | 1456.00 | 2420 | 2630 | 2735 |
| K | 8.00 | 4.07 | 1.68 | 8.02 | 4.10 | 1.64 | 0.30 | 0.94 | 1.67 | 148 | 140 | 176 | 1750 | 1660 | 1473.00 | 2400 | 2670 | 2760 |
| K | 8.13 | 4.10 | 1.63 | 8.03 | 4.16 | 1.68 | 0.34 | 0.99 | 1.67 | 154 | 130 | 178 | 1770 | 1540 | 1474.00 | 2460 | 2550 | 2767 |
| K | 8.09 | 4.10 | 1.77 | 8.02 | 4.13 | 1.63 | 0.36 | 0.97 | 1.72 | 157 | 140 | 169 | 1720 | 1460 | 1467.00 | 2480 | 2630 | 2749 |
| K | 8.08 | 4.14 | 1.66 | 8.02 | 4.05 | 1.66 | 0.32 | 0.96 | 1.63 | 141 | 140 | 176 | 1680 | 1510 | 1466.00 | 2300 | 2620 | 2739 |
| K | 8.07 | 4.18 | 1.72 | 8.04 | 4.08 | 1.65 | 0.31 | 0.97 | 1.65 | 150 | 140 | 181 | 1710 | 1500 | 1462.00 | 2420 | 2550 | 2726 |
| N | 7.95 | 4.00 | 1.63 | 8.18 | 4.03 | 1.61 | 0.39 | 1.02 | 1.66 | 190 | 138 | 190 | 1580 | 1560 | 1580.00 | 3000 | 2620 | 3040 |
| N | 7.85 | 4.00 | 1.65 | 8.12 | 4.10 | 1.72 | 0.38 | 1.00 | 1.75 | 190 | 135 | 190 | 1550 | 1590 | 1590.00 | 2990 | 2620 | 3050 |
| N | 7.95 | 4.05 | 1.75 | 8.20 | 4.07 | 1.81 | 0.39 | 1.03 | 1.89 | 195 | 143 | 180 | 1590 | 1600 | 1570.00 | 3020 | 2650 | 3050 |
| N | 7.95 | 4.05 | 1.70 | 7.93 | 4.02 | 1.77 | 0.39 | 1.00 | 1.60 | 185 | 143 | 190 | 1570 | 1580 | 1590.00 | 3020 | 2690 | 3060 |
| N | 7.95 | 4.05 | 1.73 | 7.91 | 4.04 | 1.63 | 0.39 | 1.04 | 1.90 | 185 | 139 | 180 | 1560 | 1570 | 1580.00 | 2960 | 2650 | 3060 |
| N | 7.90 | 3.95 | 1.66 | 8.12 | 4.12 | 1.66 | 0.39 | 1.05 | 1.89 | 190 | 134 | 190 | 1570 | 1580 | 1580.00 | 2950 | 2600 | 3040 |
| N | 7.90 | 3.95 | 1.67 | 7.91 | 4.08 | 1.63 | 0.39 | 1.03 | 1.88 | 190 | 140 | 190 | 1590 | 1610 | 1590.00 | 3040 | 2700 | 3060 |
| N | 7.90 | 3.95 | 1.68 | 7.94 | 4.04 | 1.61 | 0.38 | 1.01 | 1.83 | 190 | 142 | 190 | 1560 | 1590 | 1590.00 | 2970 | 2620 | 3050 |
| P | 7.90 | 3.41 | 1.46 | | | | | | | 183 | 186 | | 1519 | 1519 | | 2753 | 2755 | |
| P | 8.99 | 3.79 | 1.74 | | | | | | | 189 | 180 | | 1511 | 1511 | | 2759 | 2753 | |
| P | 7.93 | 3.48 | 1.50 | | | | | | | 189 | 186 | | 1514 | 1514 | | 2749 | 2755 | |
| P | 8.98 | 3.94 | 1.75 | | | | | | | 183 | 189 | | 1518 | 1518 | | 2753 | 2749 | |
| P | 8.82 | 3.96 | 1.69 | | | | | | | 182 | 175 | | 1508 | 1508 | | 2766 | 2761 | |
| P | 8.65 | 3.67 | 1.68 | | | | | | | 186 | 180 | | 1514 | 1514 | | 2745 | 2753 | |
| P | 8.72 | 4.00 | 1.74 | | | | | | | 178 | 186 | | 1508 | 1508 | | 2766 | 2766 | |
| P | 8.16 | 3.51 | 1.51 | | | | | | | 180 | 174 | | 1498 | 1498 | | 2746 | 2752 | |
| Q | 8.17 | 4.06 | 1.65 | | | | | | | | | | | | | | | |
| Q | 8.19 | 4.14 | 1.62 | | | | | | | | | | | | | | | |
| Q | 8.01 | 4.16 | 1.68 | | | | | | | | | | | | | | | |
| Q | 8.10 | 4.05 | 1.64 | | | | | | | | | | | | | | | |
| Q | 8.07 | 4.04 | 1.62 | | | | | | | | | | | | | | | |
| Q | 8.11 | 4.06 | 1.65 | | | | | | | | | | | | | | | |
| Q | 8.02 | 4.16 | 1.68 | | | | | | | | | | | | | | | |
| Q | 8.15 | 4.07 | 1.61 | | | | | | | | | | | | | | | |
| S | 7.26 | 3.68 | | | | | | 0.94 | | | | | 1552 | | | 2848 | | |
| S | 7.97 | 4.09 | | | | | | 1.04 | | | | | 1386 | | | 2799 | | |
| S | 7.65 | 3.89 | | | | | | 0.99 | | | | | 1567 | | | 2879 | | |
| S | 7.52 | 3.90 | | | | | | 0.99 | | | | | 1594 | | | 2898 | | |
| S | 7.96 | 3.96 | | | | | | 1.02 | | | | | 1564 | | | 2837 | | |
| S | 7.88 | 3.80 | | | | | | 0.98 | | | | | 1567 | | | 2848 | | |
| S | 7.43 | 3.61 | | | | | | 0.92 | | | | | 1467 | | | 2734 | | |
| S | 7.01 | 3.45 | | | | | | 0.88 | | | | | 1559 | | | 2857 | | |
| T | 7.93 | 3.99 | 1.75 | 7.72 | 3.95 | 1.60 | 0.41 | 1.05 | 1.84 | 188 | 128 | | 1594 | 1459 | | 2983 | 2444 | |
| T | 7.94 | 3.89 | 1.79 | 7.64 | 3.90 | 1.52 | 0.41 | 1.04 | 1.80 | 191 | 129 | | 1615 | 1468 | | 3026 | 2395 | |
| T | 7.59 | 3.89 | 1.62 | 7.88 | 4.04 | 1.66 | 0.41 | 1.07 | 1.84 | 186 | 128 | | 1565 | 1467 | | 3014 | 2446 | |
| T | 8.13 | 3.94 | 1.76 | 7.62 | 4.01 | 1.55 | 0.40 | 1.06 | 1.81 | 189 | 132 | | 1560 | 1501 | | 2917 | 2509 | |
| T | 7.98 | 4.05 | 1.78 | 7.55 | 4.00 | 1.57 | 0.40 | 1.03 | 1.81 | 191 | 122 | | 1608 | 1371 | | 2966 | 2405 | |
| T | 7.89 | 3.97 | 1.79 | 7.85 | 4.05 | 1.55 | 0.41 | 1.06 | 1.84 | 193 | 131 | | 1563 | 1480 | | 2967 | 2498 | |
| T | 7.96 | 3.96 | 1.70 | 7.71 | 3.94 | 1.53 | 0.40 | 1.07 | 1.78 | 183 | 128 | | 1559 | 1454 | | 2906 | 2476 | |
| T | 8.00 | 4.05 | 1.78 | 7.84 | 3.97 | 1.63 | 0.40 | 1.05 | 1.74 | 194 | 130 | | 1627 | 1479 | | 3092 | 2502 | |
| U | 7.87 | 3.91 | 1.65 | 7.74 | 3.86 | 1.57 | 0.36 | 0.96 | 1.71 | | | | | | | | | |
| U | 7.92 | 3.90 | 1.64 | 7.56 | 3.87 | 1.59 | 0.37 | 0.96 | 1.71 | | | | | | | | | |
| U | 7.97 | 3.88 | 1.67 | 7.54 | 3.92 | 1.57 | 0.37 | 0.95 | 1.75 | | | | | | | | | |
| U | 7.74 | 3.96 | 1.67 | 7.50 | 4.00 | 1.56 | 0.36 | 0.97 | 1.68 | | | | | | | | | |
| U | 7.89 | 4.05 | 1.62 | 7.57 | 3.93 | 1.58 | 0.37 | 0.97 | 1.72 | | | | | | | | | |
| U | 7.71 | 3.97 | 1.69 | 7.80 | 3.89 | 1.53 | 0.37 | 0.97 | 1.73 | | | | | | | | | |
| U | 7.82 | 3.87 | 1.67 | 7.65 | 3.89 | 1.56 | 0.37 | 0.95 | 1.74 | | | | | | | | | |
| U | 7.89 | 3.89 | 1.65 | 7.84 | 4.03 | 1.56 | 0.36 | 0.96 | 1.76 | | | | | | | | | |
| W | | | | | | | | | | 180 | 125 | | 1462 | 1554 | | 2695 | 2522 | |
| W | | | | | | | | | | 175 | 127 | | 1443 | 1551 | | 2675 | 2506 | |
| W | | | | | | | | | | 172 | 123 | | 1448 | 1544 | | 2882 | 2477 | |
| W | | | | | | | | | | 171 | 123 | | 1427 | 1533 | | 2951 | 2420 | |
| W | | | | | | | | | | 183 | 124 | | 1509 | 1584 | | 2774 | 2561 | |
| W | | | | | | | | | | 175 | 125 | | 1490 | 1580 | | 2825 | 2586 | |
| W | | | | | | | | | | 177 | 122 | | 1485 | 1579 | | 2962 | 2589 | |
| W | | | | | | | | | | 182 | 120 | | 1474 | 1579 | | 2883 | 2560 | |
| X | 7.87 | 4.08 | 1.70 | 7.51 | 4.06 | 1.56 | 0.42 | 1.03 | 1.92 | 179 | 160 | 205 | 1559 | 1524 | 1538.00 | 2762 | 2671 | 2754 |
| X | 7.75 | 4.08 | 1.64 | 8.03 | 4.08 | 1.66 | 0.45 | 1.06 | 1.95 | 179 | 160 | 196 | 1560 | 1527 | 1534.00 | 2767 | 2693 | 2735 |
| X | 7.56 | 3.99 | 1.67 | 7.61 | 4.03 | 1.55 | 0.42 | 1.03 | 1.90 | 180 | 160 | 198 | 1550 | 1514 | 1538.00 | 2740 | 2657 | 2760 |
| X | 7.71 | 4.05 | 1.63 | 8.04 | 4.06 | 1.62 | 0.45 | 1.05 | 1.93 | 181 | 162 | 190 | 1560 | 1527 | 1539.00 | 2742 | 2700 | 2745 |
| X | 7.55 | 3.96 | 1.64 | 7.82 | 4.10 | 1.59 | 0.47 | 1.09 | 1.98 | 180 | 160 | 203 | 1552 | 1500 | 1539.00 | 2726 | 2616 | 2760 |
| X | 7.81 | 4.09 | 1.70 | 7.95 | 4.08 | 1.65 | 0.45 | 1.06 | 1.96 | 181 | 158 | 209 | 1566 | 1518 | 1528.00 | 2726 | 2656 | 2731 |
| X | 7.81 | 4.04 | 1.61 | 7.88 | 4.10 | 1.55 | 0.44 | 1.05 | 1.94 | 182 | 159 | 193 | 1560 | 1528 | 1535.00 | 2740 | 2700 | 2745 |
| X | 7.84 | 4.08 | 1.65 | 7.72 | 4.09 | 1.60 | 0.44 | 1.05 | 1.95 | 180 | 159 | 190 | 1557 | 1526 | 1546.00 | 2757 | 2700 | 2752 |

## Economic element data (cont)

| Lab Order | Pt PbColl g/t | Pd PbColl g/t | Au PbColl g/t | Pt NIS g/t | Pd NIS g/t | Au NIS g/t | Ir NiS g/t | Rh NiS g/t | Ru NiS g/t | Co M/ICP ppm | Co P ppm | Co XRF ppm | Cu M/ICP ppm | Cu P ppm | Cu XRF ppm | Ni M/ICP ppm | Ni P ppm | Ni XRF ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y | | | | 7.76 | 4.04 | 1.65 | 0.39 | 1.02 | 1.55 | | | | | | | | | |
| Y | | | | 7.32 | 3.87 | 1.75 | 0.37 | 0.96 | 1.43 | | | | | | | | | |
| Y | | | | 7.30 | 3.90 | 1.74 | 0.38 | 0.97 | 1.48 | | | | | | | | | |
| Y | | | | 7.80 | 4.09 | 1.56 | 0.41 | 1.04 | 1.66 | | | | | | | | | |
| Y | | | | 7.63 | 4.00 | 1.43 | 0.39 | 1.02 | 1.56 | | | | | | | | | |
| Y | | | | 7.52 | 4.02 | 1.66 | 0.39 | 1.00 | 1.55 | | | | | | | | | |
| Y | | | | 7.49 | 4.01 | 1.56 | 0.38 | 1.02 | 1.57 | | | | | | | | | |
| Y | | | | 7.54 | 4.00 | 1.51 | 0.39 | 1.00 | 1.56 | | | | | | | | | |
| Z | | | | 8.24 | 4.10 | 1.54 | 0.50 | 1.04 | 2.01 | | | | | | | | | |
| Z | | | | 8.21 | 4.11 | 1.55 | 0.44 | 1.03 | 1.97 | | | | | | | | | |
| Z | | | | 8.34 | 4.16 | 1.60 | 0.45 | 1.05 | 1.99 | | | | | | | | | |
| Z | | | | 8.27 | 4.14 | 1.57 | 0.48 | 1.05 | 2.03 | | | | | | | | | |
| Z | | | | 8.28 | 4.10 | 1.58 | 0.52 | 1.05 | 2.01 | | | | | | | | | |
| Z | | | | 8.20 | 4.06 | 1.57 | 0.46 | 1.03 | 1.96 | | | | | | | | | |
| Z | | | | 8.32 | 4.13 | 1.56 | 0.44 | 1.05 | 2.01 | | | | | | | | | |
| Z | | | | 7.37 | 3.60 | 1.41 | 0.36 | 0.90 | 1.74 | | | | | | | | | |

## Major element data

| Lab Order | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | LOI % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | S Comb/LECO % | SG pyc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 12.15 | 6.39 | 2.92 | 11.40 | 0.14 | 0.70 | 14.90 | 0.17 | 0.89 | 46.70 | 0.22 | 0.72 | 2.96 |
| A | 12.15 | 6.37 | 2.89 | 11.35 | 0.14 | 0.77 | 14.90 | 0.17 | 0.89 | 46.70 | 0.21 | 0.73 | 2.97 |
| A | 12.15 | 6.38 | 2.95 | 11.30 | 0.14 | 0.89 | 14.95 | 0.16 | 0.89 | 46.60 | 0.23 | 0.73 | 2.98 |
| A | 12.15 | 6.38 | 2.98 | 11.30 | 0.14 | 0.89 | 14.90 | 0.16 | 0.89 | 46.60 | 0.22 | 0.72 | 2.98 |
| A | 12.15 | 6.40 | 2.95 | 11.30 | 0.14 | 0.76 | 14.95 | 0.16 | 0.89 | 46.70 | 0.22 | 0.72 | 2.97 |
| A | 12.15 | 6.38 | 2.96 | 11.35 | 0.14 | 0.70 | 14.95 | 0.17 | 0.90 | 46.60 | 0.22 | 0.74 | 2.97 |
| A | 12.10 | 6.39 | 3.00 | 11.35 | 0.14 | 0.68 | 14.95 | 0.17 | 0.89 | 46.70 | 0.22 | 0.72 | 2.99 |
| A | 12.15 | 6.38 | 2.86 | 11.45 | 0.14 | 0.79 | 14.90 | 0.17 | 0.89 | 46.50 | 0.22 | 0.72 | 2.94 |
| B | | | | | | | | | | | | | |
| B | 12.55 | 6.45 | 2.89 | 11.42 | 0.16 | 0.91 | 15.32 | 0.16 | 0.90 | 48.25 | 0.25 | 0.67 | 3.19 |
| B | 12.60 | 6.42 | 2.88 | 11.43 | 0.16 | 0.88 | 15.30 | 0.16 | 0.90 | 48.52 | 0.25 | 0.69 | 3.11 |
| B | 12.60 | 6.45 | 2.89 | 11.43 | 0.16 | 0.89 | 15.29 | 0.16 | 0.90 | 48.31 | 0.25 | 0.68 | 3.20 |
| B | 12.66 | 6.47 | 2.90 | 11.54 | 0.16 | 0.88 | 15.41 | 0.16 | 0.91 | 48.50 | 0.24 | 0.67 | 3.12 |
| B | 12.53 | 6.45 | 2.89 | 11.43 | 0.16 | 0.90 | 15.28 | 0.16 | 0.90 | 48.45 | 0.24 | 0.67 | 3.09 |
| B | 12.65 | 6.47 | 2.90 | 11.47 | 0.16 | 0.87 | 15.36 | 0.17 | 0.91 | 48.67 | 0.25 | 0.68 | 3.17 |
| B | 12.60 | 6.45 | 2.90 | 11.45 | 0.16 | 0.87 | 15.32 | 0.17 | 0.91 | 48.54 | 0.25 | 0.68 | 3.02 |
| C | 12.30 | 6.50 | 2.99 | 11.65 | 0.13 | 0.71 | 14.65 | 0.17 | 0.85 | 48.10 | 0.24 | | 2.98 |
| C | 12.35 | 6.53 | 2.99 | 11.65 | 0.13 | 0.74 | 14.70 | 0.17 | 0.86 | 48.20 | 0.24 | | 3.00 |
| C | 12.25 | 6.51 | 2.97 | 11.60 | 0.13 | 0.74 | 14.65 | 0.17 | 0.85 | 48.10 | 0.25 | | 2.96 |
| C | 12.25 | 6.49 | 2.97 | 11.60 | 0.13 | 0.68 | 14.65 | 0.17 | 0.85 | 48.00 | 0.24 | | 2.95 |
| C | 12.30 | 6.54 | 3.01 | 11.70 | 0.13 | 0.69 | 14.75 | 0.17 | 0.86 | 48.40 | 0.24 | | 2.96 |
| C | 12.30 | 6.53 | 3.00 | 11.70 | 0.13 | 0.72 | 14.70 | 0.17 | 0.86 | 48.20 | 0.24 | | 2.95 |
| C | 12.25 | 6.52 | 2.98 | 11.60 | 0.13 | 0.77 | 14.70 | 0.17 | 0.86 | 48.10 | 0.26 | | 2.95 |
| C | 12.35 | 6.58 | 3.03 | 11.80 | 0.13 | 0.69 | 14.80 | 0.17 | 0.85 | 48.60 | 0.24 | | 2.95 |
| D | | | | | | | | | | | | 0.77 | 3.11 |
| D | | | | | | | | | | | | 0.76 | 3.12 |
| D | | | | | | | | | | | | 0.78 | 3.12 |
| D | | | | | | | | | | | | 0.76 | 3.12 |
| D | | | | | | | | | | | | 0.77 | 3.11 |
| D | | | | | | | | | | | | 0.77 | 3.11 |
| D | | | | | | | | | | | | 0.77 | 3.12 |
| D | | | | | | | | | | | | 0.78 | 3.12 |
| E | 12.30 | 6.60 | 3.20 | 12.00 | 0.15 | 0.83 | 15.40 | 0.19 | 0.93 | 48.40 | 0.26 | | |
| E | 12.20 | 6.54 | 3.38 | 12.00 | 0.14 | 0.86 | 15.40 | 0.17 | 0.92 | 48.00 | 0.25 | | |
| E | 12.20 | 6.52 | 3.17 | 11.80 | 0.15 | 0.82 | 15.20 | 0.18 | 0.92 | 47.90 | 0.24 | | |
| E | 12.20 | 6.57 | 3.16 | 12.10 | 0.15 | 0.99 | 15.40 | 0.18 | 0.89 | 48.50 | 0.24 | | |
| E | 12.20 | 6.53 | 3.19 | 11.90 | 0.15 | 0.85 | 15.40 | 0.18 | 0.90 | 48.00 | 0.23 | | |
| E | 12.20 | 6.52 | 3.32 | 12.00 | 0.15 | 0.81 | 15.30 | 0.19 | 0.90 | 48.00 | 0.25 | | |
| E | 12.20 | 6.51 | 3.20 | 12.00 | 0.15 | 0.93 | 15.40 | 0.18 | 0.88 | 48.10 | 0.24 | | |
| E | 12.10 | 6.51 | 3.20 | 12.00 | 0.15 | 0.95 | 15.30 | 0.18 | 0.91 | 48.10 | 0.24 | | |
| G | | | | | | | | | | | | 0.60 | 3.16 |
| G | | | | | | | | | | | | 0.60 | 3.15 |
| G | | | | | | | | | | | | 0.58 | 3.20 |
| G | | | | | | | | | | | | 0.58 | 3.18 |
| G | | | | | | | | | | | | 0.58 | 3.17 |
| G | | | | | | | | | | | | 0.59 | 3.21 |
| G | | | | | | | | | | | | 0.58 | 3.16 |
| G | | | | | | | | | | | | 0.60 | 3.20 |
| H | 12.20 | 6.60 | 3.01 | 11.90 | 0.15 | 0.43 | 15.20 | 0.17 | 0.92 | 48.00 | 0.25 | 0.78 | |
| H | 12.20 | 6.61 | 3.02 | 11.90 | 0.15 | 0.43 | 15.10 | 0.17 | 0.92 | 48.00 | 0.25 | 0.76 | |
| H | 12.20 | 6.61 | 3.02 | 11.90 | 0.15 | 0.39 | 15.20 | 0.17 | 0.92 | 48.00 | 0.25 | 0.72 | |
| H | 12.20 | 6.60 | 3.00 | 11.90 | 0.15 | 0.51 | 15.10 | 0.17 | 0.91 | 48.00 | 0.24 | 0.65 | |
| H | 12.20 | 6.59 | 3.00 | 11.90 | 0.15 | 0.47 | 15.10 | 0.17 | 0.92 | 48.00 | 0.24 | 0.62 | |
| H | 12.20 | 6.60 | 3.01 | 11.90 | 0.15 | 0.55 | 15.10 | 0.17 | 0.90 | 48.00 | 0.25 | 0.60 | |
| H | 12.20 | 6.59 | 3.01 | 11.90 | 0.15 | 0.56 | 15.10 | 0.17 | 0.92 | 48.00 | 0.25 | 0.59 | |
| H | 12.20 | 6.60 | 3.01 | 11.90 | 0.15 | 0.46 | 15.20 | 0.17 | 0.90 | 48.00 | 0.25 | 0.79 | |

## Major element data (cont)

| Lab Order | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | LOI % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | S Comb/LECO % | SG pyc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 12.20 | 6.72 | 3.06 | 12.00 | 0.15 | 1.02 | 15.00 | 0.16 | 0.89 | 48.20 | 0.24 | 0.60 | |
| I | 12.20 | 6.67 | 3.06 | 11.90 | 0.15 | 1.00 | 15.00 | 0.17 | 0.89 | 47.90 | 0.23 | 0.63 | |
| I | 12.20 | 6.68 | 3.06 | 11.90 | 0.14 | 0.98 | 15.00 | 0.16 | 0.88 | 48.00 | 0.24 | 0.65 | |
| I | 12.10 | 6.63 | 3.05 | 11.90 | 0.15 | 0.93 | 15.00 | 0.16 | 0.89 | 47.80 | 0.25 | 0.65 | |
| I | 12.10 | 6.67 | 3.06 | 11.90 | 0.15 | 1.14 | 15.00 | 0.16 | 0.89 | 47.80 | 0.23 | 0.63 | |
| I | 12.10 | 6.67 | 3.05 | 11.90 | 0.15 | 1.05 | 15.00 | 0.16 | 0.89 | 47.90 | 0.24 | 0.64 | |
| I | 12.00 | 6.67 | 3.04 | 11.90 | 0.15 | 1.11 | 14.90 | 0.17 | 0.89 | 47.70 | 0.23 | 0.62 | |
| I | 12.10 | 6.64 | 3.04 | 11.80 | 0.15 | 1.05 | 15.00 | 0.16 | 0.89 | 47.70 | 0.24 | 0.62 | |
| J | | | | | | | | | | | | 0.61 | 2.98 |
| J | | | | | | | | | | | | 0.62 | 2.95 |
| J | | | | | | | | | | | | 0.62 | 2.85 |
| J | | | | | | | | | | | | 0.62 | 3.22 |
| J | | | | | | | | | | | | 0.61 | 2.95 |
| J | | | | | | | | | | | | 0.60 | 2.99 |
| J | | | | | | | | | | | | 0.61 | 2.97 |
| J | | | | | | | | | | | | 0.62 | 3.02 |
| K | 12.20 | 6.55 | 3.02 | 11.80 | 0.17 | 0.87 | 14.80 | 0.17 | 0.88 | 47.40 | 0.23 | 0.62 | 3.09 |
| K | 12.40 | 6.74 | 3.08 | 12.20 | 0.18 | 0.96 | 15.10 | 0.17 | 0.93 | 48.40 | 0.24 | 0.64 | 3.12 |
| K | 12.40 | 6.69 | 3.23 | 12.30 | 0.18 | 1.00 | 15.00 | 0.18 | 0.90 | 48.40 | 0.25 | 0.64 | 3.11 |
| K | 12.30 | 6.74 | 3.09 | 12.00 | 0.18 | 0.99 | 15.00 | 0.18 | 0.89 | 48.20 | 0.24 | 0.61 | 3.11 |
| K | 12.30 | 6.70 | 3.13 | 11.90 | 0.18 | 1.04 | 15.00 | 0.17 | 0.89 | 47.90 | 0.24 | 0.63 | 3.11 |
| K | 12.50 | 6.76 | 3.10 | 12.10 | 0.17 | 1.47 | 15.20 | 0.16 | 0.92 | 48.50 | 0.23 | 0.63 | 3.11 |
| K | 12.30 | 6.70 | 3.06 | 11.90 | 0.18 | 1.06 | 15.00 | 0.17 | 0.91 | 48.10 | 0.24 | 0.63 | 3.12 |
| K | 12.30 | 6.66 | 3.09 | 12.00 | 0.17 | 1.06 | 15.10 | 0.17 | 0.91 | 48.20 | 0.24 | 0.62 | 3.09 |
| N | 12.22 | 6.58 | 2.96 | 11.95 | 0.15 | 0.74 | 15.05 | 0.16 | | 48.36 | 0.24 | 0.64 | 3.11 |
| N | 12.22 | 6.58 | 2.97 | 11.94 | 0.15 | 0.77 | 15.06 | 0.16 | | 48.36 | 0.24 | 0.63 | 3.09 |
| N | 12.24 | 6.58 | 2.97 | 11.94 | 0.15 | 0.78 | 15.07 | 0.16 | | 48.37 | 0.24 | 0.64 | 3.07 |
| N | 12.24 | 6.59 | 2.98 | 11.95 | 0.15 | 0.74 | 15.07 | 0.16 | | 48.35 | 0.24 | 0.62 | 3.08 |
| N | 12.21 | 6.58 | 2.96 | 11.94 | 0.15 | 0.76 | 15.07 | 0.16 | | 48.35 | 0.24 | 0.62 | 3.07 |
| N | 12.23 | 6.59 | 2.96 | 11.93 | 0.15 | 0.75 | 15.08 | 0.16 | | 48.33 | 0.24 | 0.62 | 3.11 |
| N | 12.22 | 6.60 | 2.96 | 11.94 | 0.15 | 0.76 | 15.06 | 0.16 | | 48.29 | 0.24 | 0.64 | 3.10 |
| N | 12.22 | 6.59 | 2.95 | 11.93 | 0.15 | 0.75 | 15.05 | 0.16 | | 48.32 | 0.24 | 0.62 | 3.08 |
| P | | | | | | | | | | | | 0.63 | |
| P | | | | | | | | | | | | 0.67 | |
| P | | | | | | | | | | | | 0.53 | |
| P | | | | | | | | | | | | 0.54 | |
| P | | | | | | | | | | | | 0.65 | |
| P | | | | | | | | | | | | 0.65 | |
| P | | | | | | | | | | | | 0.58 | |
| P | | | | | | | | | | | | 0.62 | |
| Q | | | | | | | | | | | | | 3.13 |
| Q | | | | | | | | | | | | | 3.15 |
| Q | | | | | | | | | | | | | 3.13 |
| Q | | | | | | | | | | | | | 3.12 |
| Q | | | | | | | | | | | | | 3.13 |
| Q | | | | | | | | | | | | | 3.13 |
| Q | | | | | | | | | | | | | 3.13 |
| Q | | | | | | | | | | | | | 3.13 |
| S | | | | | | | | | | | | | 3.07 |
| S | | | | | | | | | | | | | 3.24 |
| S | | | | | | | | | | | | | 3.10 |
| S | | | | | | | | | | | | | 3.08 |
| S | | | | | | | | | | | | | 3.26 |
| S | | | | | | | | | | | | | 3.09 |
| S | | | | | | | | | | | | | 3.23 |
| S | | | | | | | | | | | | | 3.19 |
| T | 12.10 | 6.60 | 3.03 | 12.03 | 0.15 | 0.69 | 15.08 | 0.17 | 0.92 | 48.46 | 0.24 | 0.63 | 3.15 |
| T | 12.21 | 6.61 | 3.03 | 12.12 | 0.15 | 0.68 | 15.11 | 0.17 | 0.91 | 48.53 | 0.24 | 0.60 | 3.16 |
| T | 12.19 | 6.62 | 3.03 | 12.04 | 0.15 | 0.67 | 15.06 | 0.17 | 0.93 | 48.37 | 0.24 | 0.64 | 3.10 |
| T | 12.14 | 6.62 | 3.03 | 12.04 | 0.15 | 0.66 | 15.09 | 0.17 | 0.92 | 48.45 | 0.24 | 0.63 | 3.03 |
| T | 12.22 | 6.60 | 3.03 | 12.02 | 0.15 | 0.68 | 15.07 | 0.17 | 0.90 | 48.49 | 0.24 | 0.63 | 3.03 |
| T | 12.24 | 6.61 | 3.03 | 12.12 | 0.15 | 0.64 | 15.08 | 0.17 | 0.90 | 48.52 | 0.24 | 0.62 | 3.22 |
| T | 12.15 | 6.62 | 3.03 | 12.08 | 0.15 | 0.68 | 15.09 | 0.17 | 0.89 | 48.57 | 0.24 | 0.57 | 3.13 |
| T | 12.10 | 6.60 | 3.03 | 12.03 | 0.15 | 0.63 | 15.09 | 0.17 | 0.92 | 48.51 | 0.24 | 0.60 | 3.12 |
| U | | | | | | | | | | | | | 3.16 |
| U | | | | | | | | | | | | | 3.16 |
| U | | | | | | | | | | | | | 3.15 |
| U | | | | | | | | | | | | | 3.16 |
| U | | | | | | | | | | | | | 3.17 |
| U | | | | | | | | | | | | | 3.16 |
| U | | | | | | | | | | | | | 3.17 |
| U | | | | | | | | | | | | | 3.17 |
| X | 12.40 | 6.61 | 2.98 | 11.87 | 0.15 | 1.06 | 15.40 | 0.18 | 1.00 | 48.50 | 0.19 | 0.63 | 3.10 |
| X | 12.30 | 6.60 | 2.97 | 11.84 | 0.15 | 1.06 | 15.30 | 0.18 | 1.00 | 48.30 | 0.19 | 0.64 | 3.11 |
| X | 12.20 | 6.48 | 2.94 | 11.68 | 0.14 | 1.06 | 15.10 | 0.18 | 1.00 | 48.40 | 0.18 | 0.62 | 3.10 |
| X | 12.20 | 6.55 | 2.98 | 11.82 | 0.15 | 1.09 | 15.20 | 0.18 | 1.00 | 48.30 | 0.19 | 0.62 | 3.10 |
| X | 12.40 | 6.59 | 2.97 | 11.99 | 0.15 | 1.06 | 15.50 | 0.19 | 1.00 | 48.80 | 0.19 | 0.61 | 3.10 |
| X | 12.30 | 6.58 | 2.96 | 11.80 | 0.14 | 1.04 | 15.30 | 0.18 | 1.00 | 48.20 | 0.18 | 0.63 | 3.10 |
| X | 12.30 | 6.55 | 2.96 | 11.83 | 0.15 | 1.02 | 15.20 | 0.18 | 1.00 | 47.90 | 0.18 | 0.63 | 3.10 |
| X | 12.50 | 6.65 | 2.99 | 11.92 | 0.16 | 1.07 | 15.50 | 0.18 | 1.00 | 48.70 | 0.19 | 0.65 | 3.10 |
| Z | | | | | | | | | | | | | 3.17 |
| Z | | | | | | | | | | | | | 3.15 |
| Z | | | | | | | | | | | | | 3.12 |
| Z | | | | | | | | | | | | | 3.20 |
| Z | | | | | | | | | | | | | 3.23 |
| Z | | | | | | | | | | | | | 3.17 |
| Z | | | | | | | | | | | | | 3.16 |
| Z | | | | | | | | | | | | | 3.12 |

## 12. Measurement of Uncertainty:

The samples used in this certification process have been selected in such a way as to represent the entire batch of material and were taken from the final packaged units; therefore all possible sources of uncertainty (sample uncertainty and measurement uncertainty) are included in the final combined standard uncertainty determination. The uncertainty measurement takes into consideration the between lab and the within lab variances and is calculated from the square roots of the variances of these components using the formula:

*Combined standard uncertainty=sqrt((between lab.var/no of labs) + ( mean square within lab.var /no of assays))*

These uncertainty measurements may be used by laboratories as a component for calculating the total uncertainty for method validation according to ISO guidelines.

| Analyte | Method | unit | S [1] | $\sigma_L$ [2] | Sw [3] | CSU [4] |
|---|---|---|---|---|---|---|
| Pt | PbColl | g/t | 0.198 | 0.117 | 0.106 | 0.031 |
| Pd | PbColl | g/t | 4.037 | 0.050 | 0.062 | 0.015 |
| Au | PbColl | g/t | 0.063 | 0.029 | 0.048 | 0.008 |
| Pt | NIS | g/t | 0.260 | 0.216 | 0.177 | 0.085 |
| Pd | NIS | g/t | 0.077 | 0.072 | 0.044 | 0.028 |
| Au | NIS | g/t | 0.059 | 0.038 | 0.048 | 0.016 |
| Ir | NiS | g/t | 0.038 | 0.038 | 0.017 | 0.014 |
| Rh | NiS | g/t | 0.042 | 0.038 | 0.022 | 0.014 |
| Ru | NiS | g/t | 0.146 | 0.149 | 0.064 | 0.057 |
| Co | M/ICP | ppm | 6.98 | 4.94 | 3.25 | 1.409 |
| Co | P | ppm | 7.26 | 5.20 | 3.30 | 1.480 |
| Cu | M/ICP | ppm | 55.5 | 34.7 | 31.2 | 9.77 |
| Cu | P | ppm | 51.9 | 36.4 | 23.7 | 10.4 |
| Ni | M/ICP | ppm | 129 | 88 | 53.1 | 23.2 |
| Ni | P | ppm | 118 | 87 | 36.7 | 23.4 |
| Ni | XRF | ppm | 132 | 152 | 52.0 | 62.3 |
| Al2O3 | XRF | % | 0.077 | 0.059 | 0.049 | 0.020 |
| CaO | XRF | % | 0.066 | 0.056 | 0.030 | 0.019 |
| Cr2O3 | XRF | % | 0.054 | 0.049 | 0.018 | 0.017 |
| Fe2O3 | XRF | % | 0.110 | 0.090 | 0.065 | 0.033 |
| K2O | XRF | % | 0.005 | 0.005 | 0.003 | 0.002 |
| LOI | | % | 0.146 | 0.134 | 0.050 | 0.045 |
| MgO | XRF | % | 0.150 | 0.135 | 0.055 | 0.045 |
| MnO | XRF | % | 0.007 | 0.005 | 0.003 | 0.002 |
| Na2O | XRF | % | 0.014 | 0.009 | 0.011 | 0.004 |
| SiO2 | XRF | % | 0.247 | 0.182 | 0.161 | 0.064 |
| TiO2 | XRF | % | 0.006 | 0.003 | 0.005 | 0.001 |
| S | Comb/LECO | % | 0.038 | 0.028 | 0.019 | 0.009 |
| SG | pyc | | 0.079 | 0.051 | 0.043 | 0.014 |

1. *S - Std Dev for use on control charts.*
2. *$\sigma_L$ - Betw Lab Std Dev, for use to calculate a measure of accuracy.*
3. *Sw - Within Lab Stc Dev, for use to calculate a measure of precision.*
4. *CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.*

**13. Uncertified values:** The Certified, Provisional and Indicated values listed on p1 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Dr Barry Smee.

**14. Metrological Traceability:** The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the standards used by the individual laboratories the majority of which are accredited and who have maintained measurement traceability during the analytical process.

**15. Certification:** AMIS0192 is a new material.

**16. Period of validity:** The certified values are valid for this product, while still sealed in its original packaging, until notification to the contrary. The stability of the material will be subject to continuous testing for the duration of the inventory. Should product stability become an issue, all customers will be notified and notification to that effect will be placed on the www.amis.co.za website.

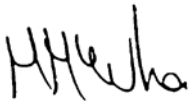
**17. Minimum sample size:** The majority of laboratories reporting used a 0.5g sample size for the ICP and a 30g sample size for the fire assay. These are the recommended minimum sample sizes for the use of this material.

**18. Availability:** This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50 to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, nitrogen flushed and vacuum sealed in foil pouches.

**19. Legal Notice:** This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

18 November 2011

**Certifying Officers:**



**African Mineral Standards:**_____

**Mike McWha**
**BSc (Hons), FGSSA, MAusIMM, Pr.Sci.Nat**

**Geochemist:**_____

**Barry W. Smee**
**BSc, PhD, P.Geo, (B.C.)**

## Appendix – uncertified trace element statistics

| Analyte | Method | Unit | Mean | 2SD | RSD% | n |
|---|---|---|---|---|---|---|
| Ag | M/ICP | ppm | 0.77 | 0.31 | 20.18 | 60 |
| Al | M/ICP | % | 6.61 | 0.47 | 3.52 | 107 |
| As | M/ICP | ppm | 10.04 | 2.92 | 14.56 | 66 |
| Ba | M/ICP | ppm | 65.93 | 10.19 | 7.73 | 95 |
| Be | M/ICP | ppm | 0.18 | 0.05 | 14.22 | 37 |
| Bi | M/ICP | ppm | 1.07 | 0.17 | 7.84 | 56 |
| Ca | M/ICP | % | 4.57 | 0.32 | 3.50 | 108 |
| Cd | M/ICP | ppm | 0.20 | 0.04 | 9.90 | 47 |
| Ce | M/ICP | ppm | 14.27 | 2.49 | 8.73 | 40 |
| Cr | M/ICP | ppm | 17136 | 5764 | 16.82 | 56 |
| Cs | M/ICP | ppm | 0.23 | 0.05 | 11.52 | 31 |
| Dy | M/ICP | ppm | 0.86 | 0.05 | 2.68 | 8 |
| Er | M/ICP | ppm | 0.56 | 0.07 | 6.29 | 8 |
| Eu | M/ICP | ppm | 0.31 | 0.05 | 7.41 | 8 |
| Fe | M/ICP | % | 8.14 | 0.75 | 4.58 | 94 |
| Ga | M/ICP | ppm | 12.69 | 1.38 | 5.43 | 53 |
| Gd | M/ICP | ppm | 0.80 | | | 8 |
| Ge | M/ICP | ppm | 0.26 | 0.27 | 51.94 | 23 |
| Hf | M/ICP | ppm | 0.57 | 0.10 | 8.80 | 35 |
| Ho | M/ICP | ppm | 0.19 | 0.02 | 5.38 | 8 |
| In | M/ICP | ppm | 0.04 | 0.01 | 13.84 | 35 |
| K | M/ICP | % | 0.13 | 0.02 | 6.65 | 107 |
| La | M/ICP | ppm | 8.06 | 1.74 | 10.80 | 61 |
| Li | M/ICP | ppm | 4.49 | 0.92 | 10.26 | 83 |
| Lu | M/ICP | ppm | 0.10 | 0.02 | 11.13 | 16 |
| Mg | M/ICP | % | 9.06 | 0.35 | 1.93 | 84 |
| Mn | M/ICP | ppm | 1238 | 136 | 5.49 | 94 |
| Mo | M/ICP | ppm | 2.82 | 0.63 | 11.07 | 69 |
| Na | M/ICP | % | 0.67 | 0.06 | 4.39 | 101 |
| Nb | M/ICP | ppm | 1.33 | 0.23 | 8.60 | 45 |
| Nd | M/ICP | ppm | 5.34 | 0.14 | 1.30 | 8 |
| P | M/ICP | ppm | 118 | 36.57 | 15.45 | 73 |
| Pb | M/ICP | ppm | 54.54 | 5.81 | 5.32 | 91 |
| Pr | M/ICP | ppm | 1.50 | 0.07 | 2.25 | 8 |
| Rb | M/ICP | ppm | 4.48 | 0.43 | 4.78 | 46 |
| Re | M/ICP | ppm | 0.01 | 0.002 | 15.40 | 23 |
| S | M/ICP | % | 0.63 | 0.06 | 4.38 | 74 |
| Sb | M/ICP | ppm | 2.08 | 0.50 | 12.04 | 54 |
| Sc | M/ICP | ppm | 18.04 | 1.54 | 4.26 | 69 |
| Se | M/ICP | ppm | 4.47 | 1.45 | 16.22 | 38 |
| Si | M/ICP | % | 22.43 | 0.37 | 0.82 | 8 |
| Sm | M/ICP | ppm | 0.91 | 0.07 | 3.87 | 8 |
| Sn | M/ICP | ppm | 1.12 | 0.26 | 11.64 | 39 |
| Sr | M/ICP | ppm | 165 | 23.98 | 7.25 | 100 |
| Ta | M/ICP | ppm | 0.15 | 0.15 | 51.21 | 35 |
| Tb | M/ICP | ppm | 0.14 | 0.01 | 2.80 | 14 |
| Te | M/ICP | ppm | 1.25 | 0.36 | 14.34 | 48 |
| Th | M/ICP | ppm | 2.22 | 0.33 | 7.44 | 46 |
| Ti | M/ICP | % | 0.14 | 0.02 | 5.92 | 92 |
| Tl | M/ICP | ppm | 0.10 | 0.02 | 10.02 | 36 |
| U | M/ICP | ppm | 13.05 | 1.80 | 6.90 | 48 |
| V | M/ICP | ppm | 217 | 20.71 | 4.78 | 78 |
| W | M/ICP | ppm | 0.45 | 0.10 | 11.28 | 39 |
| Y | M/ICP | ppm | 4.51 | 0.51 | 5.64 | 72 |
| Yb | M/ICP | ppm | 0.59 | 0.04 | 3.51 | 15 |
| Zn | M/ICP | ppm | 121.64 | 19.37 | 7.96 | 85 |
| Zr | M/ICP | ppm | 20.33 | 7.02 | 17.27 | 84 |