



## AMIS0201

### *Certified Reference Material*

**Copper cobalt oxide ore  
Tenke Fungurume, DRC**

### *Certificate of Analysis*

#### **Recommended Concentrations and Limits<sup>1</sup> (at two Standard Deviations)**

#### ***Certified Concentrations<sup>2</sup>***

|                  |      |   |      |     |
|------------------|------|---|------|-----|
| Co F             | 3059 | ± | 120  | ppm |
| Co M/ICP         | 3091 | ± | 128  | ppm |
| Co P             | 2999 | ± | 210  | ppm |
| Cu F             | 5.99 | ± | 0.44 | %   |
| Cu M/ICP         | 6.07 | ± | 0.29 | %   |
| Cu P             | 5.88 | ± | 0.40 | %   |
| Specific Gravity | 2.87 | ± | 0.14 |     |

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.

# Major Element Recommended Concentrations and Limits (at two Standard Deviations)

## ***Certified Concentrations***

|                                |       |   |       |   |
|--------------------------------|-------|---|-------|---|
| Al <sub>2</sub> O <sub>3</sub> | 14.11 | ± | 0.70  | % |
| Cr <sub>2</sub> O <sub>3</sub> | 0.030 | ± | 0.002 | % |
| Fe <sub>2</sub> O <sub>3</sub> | 2.40  | ± | 0.08  | % |
| K <sub>2</sub> O               | 3.14  | ± | 0.22  | % |
| MgO                            | 6.44  | ± | 0.54  | % |
| Na <sub>2</sub> O              | 0.099 | ± | 0.010 | % |
| SiO <sub>2</sub>               | 56.51 | ± | 1.00  | % |
| TiO <sub>2</sub>               | 0.77  | ± | 0.04  | % |
| LOI                            | 7.59  | ± | 0.48  | % |

## ***Provisional Concentrations***

|     |       |   |
|-----|-------|---|
| CaO | 0.048 | % |
| MnO | 0.011 | % |

**1. Intended Use:** AMIS0201 can be used to check analysis of samples of copper cobalt ores 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 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:** AMIS0201 is a commissioned CRM made from run-of-mine oxide Cobalt-Copper ore from the Tenke Fungurume (Tenke) mine operated by Freeport- McMoRan Copper & Gold Inc. The mine is situated in Katanga Province of the Democratic Republic of Congo 175km northwest of the regional capital Lubumbashi.

**3. Mineral and Chemical Composition:** The Tenke-Fungurume deposits are sedimentary copper deposits located in the Lufilian arc, an 800 km fold belt formed between the Angolan Plate to the southeast and Congo Plate to the northwest during the late Neoproterozoic approximately 650 to 600 million years before present (Ma). Copper mineralization at Tenke-Fungurume is stratabound and generally restricted to two dolomitic shale horizons (RSF and SDB respectively) each ranging in thickness from 5 to 15 m, separated by 20 m of cellular silicified dolomite (RSC).

The main economic minerals present at Tenke and Fungurume are malachite, chrysocolla, bornite, and heterogenite; the primary copper and cobalt mineralogy is predominately chalcocite (Cu<sub>2</sub>S), digenite (Cu<sub>9</sub>S<sub>5</sub>) bornite (Cu<sub>5</sub>FeS<sub>4</sub>), and carrollite (CuCo<sub>2</sub>S<sub>4</sub>); however oxidation has resulted in widespread alteration producing malachite (Cu<sub>2</sub>CO<sub>3</sub>(OH)<sub>2</sub>), pseudomalachite (Cu<sub>5</sub>(PO<sub>4</sub>)<sub>2</sub>(OH)<sub>4</sub>), chrysocolla (hydrated copper silicate) and heterogenite (Co<sub>3</sub>+O(OH)).

The primary copper-cobalt mineral associations are homogeneous in both mineralized zones and any variations are due to the effect of oxidation and supergene enrichment. Consequently the mineral assemblages can be grouped into three main categories dependent upon the degree of alteration – oxide, mixed and sulfide zone. Dolomite and quartz are the main gangue minerals present. Dolomite or dolomitic rocks make up the bulk of the host strata. Weathering of the host rocks is normally depth related, intensity decreasing with increasing depth, producing hydrated iron oxides and silica at the expense of dolomite, which is leached and removed.

For a detailed description please refer to the Technical Report prepared for Tenke Mining Corp by GRD Minproc Limited available at:

*<http://www.lundinmining.com/i/pdf/TenkeFungurumeFeasibilityStudy.pdf>*

**4. Appearance:** The material is a very fine Yellowish Gray powder (Corstor colour chart – 5Y 8/1).

**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 <54µm. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54µm. 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 consensus test results were carried out by an independent statistician.

**7. Methods of Analysis requested:**

1. Co, Cu. Fusion AAS or ICP-OES (F).
2. Multi-acid digest multi-element scan - ( to include Co, Cu ). ICP-OES or ICP-MS (M/ICP).
3. Aqua regia digest – Co, Cu. ICP-OES or ICP-MS (P).
4. Pressed pellet multi-element scan - ( to include Co, Cu ) (XRF).
5. Majors ( Al<sub>2</sub>O<sub>3</sub>, CaO, Cr<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, MnO, Na<sub>2</sub>O, SiO<sub>2</sub>, TiO<sub>2</sub>. LOI. ) XRF fusion.
6. SG. Gas pycnometer.

Six laboratories with the capability were requested to complete the additional specialized analyses listed below. There are too few results for a formal certification however the results are of interest. This uncertified data is presented in the appendix.

- 1 SOP 06. Quick Leach Test (QLT).
- 2 Acid soluble Cu & Co (Soluble).
- 3 Total Cu, Co, Ca, Mg & Mn (3 Acid).

**8. Information requested:**

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported.
4. All results for base metals to be reported in ppm.
5. Report all QC data, to include replicates, blanks and certified reference materials used.

**9. Method of Certification:** Twenty three laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Twenty two laboratories reported results in time for certification of the economic elements. Fifteen of these laboratories reported results for the major elements.

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a “t test” of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data. Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The “between-laboratory” standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory quality control. This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed “Certified”, RSD’s of between near 5 % and 15 % are termed “Provisional”, and RSD’s over 15 % are termed “Informational”.

**10. Participating Laboratories:** (Not in same order as in the table of assays):

1. Activation Laboratories Pty Ltd (ActLabs) CA
2. Activation Laboratorios Ltda (Chile)
3. Alex Stewart International Corporation Zambia
4. ALS Chemex Laboratory Group Brisbane Australia
5. ALS Chemex Laboratory Group Johannesburg SA
6. ALS Chemex Laboratory Group Perth WA
7. ALS Chemex Laboratory Group Vancouver CA
8. FMI Technology Center
9. Genalysis Laboratory Services (South Africa) Pty
10. Genalysis Laboratory Services WA
11. Intertek Utama Services (Indonesia)
12. Set Point Laboratories (Isando) SA
13. SGS Australia Pty Ltd (Newburn) WA
14. SGS Durango (Mexico)
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
19. SGS Toronto (Canada)
20. Skyline Assayers and Labs
21. Tenke Exploration Fungurume Laboratory
22. Ultra Trace (Pty) Ltd WA

**11. Assay Data:** Data as received from the laboratories for the important certified elements listed on p1 is set out below. A proficiency report has been sent to the managers of the participating laboratories. Additional digital data from this round robin is available on request.

| Lab Code | Co F | Co M/ICP | Co P | Co XRF | Cu F  | Cu M/ICP | Cu P  | Cu P | Al2O3 XRF | CaO XRF | Cr2O3 XRF | Fe2O3 XRF | K2O XRF | MgO XRF | MnO XRF | Na2O XRF | SiO2 XRF | TiO2 XRF | LOI % | SG pyc |
|----------|------|----------|------|--------|-------|----------|-------|------|-----------|---------|-----------|-----------|---------|---------|---------|----------|----------|----------|-------|--------|
| A        | 3180 | 3100     | 2960 |        | 57300 | 58700    | 56100 |      | 14.26     | 0.05    | 0.03      | 2.40      | 3.19    | 6.72    |         | 0.12     | 56.52    | 0.78     | 7.30  | 3.02   |
| A        | 3040 | 3110     | 2970 |        | 56000 | 60300    | 54400 |      | 14.23     | 0.05    | 0.03      | 2.41      | 3.19    | 6.72    | 0.01    | 0.11     | 56.48    | 0.76     | 7.33  | 3.02   |
| A        | 3120 | 3100     | 3030 |        | 58200 | 59800    | 55700 |      | 14.25     | 0.05    | 0.03      | 2.42      | 3.19    | 6.71    | 0.01    | 0.11     | 56.48    | 0.77     | 7.36  | 2.98   |
| A        | 3120 | 3130     | 3000 |        | 58900 | 60800    | 55700 |      | 14.27     | 0.05    | 0.03      | 2.40      | 3.20    | 6.69    | 0.01    | 0.11     | 56.45    | 0.78     | 7.33  | 2.96   |
| A        | 3060 | 3150     | 3000 |        | 56000 | 59600    | 55500 |      | 14.27     | 0.05    | 0.03      | 2.41      | 3.19    | 6.70    | 0.01    | 0.12     | 56.49    | 0.77     | 7.32  | 2.96   |
| A        | 3060 | 3100     | 3090 |        | 59900 | 60100    | 56800 |      | 14.27     | 0.05    | 0.03      | 2.42      | 3.18    | 6.72    | 0.01    | 0.12     | 56.58    | 0.77     | 7.30  | 2.98   |
| A        | 2960 | 3150     | 3030 |        | 55500 | 59500    | 57300 |      | 14.25     | 0.05    | 0.03      | 2.41      | 3.19    | 6.71    | 0.01    | 0.12     | 56.54    | 0.77     | 7.36  | 3.01   |
| A        | 3080 | 3130     | 2980 |        | 57400 | 60000    | 55900 |      | 14.27     | 0.05    | 0.03      | 2.41      | 3.18    | 6.72    | 0.01    | 0.12     | 56.52    | 0.78     | 7.34  | 2.99   |
| C        |      | 3100     |      |        |       | 61000    |       |      |           | 0.04    |           |           |         | 6.22    | 0.01    |          |          |          |       |        |
| C        |      | 3200     |      |        |       | 61600    |       |      |           | 0.03    |           |           |         | 6.35    | 0.01    |          |          |          |       |        |
| C        |      | 3200     |      |        |       | 60800    |       |      |           | 0.03    |           |           |         | 6.17    | 0.01    |          |          |          |       |        |
| C        |      | 3100     |      |        |       | 60600    |       |      |           | 0.04    |           |           |         | 6.05    | 0.01    |          |          |          |       |        |
| C        |      | 3200     |      |        |       | 61500    |       |      |           | 0.04    |           |           |         | 6.25    | 0.01    |          |          |          |       |        |
| C        |      | 3100     |      |        |       | 59600    |       |      |           | 0.03    |           |           |         | 5.92    | 0.01    |          |          |          |       |        |
| C        |      | 3100     |      |        |       | 59500    |       |      |           | 0.03    |           |           |         | 6.05    | 0.01    |          |          |          |       |        |
| C        |      | 3100     |      |        |       | 61100    |       |      |           | 0.03    |           |           |         | 6.05    | 0.01    |          |          |          |       |        |

### Assay data (cont)

| Lab Code | Co F | Co M/ICP | Co P | Co XRF | Cu F  | Cu M/ICP | Cu P  | Cu XRF | Al2O3 XRF | CaO XRF | Cr2O3 XRF | Fe2O3 XRF | K2O XRF | MgO XRF | MnO XRF | Na2O XRF | SiO2 XRF | TiO2 XRF | LOI  | SG pyc |
|----------|------|----------|------|--------|-------|----------|-------|--------|-----------|---------|-----------|-----------|---------|---------|---------|----------|----------|----------|------|--------|
| D        | 2750 | 3290     | 2940 |        | 59400 | 60900    | 56300 |        |           | 0.06    |           |           |         | 6.50    | 0.01    |          |          |          |      |        |
| D        | 2760 | 3290     | 2900 |        | 59800 | 61000    | 55600 |        |           | 0.04    |           |           |         | 6.50    | 0.01    |          |          |          |      |        |
| D        | 2750 | 3320     | 2970 |        | 59500 | 60700    | 56500 |        |           | 0.06    |           |           |         | 6.53    | 0.01    |          |          |          |      |        |
| D        | 2740 | 3320     | 2980 |        | 59700 | 61600    | 56700 |        |           | 0.08    |           |           |         | 6.65    | 0.01    |          |          |          |      |        |
| D        | 2800 | 3320     | 2950 |        | 60400 | 61500    | 56100 |        |           | 0.13    |           |           |         | 6.63    | 0.01    |          |          |          |      |        |
| D        | 2780 | 3320     | 3010 |        | 60400 | 60700    | 57000 |        |           | 0.06    |           |           |         | 6.53    | 0.01    |          |          |          |      |        |
| D        | 2740 | 3310     | 2980 |        | 59800 | 61300    | 55900 |        |           | 0.06    |           |           |         | 6.55    | 0.01    |          |          |          |      |        |
| D        | 2770 | 3290     | 3020 |        | 59800 | 61000    | 57000 |        |           | 0.04    |           |           |         | 6.50    | 0.01    |          |          |          |      |        |
| E        | 3040 |          |      |        | 65700 |          |       |        |           | 0.01    |           |           |         | 5.97    | 0.01    |          |          |          |      |        |
| E        | 3070 |          |      |        | 64180 |          |       |        |           | 0.02    |           |           |         | 6.02    | 0.01    |          |          |          |      |        |
| E        | 3065 |          |      |        | 64235 |          |       |        |           | 0.01    |           |           |         | 6.03    | 0.01    |          |          |          |      |        |
| E        | 3055 |          |      |        | 63120 |          |       |        |           | 0.02    |           |           |         | 5.94    | 0.01    |          |          |          |      |        |
| E        | 3050 |          |      |        | 62585 |          |       |        |           | 0.02    |           |           |         | 6.06    | 0.01    |          |          |          |      |        |
| E        | 3040 |          |      |        | 61975 |          |       |        |           | 0.02    |           |           |         | 5.97    | 0.01    |          |          |          |      |        |
| E        | 3080 |          |      |        | 63280 |          |       |        |           | 0.02    |           |           |         | 6.05    | 0.01    |          |          |          |      |        |
| E        | 3075 |          |      |        | 64305 |          |       |        |           | 0.02    |           |           |         | 6.00    | 0.01    |          |          |          |      |        |
| F        | 3150 | 3134     | 3129 |        | 61492 | 58981    | 60289 |        | 13.93     | 0.06    | 0.03      | 2.37      | 3.34    | 6.35    | 0.01    | 0.10     | 56.91    | 0.75     | 7.45 |        |
| F        | 2936 | 3120     | 3307 |        | 55945 | 59959    | 61859 |        | 12.89     | 0.04    | 0.03      | 2.26      | 2.92    | 5.97    | 0.01    | 0.10     | 56.91    | 0.70     | 7.49 |        |
| F        | 3128 | 3130     | 3189 |        | 58909 | 59398    | 61794 |        | 13.66     | 0.04    | 0.04      | 2.40      | 3.30    | 6.27    | 0.01    | 0.10     | 57.12    | 0.75     | 7.48 |        |
| F        | 2926 | 3018     | 3045 |        | 56337 | 58586    | 60256 |        | 12.81     | 0.06    | 0.03      | 2.24      | 3.07    | 5.87    | 0.01    | 0.10     | 53.49    | 0.70     | 7.46 |        |
| F        | 3104 | 3071     | 3180 |        | 60150 | 59269    | 61419 |        | 13.49     | 0.06    | 0.03      | 2.36      | 3.24    | 6.22    | 0.01    | 0.10     | 55.41    | 0.73     | 7.48 |        |
| F        | 3089 | 3039     | 3148 |        | 59184 | 58940    | 60175 |        | 13.47     | 0.06    | 0.03      | 2.36      | 3.22    | 6.18    | 0.01    | 0.10     | 55.84    | 0.73     | 7.48 |        |
| F        | 3116 | 3098     | 3214 |        | 59660 | 59072    | 61622 |        | 13.91     | 0.06    | 0.03      | 2.39      | 3.22    | 6.27    | 0.01    |          | 58.19    | 0.75     | 7.46 |        |
| F        | 3024 | 3063     | 3240 |        | 57634 | 58827    | 60482 |        | 13.42     | 0.06    | 0.03      | 2.33      | 3.14    | 6.15    | 0.01    | 0.10     | 56.27    | 0.73     | 7.44 |        |
| G        | 2997 | 3075     |      |        | 55049 | 59313    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.80   |
| G        | 2963 | 3004     |      |        | 55985 | 60959    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.83   |
| G        | 2998 | 2980     |      |        | 54957 | 59300    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.82   |
| G        | 3004 | 3081     |      |        | 57828 | 59512    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.82   |
| G        | 2937 | 2973     |      |        | 55388 | 59313    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.79   |
| G        | 2976 | 3028     |      |        | 55919 | 59987    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.80   |
| G        | 3026 | 2983     |      |        | 56907 | 60010    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.85   |
| G        | 2969 | 3031     |      |        | 55291 | 59736    |       |        |           |         |           |           |         |         |         |          |          |          |      | 2.80   |
| H        | 3100 | 3150     | 2860 |        | 60900 | 62800    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3100 | 3130     | 2830 |        | 60700 | 62500    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3070 | 3120     | 2810 |        | 60000 | 62500    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3070 | 3150     | 2850 |        | 60400 | 62300    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3080 | 3120     | 2830 |        | 60800 | 61900    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3070 | 3130     | 2840 |        | 60200 | 62000    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3050 | 3130     | 2820 |        | 60000 | 62900    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| H        | 3090 | 3170     | 2830 |        | 60400 | 62900    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3090     | 3060 |        | 60300 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3200     | 3140 |        | 60200 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3060     | 2980 |        | 60200 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3220     | 2980 |        | 61500 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3100     | 2990 |        | 64200 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3200     | 3010 |        | 61500 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3060     | 2970 |        | 60600 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| I        |      | 3260     | 3100 |        | 60200 |          |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| J        | 2915 | 3013     | 2905 |        | 59609 |          |       |        | 0.07      |         |           | 2.63      | 3.34    | 7.45    | 0.01    | 0.12     |          |          | 0.73 |        |
| J        | 2782 | 3066     | 2825 |        | 55907 |          |       |        | 0.11      |         |           | 2.63      | 3.35    | 7.22    | 0.01    | 0.11     |          |          | 0.71 |        |
| J        | 2847 | 2807     | 2830 |        | 61317 |          |       |        | 0.06      |         |           | 2.20      | 2.91    | 6.17    | 0.01    | 0.10     |          |          | 0.59 |        |
| J        | 3039 | 2640     | 2883 |        | 60194 |          |       |        | 0.05      |         |           | 2.26      | 2.95    | 6.24    | 0.01    | 0.10     |          |          | 0.58 |        |
| J        | 3221 | 2691     | 2901 |        | 64300 |          |       |        | 0.05      |         |           | 2.23      | 2.96    | 6.25    | 0.01    | 0.10     |          |          | 0.56 |        |
| J        | 3047 | 2661     | 2857 |        | 61007 |          |       |        | 0.05      |         |           | 2.20      | 2.87    | 6.04    | 0.01    | 0.09     |          |          | 0.56 |        |
| J        | 3053 | 2664     | 2911 |        | 61230 |          |       |        | 0.05      |         |           | 2.31      | 2.98    | 6.33    | 0.01    | 0.10     |          |          | 0.57 |        |
| J        | 2992 | 2977     | 2937 |        | 61407 |          |       |        | 0.07      |         |           | 2.73      | 3.68    | 7.73    | 0.02    | 0.13     |          |          | 0.69 |        |
| K        |      | 2990     | 3220 |        |       | 63200    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 2990     | 2990 |        |       | 63500    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 3060     | 3110 |        |       | 62800    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 3030     | 3110 |        |       | 62400    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 2830     | 3220 |        |       | 62300    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 2870     | 3160 |        |       | 62900    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 2970     | 3150 |        |       | 62300    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| K        |      | 3060     | 3120 |        |       | 63000    |       |        |           |         |           |           |         |         |         |          |          |          |      |        |
| L        |      | 3020     | 2920 |        | 59100 | 58500    | 61900 | 14.35  | 0.05      | 0.03    | 2.42      | 3.16      | 6.64    | 0.01    | 0.10    | 56.30    | 0.76     | 7.40     |      |        |
| L        |      | 3030     | 2930 |        | 59500 | 58700    | 61900 | 14.45  | 0.05      | 0.03    | 2.43      | 3.17      | 6.66    | 0.01    | 0.10    | 56.50    | 0.76     | 7.41     |      |        |
| L        |      | 3060     | 2910 |        | 60000 | 58600    | 61800 | 14.35  | 0.05      | 0.04    | 2.44      | 3.16      | 6.66    | 0.01    | 0.10    | 56.20    | 0.76     | 7.39     |      |        |
| L        |      | 3000     | 2910 |        | 59300 | 58400    | 61800 | 14.35  | 0.05      | 0.03    | 2.41      | 3.17      | 6.66    | 0.01    | 0.10    | 56.20    | 0.76     | 7.43     |      |        |
| L        |      | 3020     | 2900 |        | 59300 | 58800    | 61600 | 14.35  | 0.05      | 0.04    | 2.42      | 3.17      | 6.67    | 0.01    | 0.10    | 56.30    | 0.75     | 7.41     |      |        |
| L        |      | 3040     | 2930 |        | 60100 | 59100    | 61800 | 14.45  | 0.05      | 0.02    | 2.42      | 3.21      | 6.67    | 0.01    | 0.10    | 56.40    | 0.76     | 7.40     |      |        |
| L        |      | 3020     | 2890 |        | 59200 | 58200    | 61600 | 14.35  | 0.05      | 0.03    | 2.42      | 3.21      | 6.64    | 0.01    | 0.10    | 56.40    | 0.75     | 7.46     |      |        |
| L        |      | 2970     | 2960 |        | 58600 | 59600    | 61800 | 14.40  | 0.05      | 0.03    | 2.42      | 3.21      | 6.64    | 0.01    | 0.10    | 56.20    | 0.76     | 7.41     |      |        |
| M        |      | 3110     | 2950 |        | 58900 | 57400    | 61100 | 13.26  | 0.06      | 0.03    | 2.49      | 2.89      | 6.17    | 0.01    | 0.09    |          |          |          |      |        |
| M        |      | 3070     | 2990 |        | 58700 | 57900    | 60900 | 12.74  | 0.06      | 0.03    | 2.34      | 3.06      | 5.95    | 0.01    | 0.09    |          |          |          |      |        |
| M        |      | 3050     | 2990 |        | 58100 | 58000    | 62500 | 13.23  | 0.06      | 0.03    | 2.37      | 3.06      | 6.15    | 0.01    | 0.09    |          |          |          |      |        |
| M        |      | 3070     | 3040 |        | 58100 | 59500    | 62500 | 13.60  | 0.06      | 0.03    | 2.46      | 3.05      | 6.32    | 0.01    | 0.11    |          |          |          |      |        |
| M        |      | 3110     | 3010 |        | 58900 | 58400    | 62100 | 13.26  | 0.06      | 0.03    | 2.40      | 3.08      | 6.20    | 0.01    | 0.11    |          |          |          |      |        |
| M        |      | 3040     | 3000 |        | 58400 | 58700    | 62400 | 13.40  | 0.06      | 0.03    | 2.42      | 3.12      | 6.23    | 0.01    | 0.11    |          |          |          |      |        |
| M        |      | 2940     | 3020 |        | 58100 | 59400    | 61400 | 13.15  | 0.06      | 0.03    | 2.39      | 2.96      | 6.10    | 0.01    | 0.11    |          |          |          |      |        |
| M        |      | 3150     | 2870 |        | 58900 | 57300    | 61400 | 13.66  | 0.06      | 0.03    | 2.46      | 2.92      | 6.33    | 0.01    | 0.11    |          |          |          |      |        |
| N        | 3140 |          | 3070 |        | 61100 | 60300    | 59600 | 13.50  | 0.02      | 0.03    | 2.33      | 2.92      | 6.34    | 0.01    | 0.10    | 54.70    | 0.73     | 8.08     | 3.06 |        |
| N        | 3070 |          | 2960 |        | 60400 | 59200    | 59900 | 13.90  | 0.05      | 0.03    | 2.39      | 3.00      | 6.54    | 0.01    | 0.10    | 56.20    | 0.75     | 8.29     | 2.90 |        |
| N        | 3110 |          | 2970 |        | 60500 | 60300    | 59400 | 13.50  | 0.02      | 0.03    | 2.31      | 2.92      | 6.31    | 0.01    | 0.10    | 54.60    | 0.72     | 8.35     | 3.05 |        |
| N        | 3090 |          | 2960 |        | 59300 | 60200    | 59200 | 14.20  | 0.02      | 0.03    | 2.44      | 3.07      | 6.66    | 0.01    | 0.10    | 57.60    | 0.77     | 7.66     | 3.02 |        |
| N        | 3070 |          | 3030 |        | 59500 | 59300    | 59300 | 14.15  | 0.02      | 0.03    | 2.43      | 3.06      | 6.60    | 0.01    | 0.10    | 57.40    | 0.76     | 7.58     | 2.89 |        |
| N        | 3090 |          | 2920 |        | 60800 | 60300    | 59000 | 14.05  | 0.02      | 0.03    | 2.43      | 3.02      | 6.60    | 0.01    | 0.10    | 57.00    | 0.76     | 7.87     | 3.00 |        |
| N        | 3080 |          | 3100 |        | 60600 | 59000    | 59700 | 14.10  | 0.05      | 0.03    | 2.43      | 3.05      | 6.59    | 0.01    | 0.10    | 57.30    | 0.76     | 7        |      |        |

## Assay data (cont)

| Lab Code | Co F ppm | Co M/ICP ppm | Co P ppm | Co XRF ppm | Cu F ppm | Cu M/ICP ppm | Cu P ppm | Cu P ppm | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | LOI % | SG pyc |      |
|----------|----------|--------------|----------|------------|----------|--------------|----------|----------|-------------|-----------|-------------|-------------|-----------|-----------|-----------|------------|------------|------------|-------|--------|------|
| Q        |          | 2970         | 3130     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 3040         | 3270     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 2930         | 2990     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 2950         | 3080     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 3130         | 3280     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 3110         | 3010     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 3220         | 3270     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| Q        |          | 3070         | 3000     |            |          |              |          |          |             |           |             |             |           |           |           |            |            |            |       |        |      |
| R        |          | 3101         | 3099     |            |          | 61200        | 61200    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.79 |
| R        |          | 3122         | 3178     |            |          | 61100        | 61000    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.80 |
| R        |          | 3169         | 3153     |            |          | 61100        | 60600    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.81 |
| R        |          | 3127         | 3138     |            |          | 61300        | 61700    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.80 |
| R        |          | 3115         | 3124     |            |          | 61400        | 60600    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.83 |
| R        |          | 3105         | 3140     |            |          | 60400        | 60700    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.82 |
| R        |          | 3127         | 3115     |            |          | 61500        | 62000    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.78 |
| R        |          | 3148         | 3105     |            |          | 60800        | 60600    |          |             |           |             |             |           |           |           |            |            |            |       |        | 2.80 |
| S        |          | 3100         |          |            |          | 61200        |          |          | 14.04       | 0.04      | 0.03        | 2.27        |           | 6.23      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 60800        |          |          | 14.36       | 0.05      | 0.03        | 2.26        |           | 6.30      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 61000        |          |          | 14.50       | 0.04      | 0.03        | 2.34        |           | 6.41      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 61800        |          |          | 14.36       | 0.04      | 0.03        | 2.32        |           | 6.30      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 61000        |          |          | 14.50       | 0.04      | 0.03        | 2.29        |           | 6.23      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 61200        |          |          | 14.48       | 0.04      | 0.03        | 2.23        |           | 6.60      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 60000        |          |          | 14.80       | 0.05      | 0.03        | 2.30        |           | 6.69      | 0.01      |            |            |            |       |        |      |
| S        |          | 3100         |          |            |          | 61100        |          |          | 14.66       | 0.04      | 0.03        | 2.34        |           | 6.53      | 0.01      |            |            |            |       |        |      |
| T        | 3050     |              |          |            |          | 60500        |          |          |             | 0.07      |             |             |           | 7.26      | 0.01      |            |            |            |       |        |      |
| T        | 3100     |              |          |            |          | 61500        |          |          |             | 0.07      |             |             |           | 7.28      | 0.01      |            |            |            |       |        |      |
| T        | 3070     |              |          |            |          | 61700        |          |          |             | 0.07      |             |             |           | 7.21      | 0.01      |            |            |            |       |        |      |
| T        | 3100     |              |          |            |          | 61300        |          |          |             | 0.08      |             |             |           | 7.35      | 0.01      |            |            |            |       |        |      |
| T        | 3080     |              |          |            |          | 61800        |          |          |             | 0.07      |             |             |           | 7.28      | 0.01      |            |            |            |       |        |      |
| T        | 3030     |              |          |            |          | 61100        |          |          |             | 0.07      |             |             |           | 7.26      | 0.01      |            |            |            |       |        |      |
| T        | 3090     |              |          |            |          | 61700        |          |          |             | 0.07      |             |             |           | 7.28      | 0.01      |            |            |            |       |        |      |
| T        | 3090     |              |          |            |          | 61200        |          |          |             | 0.06      |             |             |           | 7.23      | 0.01      |            |            |            |       |        |      |
| V        |          | 3100         | 3000     | 2568.38    |          | 63300        | 61000    | 65057    | 14.31       |           | 0.03        | 2.71        | 3.19      | 6.62      | 0.01      | 0.09       | 56.20      | 0.80       | 7.85  | 2.87   |      |
| V        |          | 3100         | 3000     | 2555.93    |          | 63400        | 61100    | 64863    | 14.34       |           | 0.03        | 2.73        | 3.19      | 6.65      | 0.01      | 0.09       | 56.10      | 0.80       | 7.89  | 2.87   |      |
| V        |          | 3200         | 3000     | 2544.97    |          | 63500        | 61100    | 64423    | 14.35       |           | 0.03        | 2.73        | 3.20      | 6.61      | 0.01      | 0.09       | 56.30      | 0.80       | 7.82  | 2.87   |      |
| V        |          | 3300         | 3000     | 2586.34    |          | 63400        | 61200    | 65170    | 14.36       |           | 0.03        | 2.73        | 3.20      | 6.63      | 0.01      | 0.10       | 56.81      | 0.80       | 7.82  | 2.87   |      |
| V        |          | 3200         | 3000     | 2567.36    |          | 63300        | 61100    | 64620    | 14.27       |           | 0.03        | 2.75        | 3.21      | 6.69      | 0.02      | 0.10       | 56.22      | 0.81       | 7.89  | 2.88   |      |
| V        |          | 3200         | 3000     | 2552.51    |          | 63400        | 61200    | 65101    | 14.32       |           | 0.03        | 2.73        | 3.21      | 6.68      | 0.02      | 0.09       | 56.28      | 0.81       | 7.82  | 2.87   |      |
| V        |          | 3100         | 3000     | 2526.20    |          | 63500        | 61100    | 65312    | 14.17       |           | 0.03        | 2.74        | 3.20      | 6.66      | 0.02      | 0.09       | 56.09      | 0.81       | 7.86  | 2.86   |      |
| V        |          | 3300         | 2900     | 2557.18    |          | 63300        | 61000    | 64960    | 14.33       |           | 0.03        | 2.74        | 3.21      | 6.65      | 0.01      | 0.08       | 56.30      | 0.80       | 7.87  | 2.87   |      |
| W        |          | 2550         | 2950     | 3244.00    |          | 54400        | 58600    |          | 14.10       | 0.07      | 0.03        | 2.40        | 3.17      | 6.58      | 0.01      | 0.14       | 57.20      | 0.77       | 7.85  | 2.90   |      |
| W        |          | 2590         | 2800     | 3230.00    |          | 54300        | 55600    |          | 14.30       | 0.06      | 0.03        | 2.42        | 3.25      | 6.78      | 0.01      | 0.13       | 57.10      | 0.80       | 7.85  | 2.91   |      |
| W        |          | 2600         | 3020     | 3237.00    |          | 53400        | 56400    |          | 14.40       | 0.06      | 0.03        | 2.41        | 3.17      | 6.71      | 0.01      | 0.15       | 56.90      | 0.78       | 7.85  | 2.86   |      |
| W        |          | 2600         | 2840     | 3221.00    |          | 53100        | 58300    |          | 14.10       | 0.07      | 0.03        | 2.41        | 3.15      | 6.66      | 0.01      | 0.13       | 56.90      | 0.78       | 7.84  | 2.91   |      |
| W        |          | 2580         | 2860     | 3249.00    |          | 55000        | 57500    |          | 14.10       | 0.06      | 0.03        | 2.38        | 3.19      | 6.58      | 0.02      | 0.16       | 56.90      | 0.77       | 7.86  | 2.91   |      |
| W        |          | 2570         | 3080     | 3224.00    |          | 52800        | 55300    |          | 14.30       | 0.07      | 0.04        | 2.42        | 3.22      | 6.78      | 0.01      | 0.14       | 57.10      | 0.78       | 7.88  | 2.88   |      |
| W        |          | 2650         | 2920     | 3233.00    |          | 54200        | 58400    |          | 14.40       | 0.07      | 0.03        | 2.44        | 3.22      | 6.81      | 0.01      | 0.14       | 57.40      | 0.79       | 7.89  | 2.91   |      |
| W        |          | 2540         | 2850     | 3219.00    |          | 54300        | 56000    |          | 14.30       | 0.07      | 0.03        | 2.43        | 3.20      | 6.80      | 0.01      | 0.13       | 57.30      | 0.79       | 7.87  | 2.86   |      |

**12. Measurement of Uncertainty:** The samples used in the certification process were 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:

$$\text{Combined standard uncertainty} = \sqrt{(\text{between lab.var}/\text{no of labs}) + (\text{mean square within lab.var}/\text{no of assays})}$$

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

| Analyte                        | Method | Unit | S <sup>1</sup> | $\sigma_L$ <sup>2</sup> | SW <sup>3</sup> | CSU <sup>4</sup> |
|--------------------------------|--------|------|----------------|-------------------------|-----------------|------------------|
| Co                             | F      | ppm  | 59.846         | 36.195                  | 46.156          | 13.336           |
| Co                             | M/ICP  | ppm  | 64.359         | 31.127                  | 49.624          | 9.615            |
| Co                             | P      | ppm  | 105.179        | 65.706                  | 54.478          | 17.722           |
| Cu                             | F      | ppm  | 2195.808       | 1624.157                | 1302.982        | 534.638          |
| Cu                             | M/ICP  | ppm  | 1465.901       | 1081.720                | 479.888         | 292.636          |
| Cu                             | P      | ppm  | 1991.088       | 1839.529                | 695.618         | 618.709          |
| Al <sub>2</sub> O <sub>3</sub> | XRF    | %    | 0.352          | 0.302                   | 0.161           | 0.102            |
| CaO                            | XRF    | %    | 0.016          | 0.011                   | 0.007           | 0.003            |
| Cr <sub>2</sub> O <sub>3</sub> | XRF    | %    | 0.001          | 0.001                   | 0.001           | 0.000            |
| Fe <sub>2</sub> O <sub>3</sub> | XRF    | %    | 0.051          | 0.041                   | 0.032           | 0.015            |
| K <sub>2</sub> O               | XRF    | %    | 0.110          | 0.070                   | 0.084           | 0.025            |
| LOI                            |        | %    | 0.240          | 0.257                   | 0.074           | 0.098            |
| MgO                            | XRF    | %    | 0.268          | 0.198                   | 0.103           | 0.056            |
| MnO                            | XRF    | %    | 0.002          | 0.001                   | 0.000           | 0.000            |
| Na <sub>2</sub> O              | XRF    | %    | 0.005          | 0.003                   | 0.004           | 0.001            |
| SiO <sub>2</sub>               | XRF    | %    | 0.499          | 0.431                   | 0.310           | 0.169            |
| TiO <sub>2</sub>               | XRF    | %    | 0.021          | 0.021                   | 0.010           | 0.008            |
| SG                             | pyc    |      | 0.070          | 0.064                   | 0.041           | 0.025            |

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. Certified values:** The Certified, Provisional and Informational 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, who have maintained measurement traceability during the analytical process.

**15. Certification:** AMIS0201 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](http://www.amis.co.za) website.

**17. Minimum sample size:** The majority of laboratories reporting used a 0.5g sample size for the ICP. This is the recommended minimum sample size 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 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, vacuum sealed in foil pouches.

**19. Recommended use:** The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any “inter-laboratory issues” and should lead to a very accurate measure for the given methods, notwithstanding the underlying assumption that what the good inter-laboratory labs reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

**20. 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.

20 March 2012

**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 1 - Uncertified economic element statistics

Six laboratories with the capability were requested to complete the additional specialized analyses listed below. There are too few results for a formal certification however the results are of interest. This data has been compiled and iterated.

| Analyte | Method  | Unit | Mean  | 2SD  | RSD% | n  |
|---------|---------|------|-------|------|------|----|
| Co      | 3 Acid  | ppm  | 3104  | 247  | 3.98 | 40 |
| Co      | QLT     | ppm  | 2988  | 373  | 6.24 | 14 |
| Co      | Soluble | ppm  | 2909  | 360  | 6.19 | 39 |
| Cu      | 3 Acid  | ppm  | 60962 | 2317 | 1.90 | 31 |
| Cu      | QLT     | ppm  | 58917 | 2954 | 2.51 | 46 |
| Cu      | Soluble | ppm  | 59885 | 2594 | 2.17 | 39 |

## Appendix 1 (cont) - Uncertified economic element statistics

Nineteen of the laboratories submitted significant total digestion / multi element scan trace element data and ten laboratories submitted additional Co and Cu methods. This data has been compiled and iterated but not certified. It is presented below for informational use.

| Analyte | Method | Unit | Mean  | 2SD   | RSD%   | n   |
|---------|--------|------|-------|-------|--------|-----|
| Ag      | M/ICP  | ppm  | 0.25  | 0.15  | 30.24  | 23  |
| Al      | M/ICP  | %    | 7.46  | 0.95  | 6.38   | 79  |
| As      | M/ICP  | ppm  | 10.90 | 2.19  | 10.05  | 68  |
| B       | M/ICP  | ppm  | 433   | 36.65 | 4.24   | 8   |
| Ba      | M/ICP  | ppm  | 220   | 38.66 | 8.79   | 78  |
| Be      | M/ICP  | ppm  | 2.19  | 0.36  | 8.15   | 64  |
| Bi      | M/ICP  | ppm  | 44.28 | 37.84 | 42.73  | 83  |
| Ca      | M/ICP  | %    | 0.04  | 0.02  | 20.45  | 121 |
| Cd      | M/ICP  | ppm  | 0.40  | 0.88  | 110.75 | 21  |
| Ce      | M/ICP  | ppm  | 58.73 | 8.15  | 6.94   | 32  |
| Cr      | M/ICP  | ppm  | 176   | 80.04 | 22.77  | 93  |
| Cs      | M/ICP  | ppm  | 3.04  | 0.23  | 3.82   | 24  |
| Dy      | M/ICP  | ppm  | 3.56  | 0.15  | 2.10   | 23  |
| Er      | M/ICP  | ppm  | 2.38  | 0.22  | 4.69   | 23  |
| Eu      | M/ICP  | ppm  | 0.75  | 0.08  | 5.02   | 24  |
| Fe      | M/ICP  | %    | 1.63  | 0.16  | 4.89   | 100 |
| Ga      | M/ICP  | ppm  | 18.63 | 2.75  | 7.39   | 40  |
| Gd      | M/ICP  | ppm  | 3.72  | 0.39  | 5.28   | 23  |
| Hf      | M/ICP  | ppm  | 4.51  | 0.95  | 10.49  | 32  |
| Ho      | M/ICP  | ppm  | 0.76  | 0.05  | 3.61   | 23  |
| In      | M/ICP  | ppm  | 0.16  | 0.02  | 4.70   | 30  |
| K       | M/ICP  | %    | 2.61  | 0.25  | 4.75   | 85  |
| La      | M/ICP  | ppm  | 34.38 | 4.19  | 6.09   | 61  |
| Li      | M/ICP  | ppm  | 306   | 22.91 | 3.74   | 80  |
| Lu      | M/ICP  | ppm  | 0.37  | 0.03  | 3.73   | 30  |
| Mg      | M/ICP  | %    | 3.71  | 0.39  | 5.23   | 121 |
| Mn      | M/ICP  | ppm  | 103   | 8.86  | 4.30   | 126 |
| Mo      | M/ICP  | ppm  | 2.27  | 1.53  | 33.83  | 56  |
| Na      | M/ICP  | %    | 0.07  | 0.01  | 8.88   | 69  |
| Nb      | M/ICP  | ppm  | 11.41 | 8.49  | 37.23  | 43  |
| Nd      | M/ICP  | ppm  | 22.68 | 1.07  | 2.37   | 24  |
| Ni      | M/ICP  | ppm  | 28.85 | 4.92  | 8.53   | 100 |
| P       | M/ICP  | ppm  | 786   | 79.69 | 5.07   | 70  |
| Pb      | M/ICP  | ppm  | 14.17 | 22.89 | 80.74  | 72  |
| Pr      | M/ICP  | ppm  | 6.57  | 0.84  | 6.37   | 24  |
| Rb      | M/ICP  | ppm  | 101   | 50.56 | 25.12  | 32  |
| Re      | M/ICP  | ppm  | 0.01  | 0.005 | 45.50  | 8   |
| S       | M/ICP  | %    | 0.02  | 0.01  | 17.43  | 79  |
| Sb      | M/ICP  | ppm  | 0.79  | 0.14  | 8.68   | 31  |
| Sc      | M/ICP  | ppm  | 14.34 | 1.79  | 6.25   | 86  |
| Se      | M/ICP  | ppm  | 1.77  | 0.77  | 21.86  | 14  |
| Si      | M/ICP  | %    | 26.49 | 1.04  | 1.95   | 15  |
| Sm      | M/ICP  | ppm  | 3.90  | 0.23  | 2.91   | 24  |
| Sn      | M/ICP  | ppm  | 3.92  | 0.51  | 6.50   | 30  |
| Sr      | M/ICP  | ppm  | 67.93 | 5.67  | 4.17   | 69  |
| Ta      | M/ICP  | ppm  | 4.31  | 10.75 | 124.69 | 40  |
| Tb      | M/ICP  | ppm  | 0.54  | 0.11  | 10.43  | 31  |
| Te      | M/ICP  | ppm  | 0.09  | 0.04  | 24.00  | 4   |
| Th      | M/ICP  | ppm  | 12.56 | 1.14  | 4.54   | 32  |
| Ti      | M/ICP  | %    | 0.29  | 0.27  | 46.34  | 88  |
| Tl      | M/ICP  | ppm  | 0.39  | 0.05  | 6.91   | 30  |
| Tm      | M/ICP  | ppm  | 0.36  | 0.03  | 4.38   | 22  |
| U       | M/ICP  | ppm  | 6.13  | 0.55  | 4.50   | 32  |
| V       | M/ICP  | ppm  | 134   | 36.19 | 13.50  | 93  |
| W       | M/ICP  | ppm  | 2.43  | 1.52  | 31.19  | 30  |
| Y       | M/ICP  | ppm  | 18.33 | 3.08  | 8.39   | 72  |
| Yb      | M/ICP  | ppm  | 2.40  | 0.22  | 4.51   | 29  |
| Zn      | M/ICP  | ppm  | 30.37 | 14.35 | 23.63  | 91  |
| Zr      | M/ICP  | ppm  | 143   | 23.04 | 8.03   | 79  |