African Mineral Standards
MATRIX REFERENCE MATERIALS

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# AMIS0238

## *Certified Reference Material*

# Gold ore
# Tarkwa Gold Mine, Ghana

## *Certificate of Analysis*

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

### *Provisional Concentrations[2.]*

| | | | | |
|---|---|---|---|---|
| Au Pb Collection | 0.347 | ± | 0.058 | g/t |

### *Certified Concentrations[3.]*

| | | | | |
|---|---|---|---|---|
| Specific Gravity | 2.76 | ± | 0.06 | |

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. *The terms Provisional and Certified refer to the limits; Provisional being wider. Refer to Section 9 for an explanation.*
3. *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*

| | | | | |
|---|---|---|---|---|
| $Al_2O_3$ | 5.27 | ± | 0.08 | % |
| $Fe_2O_3$ | 4.01 | ± | 0.08 | % |
| $K_2O$ | 0.97 | ± | 0.01 | % |
| MnO | 0.14 | ± | 0.01 | % |
| $Na_2O$ | 0.38 | ± | 0.03 | % |
| $SiO_2$ | 87.78 | ± | 0.36 | % |
| $TiO_2$ | 0.24 | ± | 0.01 | % |

## *Provisional Concentrations*

| | | | | |
|---|---|---|---|---|
| CaO | 0.09 | ± | 0.03 | % |
| $Cr_2O_3$ | 0.04 | ± | 0.01 | % |
| MgO | 0.13 | ± | 0.03 | % |
| LOI | 0.83 | ± | 0.12 | % |

**1. Intended Use:** AMIS0238 can be used to check analysis of samples of siliceous gold 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 Section19). 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:** AMIS0238 is a CRM commissioned by SGS Minerals Services; made from heap leach material collected by the Tarkwa Gold Mine Mineral Resources Department. Tarkwa mine is owned and operated by Gold Fields Ltd.

The Tarkwa mine is located in south-western Ghana, about 300 kilometers by road west of Accra. It consists of several open pit operations on the original Tarkwa property and on the adjacent southern portion of the property (formerly referred to as the Teberebie property); and was acquired by Gold Fields in August 2000, together with two heap leach facilities; referred to as the North Plant and the South Plant. A new SAG mill and CIL plant commenced continuous operations at the Tarkwa property in November 2004. The Tarkwa mine operates under mining leases with a total area of approximately 20,800 hectares. It currently conducts only surface operations, although it previously had a small underground mining operation which it operated through July 1999 under Gold Fields' agreement with the government of Ghana.

Gold mineralization at the Tarkwa Gold Mine is hosted by Proterozoic Tarkwaian metasediments, which unconformably overlie a Birimian greenstone belt sequence. Gold mineralization is concentrated in conglomerate reefs and is similar to deposits in the Witwatersrand Basin in South Africa. The deposit comprises a succession of stacked tabular palaeoplacer units consisting of quartz pebble conglomerates. Approximately 10 such separate economic units occur in the concession area within a sedimentary package ranging from 40m to 110m in thickness. Low grade

to barren quartzite units are interlayered between the separate reef units. The existing surface operation currently exploits narrow auriferous conglomerates from five pits, namely Pepe, Akontansi, Teberebie, Kottraverchy and West Hill. Two additional pits, Atuabo and Mantraim, which have previously been mined by Gold Fields, are temporarily inactive, but both are planned to be reactivated within the next few years pending the relocation of an electrical sub-station which lies on the edge of the current allowed blast radius and as adjacent active pits are expanded to join them.

**3. Mineral and Chemical Composition:** This deposit is in altered Tarkwaian rocks, which are similar to Witwatersrand quartz pebble conglomerate ores with the important exception that the heavy mineral suites are dominated by iron oxides; the uraninite and pyrite present in the Wits being absent.

**4. Appearance:** The material is a very fine powder. It is colored a Greyish Orange Pink (Corstor 5YR 7/2).

**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 parti**c**le 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. Au – Pb collection ICP-OES or ICP-MS.
2. Multi-acid digest, including HF, ICP- OES or ICP-MS. Multi element scan to include Ag.
3. Majors ( Al2O3, CaO, Cr2O3, Fe2O3, K2O, MgO, MnO, Na2O, SiO2, TiO2. LOI. ) XRF fusion.
4. S – Total Combustion.
5. SG ( gas pycnometer )

**8. Information requested:**

1. State aliquots used for all determinations.
2. Report all results for gold and uranium in ppm.
3. All results for major elements to be reported as oxides in percentages.
4. All results for multi-element scans to be reported in ppm.
5. Report all QC data, to include replicates, blanks and certified reference materials used.
6. State and provide brief description of analytical techniques used.

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

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:** The 21 out of 30 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ALS Chemex Laboratory Group Johannesburg SA
2. Anglo Gold Ashanti - Navachab Gold Mine Laboratory Namibia
3. Genalysis Laboratory Services (South Africa) Pty
4. Genalysis Laboratory Services W Australia
5. Intertek Utama Services (Indonesia)
6. Set Point Laboratories (Isando) SA
7. SGS Australia Pty Ltd (Newburn) WA
8. SGS Geosol Laboratories Ltda (Brazil)
9. SGS Kalgoorlie WA
10. SGS Mineral Services Callao (Peru)
11. SGS Mineral Services Lakefield (Canada)
12. SGS Mwanza
13. SGS South Africa (Pty) Ltd - Booysens JHB
14. SGS Tarkwa (Ghana)
15. SGS Toronto (Canada)
16. SGS Townsville (Australia)
17. Super Laboratory Services (Balfour SA)
18. Super Laboratory Services (Barberton SA)
19. Super Laboratory Services (Klerksdorp SA)
20. Super Laboratory Services (Springs SA)
21. Ultra Trace (Pty) Ltd WA

**11. Assay Data:** Data as received from the laboratories for the important certified elements listed on p1 and 2 are 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 | Au Pb Coll g/t | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | LOI % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | S Comb % | SG pycnometer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0.32 | 5.02 | 0.07 | 0.04 | 3.97 | 0.93 | 0.88 | 0.15 | 0.14 | 0.49 | 87.49 | 0.25 | | 2.76 |
| A | 0.32 | 4.92 | 0.07 | 0.04 | 3.96 | 0.94 | 0.89 | 0.15 | 0.14 | 0.50 | 87.61 | 0.25 | | 2.76 |
| A | 0.32 | 5.05 | 0.07 | 0.04 | 3.96 | 0.93 | 0.88 | 0.16 | 0.14 | 0.50 | 87.49 | 0.25 | | 2.75 |
| A | 0.31 | 5.00 | 0.07 | 0.04 | 3.97 | 0.94 | 0.87 | 0.13 | 0.14 | 0.50 | 88.03 | 0.24 | | 2.76 |
| A | 0.31 | 5.07 | 0.07 | 0.04 | 3.96 | 0.93 | 0.89 | 0.12 | 0.14 | 0.49 | 87.83 | 0.25 | | 2.76 |
| A | 0.33 | 4.92 | 0.07 | 0.04 | 3.93 | 0.94 | 0.88 | 0.11 | 0.14 | 0.49 | 87.80 | 0.24 | | 2.75 |
| A | 0.32 | 5.00 | 0.07 | 0.04 | 3.98 | 0.94 | 0.89 | 0.13 | 0.14 | 0.49 | 88.01 | 0.25 | | 2.75 |
| A | 0.33 | 4.93 | 0.07 | 0.04 | 3.97 | 0.94 | 0.87 | 0.10 | 0.14 | 0.49 | 88.06 | 0.24 | | 2.76 |
| B | 0.37 | | | | | | | | | | | | | 2.72 |
| B | 0.34 | | | | | | | | | | | | | 2.72 |
| B | 0.37 | | | | | | | | | | | | | 2.71 |
| B | 0.35 | | | | | | | | | | | | | 2.70 |
| B | 0.35 | | | | | | | | | | | | | 2.71 |
| B | 0.35 | | | | | | | | | | | | | 2.72 |
| B | 0.34 | | | | | | | | | | | | | 2.71 |
| B | 0.34 | | | | | | | | | | | | | 2.70 |
| C | 0.32 | 5.28 | 0.11 | 0.04 | 3.96 | 0.98 | 0.87 | 0.13 | 0.14 | 0.34 | 86.80 | 0.23 | 0.01 | 2.76 |
| C | 0.35 | 5.18 | 0.12 | 0.04 | 4.01 | 0.99 | 0.94 | 0.13 | 0.14 | 0.35 | 86.10 | 0.23 | 0.01 | 2.73 |
| C | 0.36 | 5.27 | 0.10 | 0.04 | 4.03 | 0.99 | 0.93 | 0.13 | 0.14 | 0.35 | 87.10 | 0.24 | 0.01 | 2.74 |
| C | 0.36 | 5.25 | 0.11 | 0.04 | 4.05 | 1.00 | 0.87 | 0.14 | 0.14 | 0.36 | 86.90 | 0.23 | 0.01 | 2.76 |
| C | 0.34 | 5.29 | 0.11 | 0.04 | 4.07 | 1.00 | 0.91 | 0.13 | 0.14 | 0.35 | 87.70 | 0.24 | | 2.78 |
| C | 0.33 | 5.34 | 0.11 | 0.04 | 4.12 | 1.01 | 0.88 | 0.15 | 0.15 | 0.37 | 88.10 | 0.24 | 0.01 | 2.73 |
| C | 0.34 | 5.27 | 0.11 | 0.04 | 4.01 | 1.00 | 0.91 | 0.13 | 0.14 | 0.35 | 87.00 | 0.23 | 0.01 | 2.73 |
| C | 0.35 | 5.24 | 0.17 | 0.04 | 4.04 | 0.98 | 0.93 | 0.13 | 0.14 | 0.34 | 86.00 | 0.23 | 0.01 | 2.76 |
| G | 0.49 | | | | | | | | | | | | | |
| G | 0.41 | | | | | | | | | | | | | |
| G | 0.41 | | | | | | | | | | | | | |
| G | 0.41 | | | | | | | | | | | | | |
| G | 0.41 | | | | | | | | | | | | | |
| G | 0.40 | | | | | | | | | | | | | |
| G | 0.44 | | | | | | | | | | | | | |
| G | 0.42 | | | | | | | | | | | | | |
| J | 0.36 | | | | | | | | | | | | | 2.82 |
| J | 0.33 | | | | | | | | | | | | | 2.86 |
| J | 0.34 | | | | | | | | | | | | | 2.81 |
| J | 0.36 | | | | | | | | | | | | | 2.86 |
| J | 0.33 | | | | | | | | | | | | | 2.83 |
| J | 0.33 | | | | | | | | | | | | | 2.80 |
| J | 0.34 | | | | | | | | | | | | | 2.84 |
| J | 0.30 | | | | | | | | | | | | | 2.85 |

## Assay data (cont)

| Lab Code | Au Pb Coll g/t | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | LOI % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | S Comb % | SG pycnometer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | 0.32 | | | | | | | | | | | | | |
| L | 0.34 | | | | | | | | | | | | | |
| L | 0.31 | | | | | | | | | | | | | |
| L | 0.38 | | | | | | | | | | | | | |
| L | 0.28 | | | | | | | | | | | | | |
| L | 0.40 | | | | | | | | | | | | | |
| L | 0.33 | | | | | | | | | | | | | |
| L | 0.33 | | | | | | | | | | | | | |
| N | 0.38 | | | | | | | | | | | | | 2.73 |
| N | 0.35 | | | | | | | | | | | | | 2.75 |
| N | 0.36 | | | | | | | | | | | | | 2.78 |
| N | 0.36 | | | | | | | | | | | | | 2.75 |
| N | 0.33 | | | | | | | | | | | | | 2.79 |
| N | 0.35 | | | | | | | | | | | | | 2.77 |
| N | 0.35 | | | | | | | | | | | | | 2.76 |
| N | 0.35 | | | | | | | | | | | | | 2.81 |
| O | 0.35 | 5.25 | 0.09 | 0.05 | 4.07 | 0.97 | 0.82 | 0.13 | 0.14 | 0.38 | 87.79 | 0.23 | 0.01 | 2.84 |
| O | 0.33 | 5.22 | 0.09 | 0.04 | 4.08 | 0.97 | 0.82 | 0.13 | 0.14 | 0.37 | 87.58 | 0.23 | 0.01 | 2.79 |
| O | 0.37 | 5.20 | 0.09 | 0.04 | 4.03 | 0.96 | 0.84 | 0.13 | 0.14 | 0.37 | 87.39 | 0.23 | 0.01 | 2.76 |
| O | 0.34 | 5.24 | 0.09 | 0.04 | 4.04 | 0.96 | 0.83 | 0.14 | 0.14 | 0.38 | 87.40 | 0.23 | 0.01 | 2.78 |
| O | 0.33 | 5.23 | 0.09 | 0.04 | 4.04 | 0.96 | 0.81 | 0.13 | 0.14 | 0.38 | 87.79 | 0.23 | 0.01 | 2.82 |
| O | 0.35 | 5.23 | 0.09 | 0.04 | 4.07 | 0.96 | 0.82 | 0.14 | 0.14 | 0.38 | 87.78 | 0.23 | 0.01 | 2.82 |
| O | 0.33 | 5.20 | 0.09 | 0.04 | 4.03 | 0.96 | 0.81 | 0.14 | 0.14 | 0.38 | 87.62 | 0.23 | 0.01 | 2.82 |
| O | 0.35 | 5.27 | 0.09 | 0.04 | 4.05 | 0.96 | 0.80 | 0.13 | 0.14 | 0.38 | 87.68 | 0.23 | 0.01 | 2.79 |
| P | 0.38 | | | | | | | | | | | | | |
| P | 0.32 | | | | | | | | | | | | | |
| P | 0.29 | | | | | | | | | | | | | |
| P | 0.39 | | | | | | | | | | | | | |
| P | 0.35 | | | | | | | | | | | | | |
| P | 0.33 | | | | | | | | | | | | | |
| P | 0.38 | | | | | | | | | | | | | |
| P | 0.35 | | | | | | | | | | | | | |
| Q | 0.38 | 5.24 | 0.10 | | 3.99 | 0.97 | 0.85 | 0.15 | 0.13 | 0.38 | 87.70 | 0.23 | 0.03 | |
| Q | 0.31 | 5.22 | 0.11 | | 4.01 | 0.97 | 0.80 | 0.15 | 0.14 | 0.38 | 87.80 | 0.24 | 0.02 | |
| Q | 0.34 | 5.17 | 0.11 | | 4.00 | 0.96 | 0.81 | 0.14 | 0.14 | 0.38 | 87.80 | 0.24 | 0.02 | |
| Q | 0.32 | 5.22 | 0.10 | | 4.02 | 0.97 | 0.82 | 0.15 | 0.14 | 0.40 | 87.80 | 0.23 | 0.02 | |
| Q | 0.29 | 5.25 | 0.11 | | 4.01 | 0.97 | 0.80 | 0.14 | 0.13 | 0.38 | 87.80 | 0.24 | 0.02 | |
| Q | 0.35 | 5.26 | 0.11 | | 3.98 | 0.97 | 0.81 | 0.14 | 0.14 | 0.40 | 87.80 | 0.24 | 0.02 | |
| Q | | 5.26 | 0.11 | | 4.01 | 0.96 | 0.84 | 0.15 | 0.14 | 0.38 | 87.80 | 0.23 | 0.02 | |
| Q | 0.33 | 5.20 | 0.10 | | 4.01 | 0.96 | 0.85 | 0.14 | 0.14 | 0.40 | 87.80 | 0.23 | | |
| R | 0.28 | | | | | | | | | | | | | |
| R | 0.27 | | | | | | | | | | | | | |
| R | 0.26 | | | | | | | | | | | | | |
| R | 0.23 | | | | | | | | | | | | | |
| R | 0.27 | | | | | | | | | | | | | |
| R | 0.25 | | | | | | | | | | | | | |
| R | 0.21 | | | | | | | | | | | | | |
| R | 0.25 | | | | | | | | | | | | | |
| S | 0.40 | | | | | | | | | | | | | |
| S | 0.36 | | | | | | | | | | | | | |
| S | 0.39 | | | | | | | | | | | | | |
| S | 0.36 | | | | | | | | | | | | | |
| S | 0.36 | | | | | | | | | | | | | |
| S | 0.36 | | | | | | | | | | | | | |
| S | 0.36 | | | | | | | | | | | | | |
| S | 0.35 | | | | | | | | | | | | | |
| T | 0.34 | 5.28 | 0.08 | 0.04 | 4.03 | 0.96 | 0.86 | 0.14 | 0.12 | 0.37 | 88.00 | 0.23 | 0.01 | |
| T | 0.34 | 5.33 | 0.08 | 0.04 | 4.07 | 0.97 | 0.92 | 0.11 | 0.12 | 0.39 | 88.80 | 0.24 | 0.01 | |
| T | 0.40 | 5.32 | 0.08 | 0.03 | 4.07 | 0.97 | 0.98 | 0.10 | 0.11 | 0.39 | 88.50 | 0.24 | 0.01 | |
| T | 0.33 | 5.32 | 0.08 | 0.05 | 4.07 | 0.97 | 0.86 | 0.10 | 0.12 | 0.38 | 88.40 | 0.24 | 0.01 | |
| T | 0.34 | 5.31 | 0.08 | 0.04 | 4.06 | 0.97 | 0.82 | 0.14 | 0.12 | 0.37 | 88.10 | 0.24 | 0.01 | |
| T | 0.40 | 5.30 | 0.08 | 0.04 | 4.07 | 0.96 | 0.79 | 0.12 | 0.12 | 0.38 | 88.20 | 0.24 | 0.01 | |
| T | 0.33 | 5.27 | 0.08 | 0.04 | 4.05 | 0.97 | 0.76 | 0.14 | 0.13 | 0.38 | 87.80 | 0.24 | 0.01 | |
| T | 0.40 | 5.27 | 0.08 | 0.04 | 4.06 | 0.96 | 0.69 | 0.11 | 0.12 | 0.40 | 87.90 | 0.24 | | |
| U | 0.35 | | | | | | | | | | | | | 2.78 |
| U | 0.36 | | | | | | | | | | | | | 2.75 |
| U | 0.37 | | | | | | | | | | | | | 2.78 |
| U | 0.34 | | | | | | | | | | | | | 2.77 |
| U | 0.35 | | | | | | | | | | | | | 2.77 |
| U | 0.35 | | | | | | | | | | | | | 2.79 |
| U | 0.36 | | | | | | | | | | | | | 2.78 |
| U | 0.35 | | | | | | | | | | | | | 2.80 |
| V | 0.30 | | | | | | | | | | | | | |
| V | 0.31 | | | | | | | | | | | | | |
| V | 0.32 | | | | | | | | | | | | | |
| V | 0.30 | | | | | | | | | | | | | |
| V | 0.31 | | | | | | | | | | | | | |
| V | 0.29 | | | | | | | | | | | | | |
| V | 0.30 | | | | | | | | | | | | | |
| V | 0.31 | | | | | | | | | | | | | |
| W | 0.38 | 5.28 | 0.10 | 0.04 | 3.97 | 0.97 | 0.90 | 0.21 | 0.15 | 0.39 | 87.80 | 0.28 | 0.02 | |
| W | 0.37 | 5.29 | 0.09 | 0.05 | 3.96 | 0.96 | 0.90 | 0.21 | 0.15 | 0.38 | 87.77 | 0.27 | 0.02 | |
| W | 0.37 | 5.28 | 0.10 | 0.05 | 3.99 | 0.96 | 0.90 | 0.20 | 0.15 | 0.38 | 87.83 | 0.27 | 0.02 | |
| W | 0.37 | 5.29 | 0.09 | 0.05 | 3.99 | 0.97 | 0.80 | 0.19 | 0.15 | 0.38 | 87.83 | 0.26 | 0.02 | |
| W | 0.37 | 5.29 | 0.10 | 0.05 | 3.98 | 0.97 | 0.90 | 0.21 | 0.15 | 0.38 | 87.80 | 0.27 | 0.02 | |
| W | 0.36 | 5.32 | 0.10 | 0.05 | 3.98 | 0.97 | 0.90 | 0.21 | 0.15 | 0.38 | 87.83 | 0.27 | 0.02 | |
| W | 0.37 | 5.33 | 0.10 | 0.05 | 3.98 | 0.97 | 0.90 | 0.20 | 0.15 | 0.38 | 87.73 | 0.27 | 0.02 | |
| W | 0.37 | 5.30 | 0.10 | 0.05 | 3.99 | 0.97 | 0.80 | 0.20 | 0.15 | 0.38 | 87.97 | 0.29 | 0.02 | |
| X | 0.30 | 5.22 | 0.09 | 0.05 | 4.04 | 0.96 | 0.77 | 0.12 | 0.13 | 0.34 | 87.80 | 0.24 | | |
| X | 0.27 | 5.19 | 0.09 | 0.04 | 4.06 | 0.94 | 0.76 | 0.11 | 0.13 | 0.33 | 87.70 | 0.24 | | |
| X | 0.30 | 5.23 | 0.09 | 0.04 | 4.06 | 0.96 | 0.77 | 0.12 | 0.13 | 0.45 | 88.00 | 0.24 | | |
| X | 0.29 | 5.22 | 0.10 | 0.05 | 4.09 | 0.97 | 0.72 | 0.11 | 0.13 | 0.36 | 87.80 | 0.25 | | |
| X | 0.29 | 5.24 | 0.09 | 0.04 | 4.04 | 0.94 | 0.73 | 0.11 | 0.13 | 0.35 | 88.20 | 0.24 | | |
| X | 0.29 | 5.13 | 0.11 | 0.04 | 4.03 | 0.95 | 0.77 | 0.12 | 0.13 | 0.36 | 87.50 | 0.24 | | |
| X | 0.29 | 5.12 | 0.09 | 0.04 | 3.95 | 0.96 | 0.74 | 0.12 | 0.13 | 0.34 | 87.40 | 0.23 | | |
| X | 0.31 | 5.27 | 0.08 | 0.04 | 4.02 | 0.96 | 0.77 | 0.12 | 0.13 | 0.32 | 87.50 | 0.23 | | |

## Assay data (cont)

| Lab Code | Au Pb Coll g/t | Al2O3 XRF % | CaO XRF % | Cr2O3 XRF % | Fe2O3 XRF % | K2O XRF % | LOI % | MgO XRF % | MnO XRF % | Na2O XRF % | SiO2 XRF % | TiO2 XRF % | S Comb % | SG pycnometer |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y | 0.33 | 5.30 | 0.09 | 0.04 | 3.98 | 0.97 | 0.73 | 0.14 | 0.14 | 0.39 | 87.74 | 0.23 | | 2.78 |
| Y | 0.35 | 5.30 | 0.09 | 0.04 | 4.00 | 0.97 | 0.75 | 0.15 | 0.14 | 0.39 | 87.79 | 0.24 | | 2.78 |
| Y | 0.35 | 5.30 | 0.09 | 0.04 | 3.99 | 0.97 | 0.73 | 0.15 | 0.14 | 0.39 | 87.77 | 0.24 | | 2.74 |
| Y | 0.34 | 5.32 | 0.09 | 0.04 | 4.01 | 0.97 | 0.76 | 0.15 | 0.14 | 0.39 | 87.81 | 0.24 | | 2.75 |
| Y | 0.35 | 5.30 | 0.09 | 0.04 | 3.98 | 0.97 | 0.76 | 0.15 | 0.14 | 0.40 | 87.73 | 0.24 | | 2.74 |
| Y | 0.33 | 5.28 | 0.09 | 0.04 | 3.97 | 0.97 | 0.75 | 0.15 | 0.14 | 0.39 | 87.78 | 0.24 | | 2.77 |
| Y | 0.33 | 5.31 | 0.09 | 0.04 | 3.97 | 0.97 | 0.77 | 0.15 | 0.14 | 0.39 | 87.77 | 0.24 | | 2.78 |
| Y | 0.32 | 5.32 | 0.09 | 0.04 | 4.00 | 0.97 | 0.75 | 0.15 | 0.14 | 0.39 | 87.74 | 0.24 | | 2.76 |
| ZB | 0.41 | | | | | | | | | | | | | |
| ZB | 0.38 | | | | | | | | | | | | | |
| ZB | 0.38 | | | | | | | | | | | | | |
| ZB | 0.38 | | | | | | | | | | | | | |
| ZB | 0.36 | | | | | | | | | | | | | |
| ZB | 0.39 | | | | | | | | | | | | | |
| ZB | 0.38 | | | | | | | | | | | | | |
| ZB | 0.32 | | | | | | | | | | | | | |
| ZC | 0.40 | | | | | | | | | | | | | |
| ZC | 0.36 | | | | | | | | | | | | | |
| ZC | 0.40 | | | | | | | | | | | | | |
| ZC | 0.40 | | | | | | | | | | | | | |
| ZC | 0.36 | | | | | | | | | | | | | |
| ZC | 0.40 | | | | | | | | | | | | | |
| ZC | 0.36 | | | | | | | | | | | | | |
| ZC | 0.36 | | | | | | | | | | | | | |
| ZD | 0.41 | | | | | | | | | | | | | |
| ZD | 0.40 | | | | | | | | | | | | | |
| ZD | 0.38 | | | | | | | | | | | | | |
| ZD | 0.36 | | | | | | | | | | | | | |
| ZD | 0.36 | | | | | | | | | | | | | |
| ZD | 0.38 | | | | | | | | | | | | | |
| ZD | 0.38 | | | | | | | | | | | | | |
| ZD | 0.36 | | | | | | | | | | | | | |

**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 the relevant ISO guidelines.

| Analyte | Method | Unit | S [1] | $\sigma_L$ [2] | Sw [3] | CSU [4] |
|---|---|---|---|---|---|---|
| Au | Pb Coll | g/t | 0.029 | 0.014 | 0.019 | 0.004 |
| Al2O3 | XRF | % | 0.043 | 0.036 | 0.028 | 0.014 |
| CaO | XRF | % | 0.013 | 0.013 | 0.004 | 0.005 |
| Cr2O3 | XRF | % | 0.004 | 0.003 | 0.003 | 0.001 |
| Fe2O3 | XRF | % | 0.039 | 0.033 | 0.022 | 0.012 |
| K2O | XRF | % | 0.007 | 0.005 | 0.006 | 0.002 |
| LOI | | % | 0.061 | 0.056 | 0.029 | 0.020 |
| MgO | XRF | % | 0.015 | 0.012 | 0.011 | 0.005 |
| MnO | XRF | % | 0.006 | 0.007 | 0.002 | 0.003 |
| Na2O | XRF | % | 0.017 | 0.016 | 0.008 | 0.006 |
| SiO2 | XRF | % | 0.181 | 0.083 | 0.165 | 0.039 |
| TiO2 | XRF | % | 0.006 | 0.005 | 0.005 | 0.002 |
| SG | pycnometer | | 0.030 | 0.027 | 0.018 | 0.011 |

*S - Std Dev for use on control charts.*

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

**13. Certified values:** The Certified, Provisional and Indicated values listed on p1 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:** AMIS0238 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. 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.

14 October 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 | 0.11 | 0.09 | 42.36 | 22 |
| Al | M/ICP | % | 2.75 | 0.18 | 3.31 | 76 |
| As | M/ICP | ppm | 3.20 | 1.29 | 20.23 | 45 |
| Ba | M/ICP | ppm | 559 | 64.68 | 5.79 | 71 |
| Be | M/ICP | ppm | 0.50 | 0.11 | 10.59 | 47 |
| Bi | M/ICP | ppm | 0.13 | 0.04 | 15.16 | 39 |
| Ca | M/ICP | % | 0.07 | 0.01 | 7.06 | 68 |
| Cd | M/ICP | ppm | 0.07 | 0.04 | 31.08 | 37 |
| Ce | M/ICP | ppm | 53.29 | 5.86 | 5.49 | 54 |
| Co | M/ICP | ppm | 15.76 | 1.58 | 5.03 | 64 |
| Cr | M/ICP | ppm | 249 | 66.04 | 13.26 | 78 |
| Cs | M/ICP | ppm | 1.12 | 0.09 | 3.89 | 37 |
| Cu | M/ICP | ppm | 32.30 | 4.44 | 6.87 | 76 |
| Dy | M/ICP | ppm | 1.54 | 0.24 | 7.77 | 31 |
| Er | M/ICP | ppm | 0.71 | 0.14 | 10.18 | 30 |
| Eu | M/ICP | ppm | 0.80 | 0.06 | 3.48 | 31 |
| Fe | M/ICP | % | 2.73 | 0.17 | 3.09 | 70 |
| Ga | M/ICP | ppm | 7.42 | 0.85 | 5.70 | 48 |
| Gd | M/ICP | ppm | 2.34 | 0.21 | 4.53 | 32 |
| Ge | M/ICP | ppm | 0.23 | 0.09 | 20.57 | 8 |
| Hf | M/ICP | ppm | 1.31 | 0.19 | 7.34 | 40 |
| Ho | M/ICP | ppm | 0.25 | 0.04 | 8.45 | 24 |
| In | M/ICP | ppm | 0.02 | 0.00 | 13.20 | 16 |
| K | M/ICP | % | 0.78 | 0.07 | 4.72 | 78 |
| La | M/ICP | ppm | 23.59 | 1.58 | 3.35 | 67 |
| Li | M/ICP | ppm | 11.86 | 1.11 | 4.66 | 72 |
| Lu | M/ICP | ppm | 0.09 | 0.02 | 11.61 | 47 |
| Mg | M/ICP | % | 0.08 | 0.01 | 8.79 | 70 |
| Mn | M/ICP | ppm | 1083 | 64.26 | 2.97 | 75 |
| Mo | M/ICP | ppm | 1.99 | 0.15 | 3.69 | 37 |
| Na | M/ICP | % | 0.28 | 0.04 | 6.40 | 63 |
| Nb | M/ICP | ppm | 1.36 | 0.18 | 6.49 | 29 |
| Nd | M/ICP | ppm | 18.05 | 1.73 | 4.79 | 32 |
| Ni | M/ICP | ppm | 24.12 | 3.90 | 8.07 | 64 |
| P | M/ICP | ppm | 105 | 12.93 | 6.13 | 51 |
| Pb | M/ICP | ppm | 10.04 | 2.27 | 11.31 | 45 |
| Pr | M/ICP | ppm | 5.06 | 0.49 | 4.82 | 31 |
| Rb | M/ICP | ppm | 26.39 | 2.00 | 3.80 | 53 |
| S | M/ICP | % | 0.01 | 0.01 | 25.39 | 62 |
| Sb | M/ICP | ppm | 2.40 | 0.36 | 7.58 | 46 |
| Sc | M/ICP | ppm | 5.00 | 0.50 | 5.02 | 52 |
| Si | M/ICP | % | 40.85 | 0.47 | 0.57 | 8 |
| Sm | M/ICP | ppm | 3.10 | 0.30 | 4.89 | 30 |
| Sn | M/ICP | ppm | 1.14 | 0.29 | 12.73 | 47 |
| Sr | M/ICP | ppm | 87.04 | 9.00 | 5.17 | 80 |
| Ta | M/ICP | ppm | 0.12 | 0.04 | 18.27 | 23 |
| Tb | M/ICP | ppm | 0.31 | 0.04 | 6.64 | 53 |
| Te | M/ICP | ppm | 0.08 | 0.05 | 28.86 | 29 |
| Th | M/ICP | ppm | 5.80 | 0.55 | 4.76 | 63 |
| Ti | M/ICP | % | 0.11 | 0.04 | 17.88 | 64 |
| Tl | M/ICP | ppm | 0.17 | 0.04 | 12.45 | 40 |
| Tm | M/ICP | ppm | 0.09 | 0.02 | 9.33 | 23 |
| U | M/ICP | ppm | 1.17 | 0.15 | 6.25 | 53 |
| V | M/ICP | ppm | 64.85 | 6.07 | 4.68 | 72 |
| W | M/ICP | ppm | 2.78 | 0.52 | 9.29 | 36 |
| Y | M/ICP | ppm | 6.69 | 1.36 | 10.20 | 56 |
| Yb | M/ICP | ppm | 0.62 | 0.12 | 10.09 | 39 |
| Zn | M/ICP | ppm | 26.27 | 3.47 | 6.61 | 62 |
| Zr | M/ICP | ppm | 39.87 | 15.19 | 19.06 | 56 |