



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0329

Certified Reference Material

**Nickel copper sulphide ore
Phoenix Deposit, Botswana**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Pt Pb Collection	0.27	±	0.02	g/t
Pd Pb Collection	0.55	±	0.05	g/t
Cu M/ICP	1506	±	74	ppm
Cu P	1475	±	103	ppm
Cu XRF	1421	±	115	ppm
Ni M/ICP	2150	±	229	ppm
Ni P	2025	±	138	ppm
Ni XRF	2135	±	249	ppm
Specific Gravity	2.94	±	0.12	

Provisional Concentrations

Au Pb Collection	0.034	±	0.010	g/t
Co M/ICP	93	±	16	ppm
Co P	76	±	10	ppm
Co XRF	93	±	23	ppm

PGM 3E = 0.85 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.

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

Certified Concentrations

Al ₂ O ₃	15.19	±	0.26	%
CaO	8.35	±	0.12	%
Cr ₂ O ₃	0.38	±	0.03	%
Fe ₂ O ₃	9.85	±	0.18	%
K ₂ O	0.71	±	0.02	%
MgO	7.87	±	0.26	%
MnO	0.12	±	0.01	%
Na ₂ O	2.22	±	0.13	%
SiO ₂	51.15	±	0.70	%
TiO ₂	0.75	±	0.02	%
S Combustion / LECO	0.98	±	0.04	%

Provisional Concentration

LOI	2.61	±	0.58	%
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1. Intended Use: AMIS0329 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of nickel-copper-PGM sulphide ores hosted by mafic-ultramafic rocks.

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: AMIS0329 was provided by the Tati Nickel Mining Company, a subsidiary of Norilsk Nickel Africa (Pty) Ltd., from the Phoenix open pit mine in Eastern Botswana. The mine is situated approximately 25 km southwest of Francistown. The deposit occurs in mafic intrusive rocks in the Tati Greenstone Belt of the Rhodesian Craton.

3. Mineral and Chemical Composition: Nickel-copper mineralization occurs in metasomatised feldspathic amphibolites intruded by pegmatites and granites. Mineralisation is in the form of massive sulphide lenses with secondary thin mineralized fractures into the country rock. The primary sulphide is pyrrhotite with lesser pentlandite, chalcopyrite and minor spalerite. Uncertified trace element data is provided as an appendix to this certificate.

4. **Appearance:** The material is a very fine powder. It is colored a Light Grey (Corstor 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 <54um. Wet sieve particle 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. Pb collection with Ag as a co-collector, ICP-OES or ICP-MS.
2. Multi element scan to include Co, Cu and Ni. Multi-acid total digestion, including HF, ICP-OES or ICP-MS.
3. Co, Cu and Ni. Aqua regia digestion with ICP-OES or ICP-MS.
4. Co, Cu and Ni. Pressed Pellet, XRF.
5. Majors (Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, SiO₂, TiO₂. LOI.) XRF fusion.
6. S by LECO
7. SG, gas pycnometer.

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 two 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 22 out of 26 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. Activation Laboratories Pty Ltd (ActLabs) CA
3. ALS Chemex Laboratory Group Brisbane Australia
4. ALS Chemex Laboratory Group Johannesburg SA
5. ALS Chemex Laboratory Group Perth WA
6. ALS OMAC
7. BCL Botswana
8. Bureau Veritas (USA)
9. Genalysis Laboratory Services (W Australia P)
10. Intertek Utama Services (Indonesia)
11. Labtium Inc Finland
12. Set Point Laboratories (Isando) SA
13. SGS Australia Pty Ltd (Newburn) WA
14. SGS Geosol Laboratories Ltda (Brazil)
15. SGS Mineral Services Callao (Peru)
16. SGS Mineral Services Lakefield (Canada)
17. SGS South Africa (Pty) Ltd - Booyens JHB
18. SGS Toronto (Canada)
19. SGS Townsville (Australia)
20. SGS Vancouver (Canada)
21. Tati Nickel Mine Laboratory (Botswana)
22. Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 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.

Assay data: Economic elements

Lab Code	Pt PbColl g/t	Pd PbColl g/t	Au PbColl 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	0.25	0.57	0.03	100.00			1500			2300		
A	0.26	0.56	0.03	100.00			1500			2100		
A	0.26	0.57	0.04	100.00			1500			2156		
A	0.25	0.56	0.03	100.00			1467			2300		
A	0.26	0.56	0.03	100.00			1450			2000		
A	0.27	0.57	0.03	66.67			1500			2300		
A	0.25	0.55	0.03	100.00			1467			2267		
A	0.26	0.58	0.05	100.00			1442			2217		
B	0.28	0.58	0.03	87.00	69.00		1480	1370		1970	1920	
B	0.27	0.56	0.03	87.00	70.00		1480	1370		1960	1880	
B	0.26	0.58	0.03	85.00	70.00		1470	1380		1920	1900	
B	0.28	0.58	0.03	86.00	72.00		1470	1420		1930	1900	
B	0.27	0.58	0.03	84.00	72.00		1490	1390		1910	1960	
B	0.27	0.58	0.03	87.00	71.00		1470	1390		1930	1900	
B	0.28	0.58	0.03	87.00	71.00		1510	1400		1930	1950	
B	0.27	0.56	0.03	82.00	70.00		1500	1420		1970	1870	

Assay data (cont) : Economic elements

Lab Code	Pt PbColl g/t	Pd PbColl g/t	Au PbColl 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
C	0.28	0.57	0.03	98.90	74.60	120.00	1501	1437	1400	2319	1928	2320
C	0.26	0.54	0.03	104.10	72.80	110.00	1541	1453	1370	2365	1939	2260
C	0.26	0.54	0.03	106.60	73.90	110.00	1537	1418	1400	2378	1890	2270
C	0.26	0.53	0.04	103.30	76.20	110.00	1457	1457	1420	2248	1943	2300
C	0.27	0.55	0.03	94.90	73.10	120.00	1467	1414	1400	2256	1900	2290
C	0.26	0.52	0.04	107.10	74.80	120.00	1504	1435	1370	2327	1911	2270
C	0.27	0.54	0.03	103.20	75.30	110.00	1523	1475	1360	2341	1973	2230
C	0.26	0.55	0.03	102.20	78.50	120.00	1483	1472	1390	2298	1971	2290
D	0.26	0.56	0.03	78.93	77.27		1726	1652	1600	2073	2087	2300
D	0.27	0.56	0.04	90.06	74.69	100.00	1640	1648	1500	2088	2026	2400
D	0.27	0.55	0.04	96.78	77.13	100.00	1595	1654	1600	2101	2080	2300
D	0.27	0.56	0.04	87.33	76.94		1582	1639	1600	2144	2064	2300
D	0.27	0.56	0.04	87.22	77.60	200.00	1615	1587	1600	2138	2076	2300
D	0.27	0.56	0.04	94.74	75.51	200.00	1592	1602	1500	2146	2040	2200
D	0.27	0.55	0.04	91.86	79.36	200.00	1605	1650	1500	2118	2114	2100
D	0.28	0.55	0.04	83.09	78.08		1578	1618		2122	2116	
E				100.00			1440			2010		
E				100.00			1440			2010		
E				100.00			1410			2020		
E				100.00			1430			2010		
E				100.00			1430			2000		
E				100.00			1400			2010		
E				100.00			1430			2100		
E				100.00			1430			2080		
F	0.26	0.50	0.03	105.00	76.00		1570	1520		2260	2080	
F	0.30	0.50	0.04	95.00	78.00		1560	1510		2260	2040	
F	0.24	0.52	0.04	95.00	81.00		1510	1550		2280	2110	
F	0.30	0.52	0.04	100.00	77.00		1540	1560		2220	2100	
F	0.28	0.54	0.04	95.00	79.00		1540	1550		2240	2110	
F	0.28	0.52	0.04	100.00	79.00		1550	1550		2310	2060	
F	0.26	0.52	0.03	95.00	76.00		1530	1520		2230	2050	
F	0.24	0.50	0.04	95.00	81.00		1540	1620		2300	2180	
H	0.24	0.50	0.03	90.00	70.00		1570	1520		2170	2060	
H	0.25	0.52	0.03	90.00	80.00		1550	1510		2160	2100	
H	0.27	0.53	0.03	90.00	80.00		1560	1480		2180	2080	
H	0.27	0.54	0.03	90.00	80.00		1530	1510		2130	2080	
H	0.25	0.51	0.04	90.00	70.00		1560	1480		2160	2090	
H	0.26	0.51	0.03	90.00	80.00		1550	1490		2180	2110	
H	0.25	0.51	0.05	90.00	80.00		1540	1470		2150	2060	
H	0.26	0.52	0.04	90.00	80.00		1550	1500		2150	2120	
I	0.28	0.57	0.05	77.00	71.00	88.00	1503	1516	1380	2213	2108	1992
I	0.27	0.55	0.03	77.00	72.00	88.00	1524	1503	1393	2146	2097	2010
I	0.26	0.52	0.03	76.00	71.00	86.00	1471	1504	1368	2106	2058	1976
I	0.26	0.53	0.03	75.00	71.00	86.00	1490	1501	1380	2104	2058	1987
I	0.26	0.54	0.03	76.00	72.00	82.00	1492	1505	1326	2061	2133	1917
I	0.26	0.54	0.03	75.00	71.00	84.00	1469	1504	1325	2165	2048	1911
I	0.27	0.56	0.04	76.00	71.00	84.00	1502	1532	1396	2100	2027	2011
I	0.28	0.59	0.03	76.00	72.00	80.00	1502	1457	1364	2193	2042	1964
J	0.27	0.56	0.03	90.00	70.00		1590	1480		2240	2000	
J	0.26	0.56	0.02	90.00	70.00		1500	1470		2140	1990	
J	0.26	0.57	0.03	90.00	70.00		1510	1430		2140	1920	
J	0.25	0.57	0.04	90.00	80.00		1510	1480		2150	2020	
J	0.27	0.57	0.04	90.00	80.00		1480	1480		2110	2010	
J	0.25	0.56	0.03	90.00	70.00		1580	1490		2260	2050	
J	0.25	0.55	0.03	80.00	70.00		1500	1470		2130	2000	
J	0.26	0.56	0.03	90.00	80.00		1510	1450		2170	1970	
K			0.04				1637			2150		
K			0.02				1600			2103		
K			0.05				1483			1984		
K			0.03				1506			2011		
K			0.04				1508			1983		
K			0.04				1479			1974		
K			0.03				1599			2100		
K			0.02				1506			1997		
N	0.28	0.59	0.04			100.00			1500			2200
N	0.27	0.56	0.03						1500			2200
N	0.27	0.56	0.03						1400			2200
N	0.29	0.60	0.03			100.00			1400			2100
N	0.28	0.60	0.03						1500			2100
N	0.28	0.59	0.04			100.00			1400			2100
N	0.28	0.60	0.04			100.00			1400			2100
N	0.28	0.60	0.03			100.00			1500			2200

Assay data (cont): Economic elements

Lab Code	Pt PbColl g/t	Pd PbColl g/t	Au PbColl 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
O	0.24	0.52	0.03	95.00	78.00		1520	1410		2360	1920	
O	0.24	0.51	0.04	94.00	81.00		1540	1440		2370	1960	
O	0.24	0.53	0.04	98.00	82.00		1540	1440		2350	1990	
O	0.25	0.52	0.04	95.00	80.00		1520	1430		2310	1940	
O	0.24	0.52	0.04	94.00	80.00		1520	1460		2330	1980	
O	0.23	0.52	0.03	95.00	80.00		1520	1420		2310	1950	
O	0.24	0.52	0.04	94.00	81.00		1520	1460		2310	1970	
O	0.25	0.52	0.04	95.00	78.00		1550	1410		2350	1910	
P	0.26	0.56	0.04	97.60	87.00		1488	1493		2075	2101	
P	0.27	0.58	0.04	96.60	86.00		1472	1482		2081	2050	
P	0.28	0.57	0.03	97.60	86.00		1421	1511		1981	2079	
P	0.27	0.57	0.04	97.00	86.00		1475	1471		2079	2071	
P	0.27	0.56	0.03	96.80	85.00		1424	1455		1967	2078	
P	0.27	0.57	0.03	97.50	88.00		1410	1505		1936	2050	
P	0.27	0.58	0.04	97.40	86.00		1466	1483		1990	2036	
P	0.27	0.59	0.04	97.40	88.00		1459	1499		1993	2048	
Q	0.24	0.55	0.04						1473			2156
Q	0.25	0.54	0.05						1468			2164
Q	0.25	0.56	0.03						1478			2203
Q	0.26	0.57	0.04						1479			2193
Q	0.25	0.55	0.04						1501			2204
Q	0.25	0.55	0.03						1476			2185
Q	0.24	0.56	0.03						1468			2173
Q	0.25	0.57	0.03						1497			2174
S				90.00	80.00	90.00	1500	1550	1510	2160	2080	2190
S				90.00	80.00	100.00	1440	1560	1560	2080	2100	2200
S				100.00	80.00	90.00	1550	1550	1580	2240	2090	2190
S				90.00	80.00	90.00	1510	1540	1540	2180	2080	2180
S				100.00	80.00	90.00	1550	1530	1550	2240	2070	2180
S				90.00	80.00	90.00	1520	1520	1540	2200	2070	2180
S				90.00	80.00	90.00	1550	1530	1550	2250	2060	2180
S				90.00	80.00	100.00	1540	1510	1560	2240	2020	2190
T	0.28	0.56	0.04	98.00	81.00		1520	1470		1980	1920	
T	0.28	0.55	0.04	107.00	91.00		1500	1530		1990	1980	
T	0.27	0.55	0.04	103.00	82.00		1460	1440		1970	1920	
T	0.29	0.58	0.04	87.00	70.00		1510	1490		2050	1980	
T	0.27	0.53	0.04	82.00	68.00		1460	1500		2010	1990	
T	0.28	0.56	0.04	84.00	68.00		1410	1440		1960	1890	
T	0.29	0.57	0.04	94.00	72.00		1570	1490		2060	1940	
T	0.28	0.53	0.04	96.00	79.00		1490	1570		2000	1560	
U	0.26	0.54	0.03	100.00	100.00	75.00	1400	1400	1400	2200	2100	2000
U	0.25	0.54	0.03	100.00	100.00	81.00	1500	1400	1400	2200	2100	2000
U	0.25	0.52	0.02	100.00	100.00	75.00	1500	1500	1400	2200	2200	2000
U	0.26	0.53	0.03	100.00	100.00	90.00	1400	1500	1400	2200	2100	2000
U	0.25	0.53	0.04	100.00	100.00	90.00	1500	1400	1400	2200	2000	2000
U	0.25	0.53	0.03	100.00	100.00	78.00	1500	1500	1400	2200	2100	2000
U	0.26	0.52	0.02	100.00	100.00	82.00	1500	1400	1400	2200	2000	2000
U	0.26	0.53	0.03	100.00	100.00	86.00	1500	1500	1400	2200	2100	2000
V				77.00	71.00	88.00	1503	1516	1380	2213	2108	1992
V	0.28	0.62	0.03	77.00	72.00	88.00	1524	1503	1393	2146	2097	2010
V	0.27	0.58	0.03	76.00	71.00	86.00	1471	1504	1368	2106	2058	1976
V	0.28	0.58	0.04	75.00	71.00	86.00	1490	1501	1380	2104	2058	1987
V	0.27	0.57	0.03	76.00	72.00	82.00	1492	1505	1326	2061	2133	1917
V	0.28	0.59	0.03	75.00	71.00	84.00	1469	1504	1325	2165	2048	1911
V	0.27	0.59	0.03	76.00	71.00	84.00	1502	1532	1396	2100	2027	2011
V	0.26	0.57	0.03	76.00	72.00	80.00	1502	1457	1364	2193	2042	1964
W			0.04	83.00	78.00		1410	1420		1820	2090	
W	0.25	0.50	0.05	84.00	78.00		1390	1420		1830	2120	
W	0.25	0.51	0.04	83.00	76.00		1400	1400		1820	1980	
W	0.25	0.50	0.04	83.00	77.00		1390	1380		1780	2030	
W	0.25	0.49	0.05	84.00	76.00		1380	1370		1830	2070	
W	0.26	0.52	0.05	86.00	77.00		1410	1380		1900	2020	
W	0.25	0.51	0.05	87.00	76.00		1410	1350		1900	1970	
W	0.26	0.51	0.05	87.00	74.00		1420	1400		1900	1980	
X	0.27	0.56	0.04			93.00			1420			2260
X	0.27	0.55	0.03			90.00			1420			2260
X	0.28	0.55	0.03			91.00			1420			2250
X	0.26	0.53	0.03			88.00			1420			2250
X	0.27	0.54	0.04			94.00			1420			2270
X	0.27	0.55	0.03			88.00			1430			2260
X	0.28	0.56	0.03			92.00			1420			2260
X	0.28	0.58	0.03			92.00			1420			2260

Assay data (cont): Economic elements

Lab Code	Pt PbColl g/t	Pd PbColl g/t	Au PbColl 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				98.00	70.00		1476	1444		2276	2004	
Y				99.00	71.00		1506	1467		2203	2116	
Y				98.00	70.00		1535	1456		2226	2049	
Y				96.00	69.00		1534	1445		2206	2008	
Y				93.00	70.00		1492	1437		2115	1987	
Y				93.00	69.00		1543	1451		2172	1938	
Y				92.00	69.00		1517	1428		2245	1985	
Y				100.00	69.00		1496	1447		2204	1963	
Z	0.27	0.52	0.04	97.00	82.00		1590	1590		2270	2020	
Z	0.27	0.52	0.03	95.00	81.00		1530	1550		2170	2030	
Z	0.27	0.52	0.03	94.00	80.00		1530	1520		2180	1960	
Z	0.28	0.53	0.04	96.00	86.00		1550	1550		2210	2070	
Z	0.26	0.52	0.03	95.00	88.00		1520	1570		2170	2050	
Z	0.27	0.52	0.03	97.00	83.00		1550	1530		2190	2000	
Z	0.26	0.52	0.03	96.00	82.00		1550	1560		2210	2030	
Z	0.28	0.53	0.03	95.00	79.00		1560	1550		2210	1990	

Assay data: Major elements

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	S Comb/LECO %	SG pyc
B												0.98	
B												0.99	
B												0.99	
B												0.99	
B												0.98	
B												0.99	
B												0.99	
B												1.00	
C	15.16	8.37	0.39	9.98	0.72	8.03	0.12	2.24	51.10	0.74	2.30		2.90
C	15.13	8.31	0.39	9.92	0.73	8.00	0.12	2.24	51.10	0.77	2.32		2.89
C	15.18	8.35	0.39	10.02	0.71	8.03	0.12	2.24	51.20	0.74	2.29		2.86
C	15.24	8.42	0.39	10.03	0.72	8.10	0.12	2.23	51.40	0.75	2.27		2.86
C	15.14	8.38	0.39	10.00	0.71	8.03	0.12	2.24	51.10	0.73	2.25		2.86
C	15.12	8.34	0.38	9.99	0.73	8.04	0.12	2.24	51.20	0.76	2.25		2.85
C	15.13	8.33	0.39	9.93	0.73	8.02	0.12	2.23	51.00	0.75	2.28		2.89
C	15.21	8.38	0.40	9.92	0.72	8.09	0.12	2.24	51.30	0.75	2.30		2.87
D	15.39	8.41	0.39	9.90	0.71	7.93	0.12	2.21	51.33	0.78	2.75	1.00	
D	15.13	8.16	0.37	9.66	0.73	7.76	0.12	2.39	51.14	0.75	2.69	1.00	
D	15.40	8.49	0.38	9.95	0.73	7.98	0.12	2.34	52.00	0.73	2.75	0.98	
D	15.23	8.48	0.38	9.89	0.72	7.89	0.11	2.59	52.08	0.75	2.77	0.98	
D	14.97	8.27	0.37	9.60	0.70	7.75	0.11	2.47	50.57	0.72	2.72	0.99	
D	14.87	8.33	0.38	9.66	0.72	7.69	0.11	2.45	51.13	0.78	2.69	1.00	
D	15.16	8.52	0.38	9.83	0.70	7.86	0.11	2.33	51.42	0.72	2.73	1.00	
D	14.92	8.30	0.38	9.75	0.71	7.71	0.12	2.36	51.37	0.72	2.72	0.99	
E	16.41	9.85				7.49			46.00			0.96	
E	16.39	10.15				7.39			46.10			0.86	
E	17.00	9.11				7.40			46.20			0.74	
E	16.32	10.52				7.57			46.80			0.71	
E	17.03	9.24				7.33			47.90			0.71	
E	16.11	9.96				7.71			45.90			0.71	
E	16.24	7.69				7.34			45.80			0.72	
E	17.34	9.04				7.81			48.10			0.71	
F	15.20	8.40	0.37	9.84	0.72	7.94	0.12		51.33	0.75	2.47		3.01
F	15.22	8.41	0.37	9.86	0.72	7.96	0.12		51.37	0.75	2.46		3.03
F	15.23	8.39	0.37	9.85	0.72	7.94	0.12		51.36	0.75	2.47		3.01
F	15.22	8.40	0.37	9.84	0.72	7.94	0.12		51.37	0.75	2.47		3.00
F	15.22	8.40	0.37	9.83	0.72	7.94	0.12		51.37	0.75	2.45		3.00
F	15.24	8.40	0.37	9.84	0.72	7.96	0.12		51.36	0.75	2.47		3.00
F	15.22	8.41	0.37	9.86	0.72	7.95	0.12		51.39	0.75	2.48		3.05
F	15.23	8.40	0.37	9.86	0.72	7.95	0.12		51.40	0.75	2.47		3.02
H	14.25	8.15	0.36	9.27	0.66	8.25	0.12	2.02	48.70	0.70	3.03		2.96
H	14.30	8.33	0.37	9.37	0.67	8.38	0.12	2.04	49.80	0.71	2.96		2.95
H	14.10	8.18	0.37	9.20	0.66	8.28	0.12	2.00	49.20	0.70	2.83		2.95
H	14.45	8.24	0.38	9.30	0.66	8.35	0.12	2.03	49.40	0.70	3.01		2.96
H	14.35	8.31	0.38	9.33	0.67	8.38	0.12	2.04	49.90	0.70	2.86		2.89
H	14.30	8.34	0.38	9.38	0.67	8.49	0.12	2.04	50.50	0.71	3.01		2.95
H	14.35	8.33	0.38	9.33	0.66	8.42	0.12	2.02	49.70	0.70	2.91		2.95
H	14.25	8.23	0.37	9.18	0.65	8.33	0.12	1.99	49.60	0.70	3.01		2.95

Assay data (cont): Major elements

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	S Comb/LECO %	SG pyc
I	15.00	8.13	0.41	9.68	0.70	7.62	0.12	2.26	50.70	0.75			2.96
I	15.30	8.25	0.43	9.78	0.71	7.68	0.12	2.21	50.80	0.75			2.96
I	15.10	8.23	0.42	9.74	0.71	7.62	0.12	2.24	50.50	0.76			2.94
I	15.20	8.29	0.42	9.79	0.72	7.71	0.12	2.26	50.80	0.76			2.96
I	15.10	8.26	0.43	9.89	0.71	7.64	0.12	2.28	50.50	0.76			2.96
I	14.60	8.06	0.41	9.53	0.70	7.44	0.12	2.20	50.50	0.73			2.96
I	15.20	8.30	0.42	9.81	0.72	7.75	0.12	2.23	50.50	0.76			2.96
I	15.30	8.29	0.45	9.80	0.72	7.70	0.12	2.30	50.80	0.76			2.96
J	14.85	8.26	0.37	9.59	0.70	7.84	0.12		51.00	0.72			2.88
J	14.70	8.19	0.37	9.50	0.70	7.80	0.12		51.10	0.72			2.89
J	14.80	8.25	0.37	9.53	0.70	7.80	0.12		51.30	0.72			2.88
J	14.70	8.35	0.37	9.47	0.70	7.76	0.12		50.90	0.72			2.89
J	14.85	8.33	0.37	9.55	0.70	7.81	0.12		50.90	0.72			2.91
J	14.75	8.40	0.37	9.52	0.70	7.83	0.12		50.90	0.72			2.86
J	14.80	8.33	0.37	9.55	0.70	7.80	0.12		51.30	0.73			2.85
J	15.05	8.40	0.37	9.72	0.70	7.96	0.12		52.20	0.73			2.88
K												0.91	
K												0.91	
K												0.93	
K												0.99	
K												0.95	
K												0.95	
K												0.91	
K												0.99	
N	15.20	8.40	0.37	9.90	0.71	7.84	0.10	2.16	50.90	0.74	3.23	0.96	
N	15.10	8.42	0.36	9.94	0.72	7.90	0.11	2.15	50.70	0.74	3.07	0.96	
N	15.20	8.38	0.36	9.91	0.72	7.88	0.11	2.17	51.00	0.74	3.29	0.96	
N	15.20	8.34	0.37	9.87	0.71	7.86	0.12	2.20	51.00	0.74	3.40	0.95	
N	15.20	8.34	0.37	9.91	0.72	7.84	0.11	2.14	50.80	0.73	3.40	0.95	
N	15.20	8.40	0.36	9.90	0.71	7.89	0.11	2.20	50.90	0.74	3.34	0.95	
N	15.10	8.36	0.36	9.88	0.71	7.88	0.11	2.16	50.80	0.73	3.07	0.95	
N	15.20	8.41	0.36	9.91	0.71	7.90	0.11	2.18	51.00	0.74	3.15	0.96	
O	15.22	8.38	0.38	9.91	0.72	7.99	0.12	2.20	51.25	0.75	2.50		
O	15.18	8.35	0.43	9.89	0.71	7.98	0.12	2.19	51.06	0.74	2.50		
O	15.22	8.39	0.39	9.93	0.72	7.93	0.12	2.20	51.29	0.75	2.60		
O	15.20	8.39	0.40	9.99	0.72	7.99	0.12	2.20	51.26	0.75	2.60		
O	15.32	8.37	0.36	9.87	0.71	7.96	0.12	2.18	51.35	0.75	2.50		
O	15.26	8.39	0.38	9.81	0.72	7.99	0.12	2.19	51.33	0.77	2.50		
O	15.17	8.39	0.36	9.90	0.72	7.94	0.12	2.19	51.00	0.74	2.40		
O	15.20	8.39	0.37	9.83	0.72	7.95	0.12	2.22	51.22	0.76	2.50		
P	15.28	8.38	0.38	9.93	0.72	7.99	0.12	2.24	51.27	0.75	2.31		2.92
P	15.24	8.36	0.38	9.90	0.73	7.96	0.12	2.25	51.18	0.75	2.29		2.86
P	15.21	8.40	0.38	9.93	0.73	8.00	0.12	2.25	51.29	0.75	2.32		2.95
P	15.20	8.36	0.38	9.94	0.73	8.00	0.12	2.24	51.09	0.75	2.34		2.94
P	15.11	8.38	0.38	9.90	0.72	7.95	0.12	2.25	51.32	0.75	2.34		2.92
P	15.15	8.36	0.38	9.91	0.72	7.97	0.12	2.22	51.19	0.74	2.33		2.92
P	15.15	8.38	0.38	9.91	0.73	7.97	0.12	2.24	51.19	0.74	2.35		2.80
P	15.17	8.39	0.38	9.93	0.72	8.00	0.12	2.24	51.26	0.75	2.37		2.87
Q	15.90	8.37		9.66	0.65	8.03	0.11	2.31	52.00	0.74	2.67		3.02
Q	15.80	8.29		9.57	0.65	7.81	0.11	2.30	51.70	0.74	2.70		3.03
Q	15.90	8.38		9.71	0.65	7.90	0.11	2.30	52.10	0.75	2.74		3.03
Q	15.90	8.38		9.70	0.66	7.89	0.11	2.30	52.10	0.75	2.70		3.05
Q	16.00	8.41		9.74	0.66	7.89	0.11	2.31	52.30	0.76	2.72		3.06
Q	15.80	8.36		9.64	0.65	7.84	0.11	2.29	52.00	0.75	2.77		2.98
Q	15.90	8.38		9.65	0.66	7.85	0.11	2.29	51.90	0.74	2.75		3.03
Q	15.80	8.37		9.66	0.65	7.88	0.11	2.29	52.00	0.74	2.71		3.07
S	15.45	8.35	0.38	9.79	0.70	7.87	0.12	2.15	51.40	0.75	2.31	0.94	2.89
S	15.50	8.39	0.37	9.84	0.70	7.93	0.12	2.17	51.70	0.75	2.29	0.92	2.90
S	15.40	8.37	0.38	9.82	0.69	7.89	0.12	2.16	51.40	0.76	2.30	0.93	2.90
S	15.35	8.35	0.37	9.76	0.69	7.86	0.12	2.15	51.30	0.75	2.27	0.94	2.90
S	15.35	8.36	0.36	9.77	0.71	7.92	0.12	2.15	51.20	0.72	2.34	0.95	2.92
S	15.40	8.36	0.37	9.78	0.69	7.90	0.12	2.16	51.50	0.75	2.34	0.91	2.91
S	15.35	8.35	0.38	9.77	0.69	7.88	0.12	2.17	51.40	0.75	2.33	0.93	2.89
S	15.45	8.39	0.37	9.83	0.70	7.91	0.12	2.16	51.60	0.76	2.29	0.94	2.91
T													3.04
T													3.01
T													3.02
T													3.02
T													3.02
T													3.04
T													3.01
T													3.04
U	15.30	8.45	0.37	9.88	0.68	8.01	0.12	2.50	51.32	0.76	2.23	1.00	2.93
U	15.24	8.37	0.38	9.82	0.67	7.92	0.12	2.47	51.04	0.75	2.15	1.00	2.93
U	15.31	8.45	0.39	9.84	0.67	7.95	0.12	2.46	51.32	0.76	2.18	1.00	2.93
U	15.19	8.37	0.37	9.81	0.67	7.95	0.12	2.52	51.43	0.75	2.26	1.00	2.93
U	15.24	8.42	0.36	9.82	0.66	7.95	0.12	2.51	51.58	0.75	2.26	1.01	2.94
U	15.23	8.35	0.35	9.81	0.67	7.93	0.12	2.55	51.45	0.74	2.21	1.02	2.93
U	15.33	8.45	0.36	9.87	0.67	8.01	0.12	2.56	51.70	0.75	2.16	1.00	2.93
U	15.29	8.38	0.36	9.84	0.68	7.98	0.12	2.51	51.23	0.75	2.17	1.00	2.94

Assay data (cont): Major elements

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	S Comb/LECO %	SG pyc
V	15.00	8.13	0.41	9.68	0.70	7.62	0.12	2.26	50.70	0.75	2.94	0.85	2.96
V	15.30	8.25	0.43	9.78	0.71	7.68	0.12	2.21	50.80	0.75	2.94	0.85	2.96
V	15.10	8.23	0.42	9.74	0.71	7.62	0.12	2.24	50.50	0.76	2.92	0.85	2.94
V	15.20	8.29	0.42	9.79	0.72	7.71	0.12	2.26	50.80	0.76	2.94	0.87	2.96
V	15.10	8.26	0.43	9.89	0.71	7.64	0.12	2.28	50.50	0.76	2.91	0.84	2.96
V	14.60	8.06	0.41	9.53	0.70	7.44	0.12	2.20	50.50	0.73	2.98	0.86	2.96
V	15.20	8.30	0.42	9.81	0.72	7.75	0.12	2.23	50.50	0.76	3.01	0.88	2.96
V	15.30	8.29	0.45	9.80	0.72	7.70	0.12	2.30	50.80	0.76	2.97	0.85	2.96
W												0.97	3.41
W												0.98	2.82
W												0.99	3.17
W												0.98	3.30
W												0.98	3.40
W												0.98	3.23
W												1.00	3.43
W												0.99	3.48
X	15.17	8.42	0.40	10.18	0.72	7.62	0.13	1.87	49.91	0.85	3.02		2.97
X	15.27	8.40	0.45	10.26	0.72	7.63	0.14	1.83	49.92	0.82	3.04		3.00
X	15.20	8.35	0.42	10.18	0.71	7.58	0.14	1.87	49.87	0.86	3.11		2.99
X	15.19	8.31	0.41	10.21	0.74	7.61	0.14	1.85	49.71	0.81	3.09		2.98
X	15.26	8.40	0.43	10.27	0.70	7.57	0.14	1.88	49.78	0.86	3.10		2.98
X	15.20	8.29	0.42	10.16	0.71	7.66	0.13	1.87	49.64	0.80	3.11		2.99
X	15.23	8.32	0.38	10.15	0.71	7.66	0.13	1.84	49.77	0.82	3.13		2.98
X	15.21	8.34	0.39	10.14	0.73	7.60	0.14	1.87	49.55	0.80	3.07		2.99
Y												0.99	2.87
Y												0.98	2.87
Y												0.98	2.85
Y												1.00	2.87
Y												0.98	2.86
Y												0.99	2.84
Y												0.99	2.86
Y												0.99	2.85
Z	15.10	8.36	0.38	9.94	0.71	7.93	0.13	2.22	51.10	0.75	2.77		
Z	15.20	8.33	0.38	9.93	0.71	7.90	0.12	2.22	51.00	0.75	2.83		
Z	15.20	8.34	0.38	9.94	0.72	7.87	0.12	2.21	51.10	0.75	2.81		
Z	15.10	8.32	0.38	9.88	0.72	7.84	0.12	2.23	51.00	0.75	2.85		
Z	15.20	8.35	0.38	9.97	0.72	7.88	0.12	2.23	51.20	0.75	2.75		
Z	15.20	8.33	0.39	9.92	0.72	7.95	0.12	2.23	51.00	0.76	2.74		
Z	15.20	8.32	0.38	9.95	0.71	7.94	0.13	2.21	51.00	0.75	2.80		
Z	15.20	8.36	0.38	9.93	0.71	7.95	0.13	2.20	51.10	0.75	2.76		

12. Measurement of Uncertainty: (ref Dr Hugh Bartlett, Hugh Bartlett Consulting CC.)

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:

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

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	σ_L ²	Sw ³	CSU ⁴
Pt	PbColl	g/t	0.011	0.006	0.007	0.002
Pd	PbColl	g/t	0.026	0.015	0.012	0.004
Au	PbColl	g/t	0.005	0.001	0.004	0.0005
Co	M/ICP	ppm	7.803	4.719	3.394	1.149
Co	P	ppm	4.976	3.118	2.647	0.842
Co	XRF	ppm	11.413	10.495	4.005	3.750
Cu	M/ICP	ppm	37.18	19.27	24.10	5.140
Cu	P	ppm	51.61	33.40	25.37	8.94
Cu	XRF	ppm	57.47	53.06	25.97	19.05
Ni	M/ICP	ppm	114.6	70.49	49.34	17.12
Ni	P	ppm	68.86	41.66	37.55	10.94
Ni	XRF	ppm	124.4	116.2	37.10	38.99
Al ₂ O ₃	XRF	%	0.298	0.205	0.112	0.054
CaO	XRF	%	0.055	0.027	0.041	0.008
Cr ₂ O ₃	XRF	%	0.015	0.010	0.008	0.003
Fe ₂ O ₃	XRF	%	0.091	0.063	0.050	0.019
K ₂ O	XRF	%	0.015	0.011	0.008	0.003
MgO	XRF	%	0.130	0.094	0.047	0.025
MnO	XRF	%	0.004	0.003	0.002	0.001
Na ₂ O	XRF	%	0.087	0.072	0.030	0.022
SiO ₂	XRF	%	0.351	0.242	0.172	0.069
TiO ₂	XRF	%	0.013	0.006	0.010	0.002
LOI		%	0.291	0.244	0.041	0.071
S	Comb/LECO	%	0.028	0.026	0.014	0.009
SG	pycnometer		0.058	0.045	0.017	0.012

1. S - Std Dev for use on control charts.
2. σ_L - Betw Lab Std Dev, for use to calculate a measure of accuracy.
3. Sw - Within Lab Std 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 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: AMIS0329 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.

13 September 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 – uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	1.09	1.15	52.6	95
Al	M/ICP	%	8.10	0.69	4.27	112
As	M/ICP	ppm	9.80	4.53	23.1	84
Ba	M/ICP	ppm	183	24.4	6.68	110
Be	M/ICP	ppm	0.60	0.40	33.7	34
Bi	M/ICP	ppm	1.56	4.38	141	45
Ca	M/ICP	%	6.12	0.82	6.72	120
Cd	M/ICP	ppm	1.02	2.08	101	42
Ce	M/ICP	ppm	22.3	11.0	24.7	47
Cr	M/ICP	ppm	1743	900	25.8	116
Cs	M/ICP	ppm	1.26	0.11	4.33	24
Dy	M/ICP	ppm	2.31	0.22	4.65	15
Er	M/ICP	ppm	1.28	0.14	5.50	16
Eu	M/ICP	ppm	0.81	0.09	5.31	16
Fe	M/ICP	%	6.83	0.70	5.10	120
Ga	M/ICP	ppm	17.4	4.87	14.0	55
Gd	M/ICP	ppm	1.96	1.66	42.5	24
Hf	M/ICP	ppm	2.00	0.55	13.8	36
Ho	M/ICP	ppm	0.47	0.03	3.22	15
In	M/ICP	ppm	0.05	0.01	13.8	27
K	M/ICP	%	0.64	0.21	16.3	112
La	M/ICP	ppm	10.2	2.98	14.6	79
Li	M/ICP	ppm	21.3	4.53	10.7	72
Lu	M/ICP	ppm	0.17	0.02	5.55	23
Mg	M/ICP	%	4.70	0.39	4.17	112
Mn	M/ICP	ppm	913	65.2	3.57	97
Mo	M/ICP	ppm	3.38	2.02	29.9	80
Na	M/ICP	%	1.67	0.21	6.23	114
Nb	M/ICP	ppm	5.58	5.03	45.0	38
Nd	M/ICP	ppm	10.1	0.47	2.36	16
P	M/ICP	ppm	440	156	17.7	95
Pb	M/ICP	ppm	14.1	7.08	25.1	97
Pr	M/ICP	ppm	4.06	6.10	75.2	20
Rb	M/ICP	ppm	27	11.1	20.5	53
Re	M/ICP	ppm	0.02	0.01	20.7	8
S	M/ICP	%	0.98	0.12	5.88	99
Sb	M/ICP	ppm	9.59	29.1	152	60
Sc	M/ICP	ppm	18.9	2.78	7.4	114
Se	M/ICP	ppm	3.86	1.79	23.2	34
Si	M/ICP	%	37.7	29.0	38.5	16
Sm	M/ICP	ppm	2.46	0.19	3.91	15
Sn	M/ICP	ppm	1.0	1.08	55.5	41
Sr	M/ICP	ppm	197	19.0	4.83	120
Ta	M/ICP	ppm	0.64	0.87	67.6	38
Tb	M/ICP	ppm	0.37	0.07	9.17	23
Te	M/ICP	ppm	0.57	0.93	80.9	35
Th	M/ICP	ppm	2.96	0.51	8.64	40
Ti	M/ICP	%	0.44	0.04	4.45	96
Tl	M/ICP	ppm	0.57	2.84	247	36
Tm	M/ICP	ppm	0.40	0.65	81.5	24
U	M/ICP	ppm	30.0	126	210	39
V	M/ICP	ppm	143	43.7	15.3	112
W	M/ICP	ppm	5.78	6.05	52.4	44
Y	M/ICP	ppm	11.7	2.58	11.0	71
Yb	M/ICP	ppm	23.6	67.8	143	32
Zn	M/ICP	ppm	86.4	15.8	9.14	87
Zr	M/ICP	ppm	72.9	26.5	18.2	114