



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0318

**Nickel, Copper, PGM Sulphide Ore
Nkomati Mine South Africa**

Certified Reference Material

Certificate of Analysis

**Recommended Concentrations and Limits^{1, 2}
(at two Standard Deviations)**

Certified Concentrations

Pt Pb Collection	0.17	±	0.02	g/t
Pd Pb Collection	0.30	±	0.02	g/t
Co P	98	±	7	ppm
Cu M/ICP	1566	±	108	ppm
Cu P	1552	±	81	ppm
Cu XRF	1495	±	168	ppm
Ni P	1529	±	121	ppm
Ni XRF	1653	±	196	ppm
Specific Gravity	2.92		0.14	

Provisional Concentration

Au Pb Collection	0.06	±	0.01	g/t
Co M/ICP	107	±	14	ppm
Co XRF	107	±	29	ppm
Ni M/ICP	1686	±	216	ppm

PGM 3E= 0.53g/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, 10 and 13.
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	7.39	±	0.12	%
CaO	6.63	±	0.10	%
Fe ₂ O ₃	11.63	±	0.30	%
K ₂ O	0.98	±	0.02	%
MgO	9.31	±	0.20	%
MnO	0.16	±	0.01	%
Na ₂ O	1.10	±	0.10	%
SiO ₂	54.13	±	0.58	%
TiO ₂	0.57	±	0.02	%
S Combustion / LECO	1.51	±	0.08	%

Provisional Concentrations

Cr ₂ O ₃	0.20	±	0.03	%
LOI	5.51	±	0.80	%

1. Intended Use: AMIS0318 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: The material for AMIS0318 was provided by the Nkomati Nickel Mine, joint venture between ARM Platinum and Norilsk Nickel Africa (Pty) Ltd. The mine is situated in the Machadodorp area, Mpumalanga, approximately 300 km east of Johannesburg in South Africa.

3. Mineral and Chemical Composition: Mineralisation at Nkomati occurs in a number of distinct zones within the Uitkomst Complex, a layered mafic-ultramafic intrusion exposed in a broad valley dissecting the Transvaal Sequence. Economic sulphide mineralization occurs as disseminations, blebs and stringers in three zones, namely the Basal Mineralised Zone (BMZ), in the Basal Gabbro; the Main Mineralised Zone (MMZ), in the Lower Pyroxenite, and the Chromititic Peridotite Mineralised Zone (PCMZ), in the Chromititic Peridotite. The Massive Sulphide Body

(MSB), which was situated mainly in the granite basement below the Uitkomst Complex, has been mined out.

4. Appearance: The material is a very fine powder. It is colored aMedium light Grey (Corstor 10Y6/2).

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 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. SG, gas pycnometer.

8. Information requested:

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

9. Method of Certification: Twenty Five laboratories were each given eight randomly selected packages of sample. Twenty one of the laboratories submitted results in time for certification.

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 25 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 Chemex Laboratory Group Vancouver CA
7. ALS OMAC
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. 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.

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	0.18	0.32	0.07	98	98		1510	1530		1470	1500	
A	0.19	0.32	0.06	100	99		1510	1540		1490	1500	
A	0.17	0.30	0.06	100	97		1500	1560		1480	1520	
A	0.19	0.32	0.06	98	98		1480	1530		1440	1510	
A	0.18	0.31	0.06	99	97		1510	1530		1470	1500	
A	0.18	0.31	0.06	96	100		1460	1520		1460	1530	
A	0.19	0.32	0.06	99	97		1520	1530		1460	1510	
A	0.16	0.28	0.06	98	99		1510	1550		1460	1510	
B	0.18	0.31	0.06			104			1570			1680
B	0.17	0.30	0.05			105			1570			1690
B	0.19	0.32	0.07			103			1570			1680
B	0.17	0.29	0.05			103			1580			1680
B	0.19	0.32	0.07			103			1550			1670
B	0.18	0.30	0.06			99			1560			1680
B	0.17	0.30	0.06			102			1560			1670
B	0.18	0.31	0.06			101			1560			1670
C				101	94.00		1589	1539		1789	1419	
C				102	96.00		1585	1577		1723	1485	
C				100	95.00		1585	1554		1719	1451	
C				101	93.00		1530	1533		1720	1439	
C				103	94.00		1554	1565		1702	1455	
C				103	93.00		1597	1541		1760	1435	
C				102	96.00		1599	1575		1773	1486	
C				103	92.00		1619	1513		1798	1392	

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
E	0.18	0.30	0.07	103	104	200	1521	1538	1600	1355	1456	1900
E	0.19	0.31	0.07	101	104	100	1480	1527	1600	1348	1460	1800
E	0.19	0.30	0.07	108	103	200	1506	1503	1700	1380	1462	1800
E	0.19	0.31	0.07	103	101	100	1577	1477	1700	1391	1414	1800
E	0.19	0.31	0.07	101	100	100	1571	1421	1500	1440	1392	1800
E	0.19	0.30	0.07	108	102	200	1513	1495	1600	1425	1448	1700
E	0.18	0.31	0.07	105	98	100	1531	1431	1600	1385	1391	1800
E	0.18	0.31	0.06	107	101	100	1532	1466	1600	1381	1399	1800
G	0.16	0.28	0.06	100	100	96	1600	1500	1400	1800	1600	1500
G	0.16	0.28	0.07	100	100	80	1600	1500	1400	1800	1600	1500
G	0.16	0.28	0.06	100	100	101	1600	1600	1400	1800	1600	1500
G	0.17	0.28	0.06	100	100	99	1500	1600	1400	1800	1700	1500
G	0.17	0.29	0.05	100	100	85	1600	1600	1400	1800	1600	1500
G	0.17	0.29	0.05	100	100	91	1500	1600	1400	1800	1600	1500
G	0.17	0.28	0.06	100	100	83	1600	1500	1400	1800	1600	1500
G	0.17	0.28	0.05	100	100	90	1600	1500	1400	1800	1600	1500
H	0.17	0.29	0.06	94	113		1580	1550		1560	1360	
H	0.17	0.30	0.06	101	97		1510	1590		1550	1440	
H	0.17	0.30	0.06	107	86		1540	1510		1560	1340	
H	0.18	0.30	0.06	99	92		1530	1550		1570	1360	
H	0.18	0.30	0.06	108	101		1520	1590		1560	1420	
H	0.18	0.30	0.06	102	100		1550	1540		1600	1370	
H	0.18	0.29	0.06	91	113		1520	1550		1580	1360	
H	0.17	0.30	0.06	95	111		1600	1600		1610	1350	
J	0.18	0.30	0.08	106	90		1460	1440		1520	1470	
J	0.18	0.31	0.09	106	100		1490	1470		1480	1490	
J	0.18	0.31	0.09	105	91		1460	1540		1460	1460	
J	0.18	0.31	0.09	103	91		1470	1530		1440	1450	
J	0.16	0.30	0.08	103	94		1500	1630		1470	1500	
J	0.17	0.30	0.09	103	93		1470	1620		1450	1500	
J	0.17	0.30	0.08	103	95		1460	1590		1450	1520	
J	0.16	0.29	0.09	106	92		1470	1600		1460	1480	
K	0.19	0.28	0.06	94			1641			1458		
K	0.18	0.30	0.06	90			1595			1458		
K	0.17	0.28	0.06	86			1435			1375		
K	0.19	0.29	0.06	92			1609			1472		
K	0.19	0.29	0.06	91			1569			1408		
K	0.19	0.29	0.06	88			1531			1385		
K	0.21	0.29	0.06	88			1549			1399		
K	0.19	0.29	0.05	88			1523			1384		
L	0.17	0.30	0.06	118	117		1680	1590		1780	1670	
L	0.19	0.25	0.08	126	113		1660	1530		1740	1660	
L	0.18	0.31	0.06	124	114		1660	1550		1790	1630	
L	0.16	0.26	0.07	119	113		1720	1570		1800	1610	
L	0.15	0.27	0.05	116	108		1660	1590		1690	1550	
L	0.17	0.29	0.06	121	108		1620	1520		1790	1540	
L	0.17	0.28	0.05	118	112		1670	1500		1710	1540	
L	0.16	0.28	0.05	119	112		1690	1510		1760	1630	
M	0.18	0.30	0.07	115	101		1560	1580		1700	1520	
M	0.18	0.30	0.06	115	99		1560	1560		1700	1500	
M	0.17	0.29	0.06	115	105		1570	1580		1670	1570	
M	0.17	0.29	0.06	115	104		1570	1580		1670	1580	
M	0.18	0.29	0.07	115	106		1550	1550		1700	1580	
M	0.18	0.29	0.06	110	106		1560	1590		1700	1580	
M	0.17	0.28	0.07	115	102		1560	1570		1710	1510	
M	0.17	0.28	0.06	110	100		1570	1570		1680	1510	
N	0.17	0.30	0.06	99	97	100	1596	1370	1337	1766	1633	1435
N	0.14	0.31	0.06	98	97	104	1574	1387	1470	1773	1687	1572
N	0.17	0.30	0.06	102	97	102	1609	1371	1394	1774	1532	1489
N	0.12	0.31	0.06	98	99	106	1567	1382	1446	1808	1577	1545
N	0.16	0.31	0.06	101	97	100	1611	1371	1415	1791	1686	1507
N	0.17	0.31	0.06	103	97	108	1619	1381	1407	1800	1635	1504
N	0.15	0.30	0.06	101	100	98	1606	1388	1360	1766	1580	1455
N	0.17	0.32	0.06	101	97	104	1580	1362	1427	1764	1614	1515
O	0.17	0.30	0.06	109	100		1690	1530		1670	1600	
O	0.17	0.30	0.06	108	100		1670	1510		1670	1580	
O	0.17	0.30	0.05	109	100		1700	1560		1680	1600	
O	0.16	0.28	0.05	105	100		1650	1520		1620	1560	
O	0.17	0.30	0.06	108	100		1660	1540		1640	1610	
O	0.17	0.29	0.06	113	100		1630	1520		1660	1600	
O	0.17	0.29	0.05	105	100		1670	1520		1640	1580	
O	0.17	0.29	0.06	108	100		1660	1500		1660	1570	

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
P	0.19	0.31		112	96		1442	1466		1600	1491	
P	0.18	0.31		118	92		1452	1436		1590	1444	
P	0.18	0.32		115	93		1458	1482		1605	1470	
P	0.19	0.31		111	94		1430	1435		1596	1465	
P	0.18	0.32		112	95		1454	1438		1594	1481	
P	0.18	0.31		119	94		1430	1455		1575	1443	
P	0.18	0.32		112	96		1436	1456		1577	1484	
P	0.18	0.31		111	91		1453	1394		1606	1414	
Q	0.17	0.30	0.05	110	110		1540	1620		1680	1630	
Q	0.16	0.30	0.05	110	100		1600	1600		1740	1590	
Q	0.17	0.30	0.06	110	100		1570	1590		1660	1560	
Q	0.17	0.30	0.06	110	100		1570	1600		1680	1580	
Q	0.15	0.30	0.05	110	100		1590	1610		1720	1570	
Q	0.16	0.30	0.05	110	100		1570	1580		1660	1540	
Q	0.16	0.30	0.05	110	100		1560	1600		1670	1570	
Q	0.16	0.30	0.05	110	100		1530	1600		1630	1560	
R	0.18	0.31	0.05	120	101	140	1558	1515	1420	1767	1531	1750
R	0.15	0.28	0.05	118	102	130	1549	1568	1390	1749	1581	1730
R	0.18	0.32	0.07	122	96	130	1581	1444	1370	1790	1478	1720
R	0.17	0.31	0.06	124	104	130	1577	1589	1390	1819	1576	1750
R	0.18	0.30	0.05	121	101	140	1569	1535	1410	1769	1569	1750
R	0.19	0.32	0.06	123	101	140	1590	1531	1400	1821	1546	1760
R	0.18	0.31	0.07	124	97	140	1557	1509	1410	1774	1531	1790
R	0.18	0.31	0.06	118	97	130	1552	1496	1350	1755	1507	1730
S	0.18	0.30	0.06	120			1570			1740		
S	0.17	0.29	0.05	130			1570			1760		
S	0.17	0.29	0.06	110			1540			1700		
S	0.17	0.29	0.06	120			1640			1860		
S	0.17	0.29	0.05	110			1570			1740		
S	0.17	0.29	0.06	120			1570			1750		
S	0.17	0.28	0.06	110			1590			1730		
S	0.17	0.29	0.05	110			1630			1760		
T				106	81		1620	1390		1880	1260	
T				104	82		1650	1390		1890	1250	
T				108	83		1640	1420		1860	1270	
T				102	83		1640	1430		1870	1280	
T				103	84		1640	1440		1830	1300	
T				103	84		1640	1430		1850	1290	
T				101	80		1620	1360		1830	1230	
T				100	81		1640	1370		1830	1240	
U	0.19	0.29	0.07	111	95		1500	1580		1610	1510	
U	0.20	0.29	0.07	112	96		1500	1600		1605	1540	
U	0.15	0.29	0.06	111	96		1520	1600		1630	1530	
U	0.18	0.27	0.07	112	98		1540	1590		1640	1530	
U	0.17	0.28	0.06	115	98		1550	1640		1660	1555	
U	0.22	0.26	0.07	111	99		1510	1650		1600	1565	
U	0.20	0.28	0.08	112	100		1540	1640		1635	1580	
U	0.14	0.29	0.07	113	100		1530	1610		1645	1560	
W	0.17	0.29	0.06						1548			1663
W	0.17	0.29	0.06						1494			1680
W	0.16	0.30	0.06						1519			1658
W	0.16	0.29	0.05						1502			1624
W	0.17	0.29	0.07						1522			1677
W	0.16	0.29	0.06						1500			1637
W	0.16	0.29	0.07						1504			1643
W	0.15	0.28	0.06						1513			1655
X	0.18	0.30	0.07			100			1500			1600
X	0.19	0.31	0.06			100			1500			1600
X	0.18	0.31	0.06						1600			1600
X	0.18	0.30	0.06						1500			1700
X	0.18	0.31	0.06			100			1600			1700
X	0.18	0.30	0.06			100			1500			1700
X	0.19	0.32	0.06			100			1600			1600
X	0.18	0.30	0.05						1500			1700
Y				110	80	110	1530	1480	1570	1640	1430	1700
Y				110	90	110	1540	1520	1560	1660	1460	1690
Y				100	90	110	1540	1500	1620	1630	1450	1700
Y				110	90	120	1540	1530	1600	1600	1480	1700
Y				90	90	120	1470	1520	1600	1570	1480	1730
Y				110	90	110	1530	1530	1560	1630	1490	1680
Y				100	90	110	1520	1560	1570	1620	1520	1700
Y				110	90	120	1610	1560	1570	1690	1510	1690

Assay data: Major Oxides

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
A												1.51	
A												1.49	
A												1.49	
A												1.49	
A												1.50	
A												1.48	
A												1.51	
A												1.48	
B	7.36	6.60	0.20	11.86	1.03	9.10	0.17	1.19	54.32	0.59	7.21		2.97
B	7.46	6.73	0.19	11.92	1.05	9.06	0.18	1.19	54.46	0.59	7.22		2.96
B	7.49	6.62	0.19	11.83	1.04	9.01	0.17	1.14	54.33	0.59	7.30		2.98
B	7.30	6.67	0.21	11.78	1.04	9.06	0.17	1.18	54.18	0.61	7.16		2.97
B	7.32	6.59	0.22	11.90	1.04	9.11	0.18	1.16	54.20	0.60	7.04		2.97
B	7.39	6.63	0.22	11.90	1.04	9.02	0.18	1.16	54.19	0.59	7.01		2.97
B	7.33	6.58	0.21	11.81	1.03	8.95	0.17	1.11	54.38	0.61	7.02		2.96
B	7.23	6.64	0.21	11.87	1.04	9.01	0.18	1.18	54.31	0.58	6.86		2.96
C												1.53	2.83
C												1.56	2.84
C												1.52	2.85
C												1.51	2.82
C												1.55	2.82
C												1.53	2.81
C												1.52	2.82
C												1.52	2.80
E												1.50	
E												1.49	
E												1.58	
E												1.58	
E												1.57	
E												1.53	
E												1.56	
E												1.56	
G	7.32	6.78	0.19	11.72	1.00	9.32	0.16	1.18	53.98	0.58	6.02	1.49	2.90
G	7.31	6.79	0.19	11.70	1.00	9.30	0.17	1.19	53.82	0.58	6.09	1.49	2.90
G	7.31	6.80	0.19	11.69	0.99	9.34	0.16	1.19	53.50	0.57	5.97	1.49	2.90
G	7.28	6.83	0.20	11.75	1.00	9.32	0.17	1.20	54.23	0.58	5.87	1.49	2.90
G	7.41	6.76	0.19	11.59	1.00	9.28	0.16	1.21	53.26	0.57	5.94	1.49	2.89
G	7.23	6.76	0.19	11.62	1.00	9.19	0.16	1.21	53.12	0.57	6.18	1.50	2.91
G	7.27	6.80	0.19	11.74	1.00	9.31	0.17	1.20	54.19	0.58	6.11	1.50	2.89
G	7.19	6.75	0.19	11.54	1.00	9.15	0.16	1.21	53.02	0.57	5.93	1.50	2.90
H												1.50	2.99
H												1.50	2.98
H												1.48	2.98
H												1.46	2.99
H												1.46	2.99
H												1.46	2.99
H												1.44	2.99
H												1.46	2.98
J												1.54	3.25
J												1.54	3.24
J												1.52	3.27
J												1.54	3.34
J												1.52	3.15
J												1.54	3.32
J												1.53	2.99
J												1.51	3.10
K												1.45	
K												1.44	
K												1.44	
K												1.48	
K												1.45	
K												1.38	
K												1.41	
K												1.44	
L	7.46	6.65	0.20	11.70	1.02	9.33	0.16	1.11	54.40	0.59	4.97		
L	7.40	6.65	0.20	11.70	1.01	9.29	0.16	1.10	54.30	0.58	4.92		
L	7.44	6.63	0.21	11.60	1.01	9.37	0.16	1.12	54.40	0.58	4.89		
L	7.38	6.65	0.20	11.70	1.01	9.33	0.16	1.11	54.30	0.59	4.85		
L	7.40	6.65	0.20	11.60	1.01	9.33	0.16	1.12	54.30	0.59	4.90		
L	7.40	6.65	0.20	11.70	1.02	9.30	0.17	1.11	54.30	0.58	4.84		
L	7.41	6.65	0.20	11.70	1.01	9.32	0.17	1.13	54.30	0.58	4.89		
L	7.42	6.65	0.20	11.70	1.02	9.27	0.16	1.11	54.20	0.58	4.94		
M	7.36	6.70	0.20	11.65	1.00	9.29	0.16		54.22	0.57	5.43		2.97
M	7.36	6.70	0.20	11.64	1.00	9.29	0.16		54.17	0.56	5.50		3.04
M	7.37	6.70	0.20	11.67	1.00	9.29	0.16		54.18	0.57	5.46		3.00
M	7.36	6.68	0.20	11.64	1.00	9.27	0.16		54.18	0.57	5.49		2.99
M	7.37	6.69	0.20	11.69	1.00	9.29	0.16		54.20	0.57	5.47		2.98
M	7.37	6.70	0.20	11.67	1.00	9.28	0.16		54.19	0.57	5.48		3.01
M	7.37	6.70	0.20	11.70	1.00	9.27	0.16		54.17	0.57	5.52		3.02
M	7.36	6.68	0.20	11.64	1.00	9.26	0.16		54.13	0.57	5.51		3.01
N	7.31	6.54	0.22	11.50	0.99	9.16	0.16	1.07	53.80	0.58	5.91	1.45	2.94
N	7.45	6.58	0.23	11.70	0.99	9.13	0.16	1.07	54.00	0.59	5.57	1.49	2.94
N	7.38	6.59	0.22	11.60	0.99	9.17	0.17	1.09	54.10	0.59	5.85	1.44	2.93
N	7.26	6.48	0.22	11.60	0.98	9.08	0.16	1.08	53.70	0.57	5.87	1.34	2.94
N	7.43	6.61	0.22	11.60	1.00	9.18	0.16	1.11	54.10	0.59	5.85	1.39	2.93
N	7.36	6.47	0.22	11.50	0.98	9.14	0.16	1.09	53.50	0.58	5.80	1.34	2.93
N	7.34	6.58	0.23	11.60	0.99	9.13	0.16	1.09	54.00	0.58	5.39	1.35	2.93
N	7.41	6.57	0.23	11.50	1.00	9.12	0.16	1.09	53.90	0.58	5.60	1.32	2.93

Assay data (cont): Major Oxides

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
O	7.50	6.58	0.22	11.75	1.02	10.05	0.16	1.11	54.30	0.58	5.99	1.58	2.91
O	7.43	6.49	0.22	11.55	1.01	10.10	0.16	1.08	54.50	0.57	6.10	1.57	2.92
O	7.35	6.53	0.22	11.60	1.01	10.10	0.16	1.09	54.80	0.57	6.06	1.58	2.86
O	7.42	6.63	0.22	11.80	1.03	10.05	0.16	1.11	54.70	0.58	6.15	1.58	2.91
O	7.44	6.59	0.22	11.65	1.02	10.20	0.16	1.10	54.90	0.58	6.10	1.57	2.92
O	7.30	6.56	0.22	11.55	1.00	10.05	0.16	1.08	54.50	0.57	6.11	1.58	2.93
O	7.36	6.61	0.22	11.60	1.01	10.05	0.16	1.09	54.40	0.57	6.02	1.58	2.86
O	7.33	6.61	0.22	11.60	1.01	10.05	0.16	1.09	54.10	0.57	6.04	1.58	2.93
P													2.91
P													2.94
P													2.90
P													2.95
P													2.98
P													2.87
P													2.90
P													2.88
Q	7.36	6.59	0.18	11.38	1.00	9.20	0.16	1.10	54.00	0.56	4.86		2.79
Q	7.39	6.61	0.18	11.40	1.00	9.24	0.16	1.11	54.10	0.56	4.82		2.80
Q	7.36	6.59	0.18	11.40	1.00	9.20	0.16	1.10	53.90	0.56	4.87		2.78
Q	7.39	6.62	0.18	11.45	1.00	9.24	0.16	1.11	54.20	0.57	5.03		2.79
Q	7.33	6.54	0.18	11.28	0.99	9.14	0.16	1.09	53.60	0.55	4.91		2.83
Q	7.35	6.60	0.18	11.35	1.00	9.21	0.16	1.10	53.90	0.56	4.73		2.83
Q	7.32	6.53	0.18	11.33	0.99	9.13	0.16	1.10	53.60	0.55	4.83		2.81
Q	7.31	6.54	0.18	11.32	0.99	9.15	0.16	1.09	53.60	0.55	4.83		2.81
R	7.38	6.64	0.21	11.85	1.01	9.43	0.16	1.09	54.00	0.56	5.05		2.82
R	7.38	6.62	0.20	11.86	1.01	9.44	0.16	1.08	53.90	0.56	5.36		2.83
R	7.40	6.66	0.21	11.77	1.01	9.49	0.16	1.10	54.20	0.57	5.25		2.82
R	7.36	6.63	0.21	11.87	1.02	9.44	0.16	1.10	54.10	0.59	5.44		2.82
R	7.39	6.64	0.21	11.79	1.01	9.46	0.16	1.10	54.30	0.58	5.34		2.84
R	7.39	6.66	0.21	11.88	1.01	9.45	0.16	1.08	54.20	0.56	5.28		2.83
R	7.38	6.65	0.22	11.81	1.01	9.44	0.16	1.09	54.00	0.56	5.25		2.82
R	7.35	6.61	0.20	11.81	1.02	9.41	0.16	1.08	54.00	0.61	5.08		2.83
S													2.82
S													2.93
S													3.00
S													2.92
S													3.01
S													2.98
S													2.83
S													3.06
T	7.41	6.69	0.20	11.39	1.01	9.40	0.17	1.03	54.16	0.58	6.10		
T	7.38	6.65	0.18	11.30	1.00	9.37	0.17	1.02	54.18	0.58	5.90		
T	7.38	6.66	0.20	11.34	1.00	9.39	0.17	1.03	54.14	0.58	5.50		
T	7.34	6.63	0.17	11.30	1.00	9.35	0.17	1.02	53.98	0.57	5.80		
T	7.37	6.66	0.18	11.34	1.01	9.35	0.17	1.02	54.14	0.58	5.70		
T	7.37	6.66	0.19	11.48	1.01	9.37	0.17	1.03	54.12	0.59	5.50		
T	7.33	6.64	0.16	11.45	1.00	9.33	0.17	1.01	53.97	0.57	5.80		
T	7.39	6.67	0.18	11.54	1.01	9.39	0.17	1.03	54.26	0.59	5.40		
U													2.98
U													2.89
U													2.93
U													2.95
U													2.95
U													2.98
U													2.97
U													2.97
W	7.78	6.62		11.30	0.92	9.51	0.15	1.13	54.70	0.57	5.40		3.05
W	7.71	6.60		11.20	0.92	9.43	0.14	1.14	54.60	0.56	5.35		3.00
W	7.79	6.64		11.30	0.92	9.51	0.15	1.15	54.90	0.56	5.41		3.03
W	7.71	6.56		11.10	0.92	9.43	0.14	1.09	54.30	0.56	5.52		3.00
W	7.81	6.59		11.30	0.92	9.50	0.15	1.14	54.30	0.56	5.44		3.00
W	7.73	6.57		11.20	0.92	9.48	0.14	1.14	54.30	0.55	5.44		3.02
W	7.71	6.53		11.10	0.91	9.41	0.15	1.13	54.40	0.55	5.38		2.98
W	7.75	6.59		11.20	0.92	9.45	0.15	1.14	54.50	0.56	5.39		3.03
X	7.41	6.67	0.20	11.60	1.02	9.29	0.16	1.04	53.50	0.56	5.72	1.49	
X	7.50	6.70	0.19	11.60	1.00	9.30	0.17	1.06	53.50	0.56	5.70	1.50	
X	7.44	6.67	0.19	11.60	1.00	9.27	0.17	1.04	53.30	0.56	5.64	1.49	
X	7.44	6.67	0.19	11.60	1.01	9.35	0.16	1.07	53.60	0.57	5.76	1.49	
X	7.49	6.71	0.19	11.60	1.00	9.35	0.16	1.05	53.70	0.56	5.80	1.48	
X	7.44	6.64	0.19	11.60	1.00	9.25	0.16	1.05	53.50	0.56	5.68	1.49	
X	7.47	6.68	0.19	11.70	1.01	9.30	0.16	1.06	53.70	0.56	5.62	1.49	
X	7.41	6.72	0.19	11.60	1.00	9.30	0.16	1.06	53.80	0.57	5.87	1.49	
Y	7.47	6.65	0.20	11.52	0.98	9.25	0.16	1.04	54.40	0.58	5.56	1.51	2.86
Y	7.47	6.62	0.20	11.46	0.98	9.22	0.16	1.06	54.20	0.58	5.65	1.53	2.86
Y	7.50	6.66	0.20	11.54	0.98	9.25	0.16	1.06	54.40	0.58	5.60	1.51	2.85
Y	7.51	6.65	0.21	11.57	0.98	9.26	0.16	1.06	54.40	0.58	5.34	1.47	2.84
Y	7.49	6.66	0.20	11.58	1.00	9.24	0.16	1.02	54.10	0.55	5.31	1.50	2.88
Y	7.45	6.62	0.20	11.44	0.99	9.23	0.16	1.04	54.10	0.58	5.38	1.50	2.85
Y	7.48	6.65	0.20	11.56	0.98	9.26	0.16	1.06	54.50	0.58	5.37	1.50	2.85
Y	7.47	6.63	0.20	11.52	0.98	9.23	0.16	1.06	54.30	0.58	5.39	1.51	2.85

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	0.010	0.005	0.007	0.001
Pd	PbColl	g/t	0.011	0.006	0.007	0.002
Au	PbColl	g/t	0.006	0.002	0.005	0.001
Co	M/ICP	ppm	7.049	4.343	3.149	1.089
Co	P	ppm	3.930	2.613	1.901	0.722
Co	XRF	ppm	14.62	15.00	4.577	5.707
Cu	M/ICP	ppm	53.94	32.26	27.04	8.174
Cu	P	ppm	40.64	20.69	31.15	6.537
Cu	XRF	ppm	84.05	81.74	30.50	29.16
Ni	M/ICP	ppm	108.1	74.90	27.26	18.89
Ni	P	ppm	60.53	40.28	28.72	11.12
Ni	XRF	ppm	98.09	97.85	28.85	34.79
Al ₂ O ₃	XRF	%	0.059	0.035	0.042	0.012
CaO	XRF	%	0.047	0.033	0.027	0.010
Cr ₂ O ₃	XRF	%	0.013	0.010	0.006	0.003
Fe ₂ O ₃	XRF	%	0.149	0.119	0.059	0.037
K ₂ O	XRF	%	0.011	0.009	0.006	0.003
MgO	XRF	%	0.102	0.089	0.035	0.028
MnO	XRF	%	0.004	0.003	0.003	0.001
Na ₂ O	XRF	%	0.047	0.039	0.014	0.012
SiO ₂	XRF	%	0.289	0.195	0.164	0.059
TiO ₂	XRF	%	0.012	0.008	0.007	0.002
LOI		%	0.397	0.337	0.120	0.102
S	Comb/LECO	%	0.039	0.032	0.017	0.010
SG	pycnometer		0.071	0.051	0.027	0.014

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 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 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 Smees.

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: AMIS0318 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 or Explorer Packs containing custom weights (from 50 to 250g) of material. Laboratory Packs are sealed bottles delivered in sealed foil pouches. 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 therefore 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 Smees and Smees and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

22 September 2012

Certifying Officers:



African Mineral Standards: _____

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



Geochemist: _____

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

Appendix – uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.89	0.33	18.8	51
Al	M/ICP	%	3.97	0.48	6.01	65
As	M/ICP	ppm	18.1	7.16	19.8	53
Ba	M/ICP	ppm	157	23.8	7.59	61
Be	M/ICP	ppm	0.62	0.13	10.2	40
Bi	M/ICP	ppm	0.77	1.45	94.5	36
Ca	M/ICP	%	4.67	0.26	2.76	64
Cd	M/ICP	ppm	0.46	0.64	70.3	32
Ce	M/ICP	ppm	23.3	3.22	6.90	24
Cr	M/ICP	ppm	961	299	15.6	66
Cs	M/ICP	ppm	2.29	0.24	5.18	16
Dy	M/ICP	ppm	2.21	0.08	1.71	7
Eu	M/ICP	ppm	0.88	0.04	2.50	8
Fe	M/ICP	%	7.96	0.99	6.23	68
Ga	M/ICP	ppm	9.64	1.23	6.36	31
Gd	M/ICP	ppm	2.65	0.15	2.85	8
Ge	M/ICP	ppm	0.63	0.14	11.3	8
Hf	M/ICP	ppm	1.79	0.28	7.88	31
Ho	M/ICP	ppm	0.42	0.01	1.64	7
In	M/ICP	ppm	0.08	0.02	15.2	31
K	M/ICP	%	0.88	0.14	7.90	68
La	M/ICP	ppm	11.1	2.29	10.4	48
Li	M/ICP	ppm	19.7	5.04	12.8	47
Lu	M/ICP	ppm	0.16	0.02	4.84	16
Mg	M/ICP	%	5.5	0.48	4.31	70
Mn	M/ICP	ppm	1209	166	6.84	64
Mo	M/ICP	ppm	1.44	0.64	22.3	48
Na	M/ICP	%	0.84	0.12	7.32	64
Nb	M/ICP	ppm	3.27	0.59	8.96	32
Nd	M/ICP	ppm	11.5	0.64	2.77	8
P	M/ICP	ppm	277	43.2	7.78	63
Pb	M/ICP	ppm	8.78	5.11	29.1	61
Pr	M/ICP	ppm	2.93	0.16	2.67	8
Rb	M/ICP	ppm	28.4	3.40	5.97	32
Re	M/ICP	ppm	0.01	0.01	42.0	8
S	M/ICP	%	1.53	0.31	10.2	47
Sb	M/ICP	ppm	2.61	6.24	119	41
Sc	M/ICP	ppm	14.0	1.27	4.52	66
Se	M/ICP	ppm	4.27	0.91	10.7	22
Sm	M/ICP	ppm	2.68	0.18	3.31	8
Sn	M/ICP	ppm	1.67	0.15	4.46	31
Sr	M/ICP	ppm	169	31.3	9.24	72
Ta	M/ICP	ppm	0.25	0.12	23.2	30
Tb	M/ICP	ppm	0.37	0.05	6.62	16
Te	M/ICP	ppm	0.86	0.93	53.6	29
Th	M/ICP	ppm	1.98	0.25	6.28	32
Ti	M/ICP	%	0.32	0.03	5.32	57
Tl	M/ICP	ppm	0.21	0.02	3.81	24
Tm	M/ICP	ppm	0.17	0.02	4.95	8
U	M/ICP	ppm	0.63	0.07	5.93	32
V	M/ICP	ppm	101	14.5	7.18	72
W	M/ICP	ppm	17.7	75.1	212	38
Y	M/ICP	ppm	10.2	1.48	7.27	40
Yb	M/ICP	ppm	1.16	0.10	4.32	16
Zn	M/ICP	ppm	64.9	10.2	7.88	69
Zr	M/ICP	ppm	56.6	9.07	8.00	40