



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0320

Certified Reference Material

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

Certificate of Analysis

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

Certified Concentrations

Pt Pb Collection	0.319	±	0.026	g/t
Pd Pb Collection	0.754	±	0.062	g/t
Co P	192	±	19	ppm
Cu M/ICP	1684	±	114	ppm
Cu P	1647	±	132	ppm
Cu XRF	1666	±	118	ppm
Ni P	4720	±	363	ppm
Specific Gravity	3.12	±	0.24	

Provisional Concentration

Au Pb Collection	0.040	±	0.008	g/t
Co M/ICP	220	±	31	ppm
Ni M/ICP	4812	±	671	ppm

PGM 3E = 1.11 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, 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	6.15	±	0.06	%
CaO	5.85	±	0.06	%
Cr ₂ O ₃	5.72	±	0.18	%
Fe ₂ O ₃	15.61	±	0.24	%
K ₂ O	0.55	±	0.01	%
MgO	21.00	±	0.38	%
MnO	0.18	±	0.01	%
SiO ₂	36.75	±	0.78	%
TiO ₂	0.39	±	0.01	%
S Comb / LECO	2.80	±	0.12	%

Provisional Concentrations

Na ₂ O	0.49	±	0.09	%
LOI	5.85	±	0.96	%

1. Intended Use: AMIS0320 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 AMIS0320 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 a Medium light Grey (Corstor 10Y 6/2).

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 <54µm. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54µm. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and 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. Nineteen 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 19 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. ALS Chemex Laboratory Group Brisbane Australia
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. ALS OMAC (Ireland)
7. Bureau Veritas (USA)
8. Genalysis Laboratory Services (W Australia P)
9. Intertek Utama Services (Indonesia)
10. Labtium Inc Finland
11. Set Point Laboratories (Isando) SA
12. SGS Australia Pty Ltd (Newburn) WA
13. SGS Geosol Laboratories Ltda (Brazil)
14. SGS Mineral Services Callao (Peru)
15. SGS Mineral Services Lakefield (Canada)
16. SGS Toronto (Canada)
17. SGS Townsville (Australia)
18. SGS Vancouver (Canada)
19. 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.

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	0.31	0.72	0.04	283	225		1680	1670		4240	4630	
A	0.32	0.75	0.04	232	197		1710	1640		4290	4600	
A	0.33	0.79	0.04	211	182		1670	1700		4330	4690	
A	0.33	0.79	0.05	216	180		1730	1690		4430	4710	
A	0.32	0.75	0.04	227	193		1660	1650		4220	4580	
A	0.33	0.77	0.04	236	217		1690	1690		4230	4680	
A	0.33	0.77	0.04	267	220		1690	1660		4270	4660	
A	0.33	0.79	0.04	284	221		1760	1650		4300	4650	
B	0.31	0.73	0.04	202	185		1650	1590		4270	4560	
B	0.32	0.79	0.04	203	191		1680	1630		4290	4570	
B	0.34	0.79	0.04	205	184		1700	1570		4400	4390	
B	0.33	0.78	0.04	202	188		1660	1670		4310	4570	
B	0.35	0.81	0.04	198	187		1630	1620		4230	4530	
B	0.33	0.78	0.04	201	186		1670	1610		4280	4540	
B	0.34	0.78	0.04	200	191		1650	1640		4340	4590	
B	0.33	0.81	0.04	199	187		1610	1600		4250	4580	
C	0.35	0.80	0.04	238	191	270	1640	1517	1600	5095	4672	5160
C	0.30	0.72	0.04	235	183	270	1632	1460	1600	5057	4593	5200
C	0.31	0.74	0.04	237	184	270	1675	1477	1640	5221	4639	5120
C	0.35	0.87	0.04	232	177	270	1649	1436	1700	5161	4499	5250
C	0.33	0.79	0.04	233	180	270	1638	1470	1610	5080	4598	5160
C	0.31	0.75	0.04	231	200	260	1652	1623	1590	5122	5041	5160
C	0.33	0.79	0.04	233	185	270	1660	1497	1630	5180	4676	5130
C	0.32	0.76	0.04	232	183	270	1617	1459	1630	5055	4577	5140
D	0.32	0.72	0.04	229	185	300	1714	1701	1800	4337	4217	5300
D	0.30	0.69	0.05	250	186	300	1791	1610	1800	4704	4342	5300
D	0.29	0.69	0.04	233	184	400	1674	1618	1700	4441	4191	5200
D	0.31	0.69	0.04	231	183	300	1626	1600	1900	4364	4138	5300
D	0.31	0.66	0.04	240	182	300	1690	1596	1800	4525	4124	5300
D	0.30	0.70	0.04	239	183	400	1788	1592	1700	4549	4158	5100
D	0.31	0.68	0.05	234	183	300	1646	1623	1700	4426	4174	5300
D	0.31	0.71	0.05	235	182	300	1713	1601	1700	4401	4175	5000

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
F	0.31	0.76	0.04	230	200		1700	1650		4890	4790	
F	0.31	0.77	0.04	220	200		1710	1740		4930	5050	
F	0.30	0.76	0.04	230	200		1690	1670		4880	4870	
F	0.31	0.78	0.04	230	200		1680	1670		4870	4920	
F	0.31	0.76	0.03	220	190		1670	1660		4800	4860	
F	0.31	0.77	0.04	230	200		1700	1690		4870	4970	
F	0.32	0.77	0.04	240	200		1790	1750		5050	4990	
F	0.33	0.77	0.04	220	200		1660	1670		4740	4950	
G	0.34	0.78	0.04	230	185		1660	1660		4980	4600	
G	0.34	0.77	0.04	230	188		1710	1700		5030	4660	
G	0.34	0.78	0.04	225	184		1680	1670		4910	4610	
G	0.33	0.76	0.04	225	183		1670	1660		4980	4630	
G	0.34	0.78	0.04	225	186		1700	1710		4960	4630	
G	0.33	0.78	0.04	230	180		1670	1660		4920	4550	
G	0.33	0.77	0.05	230	175		1690	1640		5010	4490	
G	0.34	0.76	0.04	225	185		1700	1650		4980	4670	
H	0.32	0.75	0.05	216	210		1800	1680		4700	5050	
H	0.31	0.76	0.04	214	210		1730	1640		4650	4990	
H	0.33	0.77	0.04	206	210		1690	1580		4560	4940	
H	0.33	0.76	0.04	210	200		1730	1560		4580	4870	
H	0.32	0.76	0.05	212	200		1740	1630		4620	4970	
H	0.32	0.76	0.04	217	210		1770	1600		4720	4880	
H	0.33	0.75	0.04	217	210		1760	1620		4700	4960	
H	0.32	0.75	0.05	215	210		1770	1600		4660	4990	
I	0.33	0.79	0.07	205	186		1615	1640		4400	4710	
I	0.35	0.82	0.05	213	190		1675	1660		4510	4700	
I	0.33	0.74	0.03	210	191		1645	1650		4490	4760	
I	0.36	0.90	0.05	209	188		1660	1630		4530	4710	
I	0.33	0.85	0.06	210	189		1645	1670		4500	4710	
I	0.34	0.83	0.06	208	190		1665	1670		4510	4750	
I	0.32	0.79	0.07	212	191		1665	1670		4610	4720	
I	0.36	0.82	0.06	209	189		1665	1640		4550	4660	
K	0.27		0.03	174			1640			3843		
K	0.28		0.03	171			1641			3823		
K	0.13		0.02	182			1750			4061		
K	0.26		0.03	178			1666			3865		
K	0.24		0.03	177			1701			3958		
K	0.31		0.04	163			1495			3557		
K	0.32		0.04	169			1553			3677		
K	0.30		0.04	179			1686			3942		
M	0.32	0.73	0.08			200			1800			4800
M	0.33	0.76	0.05			200			1700			4900
M	0.32	0.75	0.04			200			1700			4700
M	0.33	0.72	0.04			200			1700			4700
M	0.32	0.77	0.04			200			1600			4800
M	0.31	0.76	0.04			200			1700			4900
M	0.32	0.72	0.08			200			1600			4800
M	0.33	0.74	0.04			200			1600			4700
N				229	163		1740	1470		5390	4110	
N				224	160		1710	1440		5290	4030	
N				224	162		1690	1450		5260	4070	
N				225	161		1770	1450		5230	4070	
N				224	164		1730	1480		5340	4150	
N				226	164		1770	1470		5350	4120	
N				225	160		1770	1430		5390	4020	
N				222	163		1770	1430		5280	4030	
O	0.32	0.73	0.04	234	184		1616	1519		4941	4317	
O	0.32	0.75	0.04	237	195		1597	1582		4919	4325	
O	0.33	0.75	0.04	230	186		1607	1549		4994	4390	
O	0.33	0.75	0.04	234	187		1590	1544		5044	4399	
O	0.33	0.78	0.04	234	196		1627	1556		4897	4507	
O	0.32	0.73	0.04	229	186		1622	1558		4846	4350	
O	0.33	0.76	0.04	236	193		1599	1567		4889	4432	
O	0.33	0.75	0.04	231	188		1613	1570		5127	4363	
P	0.31	0.79	0.05						1648			4951
P	0.30	0.75	0.05						1618			4955
P	0.29	0.75	0.04						1631			4931
P	0.30	0.75	0.04						1590			4875
P	0.31	0.77	0.04						1633			4922
P	0.30	0.75	0.04						1591			4904
P	0.29	0.74	0.04						1601			4899
P	0.29	0.75	0.04						1608			4870
Q	0.30	0.76	0.04	200	200	223	1700	1600	1700	5200	5000	4600
Q	0.31	0.75	0.04	200	200	227	1600	1600	1700	5200	5000	4600
Q	0.29	0.75	0.04	200	200	225	1700	1700	1700	5300	5100	4500
Q	0.31	0.75	0.04	200	200	224	1700	1700	1700	5300	5000	4600
Q	0.30	0.75	0.04	200	200	225	1700	1700	1700	5300	5000	4500
Q	0.29	0.74	0.04	200	200	222	1600	1600	1700	5200	5000	4500
Q	0.31	0.76	0.04	200	200	229	1600	1700	1700	5200	5000	4500
Q	0.32	0.76	0.03	200	200	229	1600	1600	1700	5200	5000	4600
S				210	210	200	1580	1700	1640	4550	4750	5120
S				210	210	200	1560	1740	1670	4610	4960	5050
S				220	200	200	1590	1640	1600	4600	4640	5160
S				220	200	200	1600	1640	1660	4770	4660	5080
S				210	200	200	1560	1630	1680	4590	4620	5100
S				210	200	200	1580	1620	1600	4680	4670	5110
S				220	200	200	1670	1630	1660	4820	4680	5080
S				220	190	200	1620	1610	1660	4810	4630	5140

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
T	0.30		0.04	240			1650			4980		
T	0.29		0.04	250			1670			5100		
T	0.24		0.03	240			1690			5040		
T	0.28		0.04	240			1620			4840		
T	0.29		0.04	240			1680			4960		
T	0.27		0.03	240			1750			5230		
T	0.28		0.03	250			1730			5200		
T	0.27		0.04	240			1700			5090		
V	0.15		0.03	210	187		1710	1570		4390	4710	
V	0.16		0.03	208	183		1690	1550		4280	4620	
V	0.21		0.04	217	179		1740	1530		4530	4580	
V	0.20		0.04	218	180		1780	1520		4570	4600	
V	0.15		0.03	223	180		1750	1510		4640	4590	
V	0.13		0.03	196	179		1560	1500		4160	4530	
V	0.14		0.02	215	190		1700	1530		4490	4810	
V	0.25		0.05	193	189		1530	1560		4000	4800	
X				193	185		1707	1744		5112	4749	
X				197	182		1753	1785		5079	4673	
X				194	182		1728	1745		5196	4688	
X				194	181		1730	1719		5024	4614	
X				190	175		1697	1771		5049	4551	
X				194	179		1709	1773		5062	4580	
X				191	182		1720	1752		5102	4649	
X				190	183		1721	1782		5012	4670	
Y	0.30	0.70	0.04	238	198		1850	1750		5100	4970	
Y	0.32	0.71	0.04	232	201		1780	1850		4870		
Y	0.32	0.73	0.04	232	201		1810	1770		4920	4950	
Y	0.33	0.69	0.04	239	201		1760	1760		5030	4930	
Y	0.33	0.71	0.04	241	207		1750	1700		5120	4930	
Y	0.31	0.67	0.04	231	200		1750	1700		5140	4860	
Y	0.31	0.69	0.04	235	203		1780	1720		4990		
Y	0.31	0.71	0.03	228	202		1770	1730		4830		

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
A												2.65	3.21
A												2.71	3.21
A												2.73	3.25
A												2.74	3.19
A												2.69	3.23
A												2.74	3.22
A												2.72	3.22
A												2.76	3.22
B												2.79	
B												2.79	
B												2.79	
B												2.80	
B												2.80	
B												2.81	
B												2.81	
B												2.79	
C	6.15	5.83	5.84	15.8	0.56	21.3	0.18	0.45	36.7	0.39	5.73		2.95
C	6.16	5.84	5.89	15.7	0.55	21.4	0.18	0.45	36.9	0.37	5.75		2.94
C	6.13	5.82	5.86	15.8	0.55	21.3	0.18	0.45	36.6	0.39	5.83		2.94
C	6.12	5.85	5.92	15.9	0.54	21.5	0.18	0.44	37.1	0.38	5.83		2.92
C	6.07	5.83	5.91	15.8	0.55	21.2	0.18	0.45	36.4	0.40	5.85		2.91
C	6.09	5.82	5.87	15.9	0.55	21.3	0.18	0.45	36.7	0.39	5.83		2.94
C	6.09	5.83	5.88	15.8	0.55	21.4	0.18	0.46	36.8	0.40	5.84		2.96
C	6.11	5.82	5.85	15.9	0.55	21.3	0.18	0.45	36.7	0.38	5.84		2.92
D												2.80	
D												2.63	
D												2.88	
D												2.73	
D												2.87	
D												2.88	
D												2.89	
D												2.88	
F	6.18	5.90	5.67	15.6	0.54	21.3	0.17	0.56	37.0	0.39	5.10		3.05
F	6.16	5.90	5.65	15.6	0.55	21.2	0.17	0.56	36.9	0.38	5.08		3.04
F	6.23	5.94	5.69	15.7	0.55	21.4	0.17	0.57	37.2	0.40	5.08		3.01
F	6.18	5.89	5.64	15.6	0.54	21.2	0.17	0.56	36.9	0.39	5.23		3.07
F	6.17	5.90	5.67	15.6	0.55	21.3	0.17	0.56	37.0	0.38	5.16		3.03
F	6.19	5.94	5.71	15.7	0.55	21.4	0.17	0.56	37.1	0.38	5.13		3.02
F	6.12	5.86	5.62	15.6	0.54	21.1	0.17	0.55	36.7	0.38	5.12		3.00
F	6.16	5.90	5.65	15.6	0.55	21.3	0.17	0.57	36.9	0.38	5.19		3.02

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
G	6.14	5.89	5.65	15.6	0.55	21.0	0.19		36.9	0.39	6.19		3.24
G	6.17	5.88	5.65	15.6	0.55	21.0	0.19		36.9	0.39	6.25		3.28
G	6.18	5.89	5.64	15.6	0.55	21.0	0.19		36.9	0.39	6.25		3.25
G	6.18	5.87	5.66	15.6	0.55	21.0	0.19		36.8	0.39	6.25		3.25
G	6.16	5.86	5.66	15.5	0.55	20.9	0.19		36.8	0.39	6.23		3.23
G	6.18	5.88	5.64	15.6	0.55	21.0	0.19		36.9	0.39	6.19		3.25
G	6.18	5.87	5.65	15.6	0.55	21.0	0.19		36.8	0.39	6.20		3.28
G	6.16	5.87	5.64	15.6	0.55	20.9	0.19		36.9	0.39	6.23		3.24
H	6.23	5.85	4.90	14.8	0.55	22.5	0.18	0.47	37.5	0.31	6.49	2.80	3.12
H	6.26	6.02	4.49	14.7	0.56	22.4	0.18	0.48	37.5	0.29	6.25	2.79	3.12
H	6.12	5.89	4.75	14.8	0.55	22.2	0.18	0.45	37.2	0.31	6.56	2.74	3.12
H	6.12	5.86	4.78	14.9	0.56	22.3	0.18	0.46	37.1	0.31	6.34	2.79	3.13
H	6.16	5.96	4.85	15.0	0.56	22.3	0.18	0.49	37.2	0.32	6.40	2.77	3.06
H	6.26	6.02	4.67	15.0	0.57	22.3	0.18	0.50	37.2	0.31	6.37	2.78	3.10
H	6.12	5.92	4.82	15.1	0.56	22.3	0.18	0.50	37.1	0.31	6.31	2.83	3.13
H	6.19	5.93	4.70	14.9	0.57	22.4	0.18	0.50	37.2	0.31	6.27	2.75	3.12
I													3.19
I													3.22
I													3.17
I													0.50
I													3.22
I													3.26
I													3.26
I													3.23
K												1.85	
K												2.74	
K												2.75	
K												2.76	
K												2.78	
K												2.73	
K												2.78	
K												2.71	
M	6.12	5.79	5.71	15.3	0.54	20.8	0.16	0.45	35.9	0.38	5.73		2.76
M	6.21	5.81	5.73	15.4	0.54	20.9	0.17	0.47	36.1	0.38	5.67		2.79
M	6.13	5.88	5.76	15.4	0.54	21.0	0.16	0.45	36.3	0.38	5.68		2.81
M	6.21	5.86	5.75	15.5	0.54	20.9	0.17	0.46	36.4	0.38	5.72		2.83
M	6.15	5.88	5.77	15.5	0.54	21.0	0.16	0.47	36.3	0.38	5.64		2.81
M	6.19	5.85	5.75	15.4	0.55	21.0	0.17	0.46	36.2	0.38	5.70		2.82
M	6.11	5.82	5.73	15.4	0.55	20.9	0.17	0.45	36.1	0.38	5.68		2.83
M	6.20	5.80	5.72	15.3	0.54	20.8	0.16	0.47	36.2	0.38	5.67		2.83
N	6.10	6.10	5.67	15.5	0.56	21.0	0.18	0.45	36.8	0.39	6.10		
N	6.13	6.10	5.69	15.6	0.56	21.0	0.18	0.43	36.8	0.39	6.20		
N	6.10	6.07	5.74	15.5	0.55	20.9	0.18	0.43	36.7	0.40	6.20		
N	6.13	6.12	5.75	15.6	0.56	21.0	0.18	0.43	36.7	0.39	6.10		
N	6.13	6.11	5.67	15.6	0.56	21.0	0.18	0.43	36.7	0.40	6.10		
N	6.09	6.17	5.70	15.6	0.55	21.1	0.18	0.44	36.7	0.39	6.30		
N	6.10	6.17	5.61	15.6	0.56	21.0	0.17	0.44	36.7	0.39	6.20		
N	6.13	6.13	5.68	15.6	0.56	21.0	0.17	0.42	36.7	0.38	6.20		
O													3.13
O													3.08
O													3.12
O													3.19
O													3.17
O													3.09
O													3.18
O													3.13
P	6.22	5.82		15.1	0.50	21.9	0.17	0.47	37.4	0.39	5.99		3.29
P	6.16	5.80		15.1	0.50	22.0	0.17	0.45	37.4	0.38	5.99		3.31
P	6.19	5.84		15.1	0.51	22.0	0.17	0.48	37.6	0.39	6.02		3.33
P	6.16	5.76		14.9	0.49	21.7	0.16		37.1	0.39	6.05		3.29
P	6.18	5.81		15.1	0.50	22.0	0.17	0.41	37.4	0.39	6.01		3.28
P	6.19	5.79		15.0	0.50	21.9	0.17	0.50	37.4	0.39	5.97		3.32
P	6.14	5.75		14.9	0.50	21.7	0.17	0.50	37.2	0.39	5.98		3.33
P	6.14	5.79		15.0	0.50	21.9	0.17	0.50	37.3	0.40	6.00		3.28
Q	5.93	5.87	5.90	15.7	0.54	20.8	0.20	0.53	36.2	0.40	6.42	2.80	3.09
Q	5.96	5.86	5.88	15.7	0.54	20.9	0.20	0.54	36.1	0.40	6.60	2.82	3.09
Q	5.90	5.87	5.87	15.7	0.54	20.8	0.20	0.53	36.1	0.40	6.54	2.82	3.10
Q	5.99	5.87	5.88	15.7	0.54	20.8	0.20	0.54	36.0	0.40	6.41	2.83	3.10
Q	5.96	5.85	5.86	15.7	0.54	20.9	0.20	0.54	36.2	0.39	6.52	2.81	3.10
Q	5.96	5.90	5.88	15.8	0.54	20.9	0.20	0.53	36.1	0.40	6.46	2.80	3.10
Q	5.93	5.88	5.88	15.7	0.54	20.8	0.20	0.54	36.2	0.39	6.69	2.81	3.10
Q	6.00	5.88	5.86	15.7	0.54	20.8	0.20	0.55	36.1	0.40	6.69	2.82	3.10
S	6.18	5.85	5.66	15.5	0.54	20.9	0.18		36.6	0.39	5.54	2.96	3.01
S	6.15	5.82	5.62	15.4	0.53	20.7	0.18		36.4	0.40	5.58	2.81	3.00
S	6.14	5.82	5.66	15.5	0.54	20.9	0.18		36.5	0.39	5.59	2.71	2.98
S	6.15	5.85	5.67	15.5	0.54	20.9	0.18		36.6	0.39	5.60	2.71	3.02
S	6.15	5.85	5.65	15.6	0.55	20.9	0.18		36.6	0.39	5.32	2.93	3.02
S	6.18	5.84	5.64	15.5	0.54	20.9	0.18		36.6	0.39	5.25	2.77	3.02
S	6.14	5.82	5.61	15.5	0.54	20.7	0.18		36.2	0.39	5.31	2.82	3.03
S	6.15	5.81	5.60	15.4	0.53	20.8	0.18		36.4	0.41	5.28	2.81	3.02
T													3.02
T													3.25
T													3.14
T													3.27
T													3.23
T													3.00
T													3.15
T													3.11

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
V												2.82	3.51
V												2.81	3.47
V												2.80	3.35
V												2.81	3.47
V												2.81	3.43
V												2.80	3.47
V												2.79	3.27
V												2.81	3.40
X												2.86	2.94
X												2.90	2.95
X												2.88	2.94
X												2.86	2.97
X												2.89	2.96
X												2.87	2.95
X												2.87	2.94
X												2.91	2.94
Y	6.13	5.81	5.66	15.7	0.55	20.9	0.18	0.48	36.8	0.39	5.16		
Y	6.14	5.81	5.69	15.7	0.56	20.8	0.18	0.48	36.9	0.39	5.20		
Y	6.14	5.83	5.66	15.7	0.56	20.9	0.18	0.50	36.9	0.40	5.09		
Y	6.13	5.83	5.65	15.7	0.56	21.0	0.18	0.50	36.9	0.40	5.05		
Y	6.11	5.82	5.66	15.7	0.55	20.9	0.18	0.48	36.8	0.40	5.13		
Y	6.12	5.82	5.66	15.6	0.55	21.0	0.18	0.49	36.8	0.40	5.12		
Y	6.12	5.82	5.67	15.7	0.55	20.9	0.18	0.50	36.8	0.40	5.23		
Y	6.14	5.82	5.69	15.7	0.56	21.0	0.18	0.49	36.9	0.42	5.08		

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	0.013	0.008	0.009	0.002
Pd	PbColl	g/t	0.031	0.020	0.018	0.006
Au	PbColl	g/t	0.004	0.002	0.003	0.001
Co	M/ICP	ppm	15.26	10.35	5.061	2.626
Co	P	ppm	9.360	6.381	4.283	1.755
Cu	M/ICP	ppm	56.94	29.92	37.00	7.944
Cu	P	ppm	65.86	46.21	32.23	13.21
Cu	XRF	ppm	58.81	51.65	41.45	21.94
Ni	M/ICP	ppm	335.7	234.4	89.72	59.13
Ni	P	ppm	181.5	128.2	80.52	36.49
Al ₂ O ₃	XRF	%	0.034	0.019	0.028	0.007
CaO	XRF	%	0.032	0.027	0.018	0.010
Cr ₂ O ₃	XRF	%	0.094	0.095	0.025	0.034
Fe ₂ O ₃	XRF	%	0.121	0.118	0.043	0.042
K ₂ O	XRF	%	0.007	0.006	0.004	0.002
MgO	XRF	%	0.187	0.182	0.071	0.065
MnO	XRF	%	0.008	0.007	0.002	0.002
Na ₂ O	XRF	%	0.044	0.043	0.015	0.015
SiO ₂	XRF	%	0.385	0.338	0.123	0.108
TiO ₂	XRF	%	0.009	0.005	0.007	0.002
LOI		%	0.483	0.446	0.080	0.141
S	Comb/LECO	%	0.060	0.036	0.046	0.012
SG	pyc		0.120	0.096	0.036	0.028

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 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: AMIS0320 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 Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

25 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	0.62	0.48	39.0	71
Al	M/ICP	%	3.19	0.32	5.04	104
As	M/ICP	ppm	6.97	6.22	44.6	82
Ba	M/ICP	ppm	79.0	13.4	8.46	88
Be	M/ICP	ppm	0.31	0.12	19.3	32
Bi	M/ICP	ppm	1.07	3.21	150	54
Ca	M/ICP	%	4.05	0.31	3.83	104
Cd	M/ICP	ppm	2.02	5.60	138	47
Ce	M/ICP	ppm	14.3	6.34	22.2	56
Cr	M/ICP	ppm	33652	17475	26.0	36
Cs	M/ICP	ppm	2.84	0.35	6.22	38
Dy	M/ICP	ppm	1.48	0.21	6.95	24
Er	M/ICP	ppm	0.84	0.09	5.26	24
Eu	M/ICP	ppm	0.51	0.04	4.25	23
Fe	M/ICP	%	10.4	1.47	7.03	104
Ga	M/ICP	ppm	9.73	1.60	8.24	48
Gd	M/ICP	ppm	1.59	0.24	7.50	24
Ge	M/ICP	ppm	0.57	0.28	25.0	16
Hf	M/ICP	ppm	1.20	0.35	14.4	54
Ho	M/ICP	ppm	0.30	0.02	3.24	23
In	M/ICP	ppm	0.07	0.02	13.7	43
K	M/ICP	%	0.46	0.06	5.95	106
La	M/ICP	ppm	5.78	2.68	23.2	78
Li	M/ICP	ppm	22.8	5.18	11.4	75
Lu	M/ICP	ppm	0.11	0.02	7.59	32
Mg	M/ICP	%	12.5	0.85	3.39	97
Mn	M/ICP	ppm	1308	270	10.3	103
Mo	M/ICP	ppm	0.95	0.72	38.0	66
Na	M/ICP	%	0.35	0.04	5.75	96
Nb	M/ICP	ppm	2.49	1.27	25.5	56
Nd	M/ICP	ppm	7.17	0.79	5.54	22
P	M/ICP	ppm	223	66.6	14.9	97
Pb	M/ICP	ppm	11.9	5.02	21.2	84
Pr	M/ICP	ppm	1.72	0.19	5.51	23
Rb	M/ICP	ppm	19.9	3.00	7.53	62
Re	M/ICP	ppm	0.02	0.01	16.5	15
S	M/ICP	%	2.83	0.17	2.99	80
Sb	M/ICP	ppm	50.7	179	177	67
Sc	M/ICP	ppm	13.7	1.73	6.34	105
Se	M/ICP	ppm	7.04	5.29	37.6	47
Si	M/ICP	%	17.3	0.20	0.57	8
Sm	M/ICP	ppm	1.59	0.15	4.78	22
Sn	M/ICP	ppm	1.73	0.37	10.7	47
Sr	M/ICP	ppm	64.0	14.4	11.2	96
Ta	M/ICP	ppm	0.16	0.17	51.8	49
Tb	M/ICP	ppm	0.24	0.05	10.8	31
Te	M/ICP	ppm	1.57	1.23	39.3	45
Th	M/ICP	ppm	1.05	0.25	12.0	54
Ti	M/ICP	%	0.22	0.05	10.7	91
Tl	M/ICP	ppm	3.40	9.55	140	47
Tm	M/ICP	ppm	0.11	0.02	9.02	23
U	M/ICP	ppm	0.30	0.08	13.0	56
V	M/ICP	ppm	160	85.5	26.7	108
W	M/ICP	ppm	0.54	0.22	20.4	39
Y	M/ICP	ppm	7.32	1.12	7.63	83
Yb	M/ICP	ppm	0.80	0.03	2.17	26
Zn	M/ICP	ppm	128	66.6	26.0	96
Zr	M/ICP	ppm	42.5	14.3	16.8	87