



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0316

**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	1.07	±	0.10	g/t
Pd Pb Collection	1.53	±	0.12	g/t
Co M/ICP	258	±	27	ppm
Co P	221	±	21	ppm
Co XRF	291	±	30	ppm
Cu M/ICP	2121	±	167	ppm
Cu P	2093	±	186	ppm
Cu XRF	2097	±	121	ppm
Ni P	5531	±	581	ppm
Ni XRF	5949	±	471	ppm
Specific Gravity	3.15	±	0.28	

Provisional Concentrations

Au Pb Collection	0.063	±	0.010	g/t
Ni M/ICP	5701	±	798	ppm

PGM 3E= 2.66 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	5.64	±	0.12	%
CaO	5.38	±	0.08	%
Cr ₂ O ₃	6.84	±	0.28	%
Fe ₂ O ₃	16.76	±	0.34	%
K ₂ O	0.50	±	0.02	%
MgO	21.87	±	0.36	%
MnO	0.19	±	0.02	%
SiO ₂	34.70	±	0.72	%
TiO ₂	0.27	±	0.02	%
S Comb / LECO	3.32	±	0.12	%

Provisional Concentrations

Na ₂ O	0.26	±	0.04	%
LOI	5.73	±	0.98	%

1. Intended Use: AMIS0316 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 AMIS0316 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 Dark Grey.

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. Twenty 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 20 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. LabtiumInc 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 Toronto (Canada)
18. SGS Townsville (Australia)
19. SGS Vancouver (Canada)
20. 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	1.04	1.46	0.07	300	200	263	2200	2100	2100	6100	5800	5500
A	1.03	1.47	0.07	300	200	269	2200	2000	2100	6200	5600	5500
A	1.02	1.47	0.07	300	200	273	2200	2000	2100	6100	5700	5500
A	1.08	1.54	0.06	300	200	262	2200	2100	2100	6200	5700	5500
A	1.08	1.53	0.06	300	200	264	2200	2100	2100	6100	5700	5500
A	1.03	1.48	0.06	300	200	267	2200	2100	2100	6100	5700	5500
A	1.05	1.51	0.06	300	200	273	2100	2000	2100	6100	5600	5500
A	1.04	1.48	0.06	300	200	267	2200	2000	2100	6200	5600	5400
B	1.09	1.51	0.06	270			2120			6030		
B	0.91	1.29	0.05	280			2180			5990		
B	0.61	0.85	0.04	270			2090			5920		
B	0.74	1.04	0.04	270			2020			5780		
B	0.57	0.78	0.03	270			2150			6080		
B	0.67	0.93	0.04	270			2090			6050		
B	1.04	1.46	0.05	280			2120			6110		
B	1.03	1.44	0.06	290			2130			6020		
C	1.08	1.52	0.07			211			2120			6160
C						213			2130			6110
C	1.12	1.60	0.07			211			2150			6200
C	1.14	1.58	0.06			209			2120			6140
C	1.12	1.58	0.06			212			2130			6160
C	1.10	1.52	0.06			211			2100			6090
C	1.21	1.72	0.06			212			2110			6120
C	1.08	1.51	0.06			210			2110			6090
D	1.20	1.67	0.07	260	220	290	2240	2230	2170	5920	5400	6180
D	1.15	1.61	0.06	260	222	290	2170	2180	2180	5840	5420	6180
D	1.13	1.64	0.07	260	220	290	2230	2150	2170	6010	5520	6180
D	1.06	1.59	0.07	260	221	290	2190	2210	2170	5960	5320	6170
D	1.14	1.58	0.06	255	220	300	2170	2180	2190	5790	5490	6210
D	1.12	1.63	0.07	260	218	290	2160	2150	2170	5840	5280	6180
D	1.13	1.62	0.07	260	220	300	2180	2160	2190	5910	5420	6220
D	1.12	1.53	0.06	260	220	290	2180	2180	2170	5870	5370	6190

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	1.07	1.52	0.07	254	230		2230	2060		5630	5980	
F	1.06	1.51	0.06	250	230		2220	2050		5620	5810	
F	1.10	1.53	0.06	252	230		2230	2060		5650	5810	
F	1.09	1.53	0.06	259	230		2280	2070		5720	5830	
F	1.10	1.53	0.06	256	230		2270	2100		5630	5940	
F	1.08	1.53	0.07	256	230		2260	2110		5680	5880	
F	1.10	1.55	0.08	257	230		2240	2070		5620	5930	
F	1.06	1.50	0.07	254	240		2230	2120		5650	5880	
G	1.02	1.36	0.06	228	207		2000	2030		5020	5220	
G	0.99	1.36	0.06	228	209		1970	2010		4880	5140	
G	0.96	1.31	0.06	228	208		1950	2040		4950	5060	
G	1.10	1.49	0.08	230	208		1930	1970		4890	5210	
G	0.87	1.19	0.05	236	211		1960	2090		5050	5180	
G	1.02	1.40	0.06	234	208		2010	1960		5030	5110	
G	0.90	1.22	0.06	229	208		2020	2050		4930	5210	
G	0.99	1.36	0.06	233	210		1940	2010		4950	5070	
H	1.09	1.47	0.07	261	230		2020	2250		5300	5860	
H	1.07	1.48	0.07	260	237		2050	2280		5360	5920	
H	1.05	1.50	0.07	266	232		2070	2250		5630	5820	
H	1.13	1.58	0.06	270	231		2080	2230		5520	5850	
H	1.06	1.53	0.07	267	229		2080	2190		5640	5850	
H	1.06	1.50	0.07	253	230		1970	2220		5230	5840	
H	1.05	1.46	0.07	259	230		2010	2190		5340	5890	
H	1.17	1.52	0.07	257	228		1970	2170		5330	5800	
I	1.01	1.44	0.06	273	233		2240	2240		6040		
I	1.04	1.47	0.06	275	230		2270	2180		6080		
I	1.02	1.49	0.06	270	230		2310	2180		6230		
I	1.02	1.48	0.06	265	233		2280	2180		6010		
I	1.08	1.45	0.06	275	236		2270	2170		5740		
I	1.05	1.46	0.06	279	240		2320	2170		5910		
I	1.00	1.46	0.06	282	245		2250	2180		5870		
I	1.01	1.41	0.06	269	233		2250	2150		5950		
J				250	210	280	2090	2150	2160	5750	5620	5970
J				260	220	280	2080	2170	2150	5700	5660	5970
J				250	210	270	2050	2120	2090	5700	5620	5890
J				250	220	280	2050	2110	2150	5710	5630	6060
J				250	210	280	2100	2100	2080	5740	5610	5910
J				250	210	280	2050	2080	2100	5510	5580	5930
J				260	220	280	2140	2140	2090	5820	5550	5930
J				250	210	280	2070	2120	2090	5650	5710	5890
K				230			2117			6064	6052	1346
K				227			2125			6138	6216	1321
K				225			2086			6152	6148	1325
K				232			2131			6194	6129	1354
K				230			2086			6227	6239	1332
K				226			2079			6159	6185	1325
K				232			2102			6235	6170	1346
K				232			2145			6142	6114	1320
L	1.02	1.55	0.06	260	230		2140	2220		5770	5900	
L	1.00	1.59	0.06	260	240		2140	2260		5770	6070	
L	1.06	1.62	0.05	260	250		2110	2300		5650	6180	
L	1.05	1.64	0.07	240	240		2110	2300		5580	6130	
L	1.06	1.62	0.06	260	240		2160	2290		5810	6130	
L	1.05	1.62	0.06	260	240		2170	2250		5800	6080	
L	1.04	1.59	0.06	270	220		2180	2100		5870	5870	
L	1.06	1.64	0.07	270	230		2200	2220		5840	5980	
O	1.09	1.49	0.07	261	218		2027	1964		5797	4997	
O	1.07	1.50	0.07	269	226		2057	2046		5864	5234	
O	1.10	1.51	0.06	270	224		2035	2031		5776	5161	
O	1.11	1.53	0.06	267	220		1992	1994		5688	5124	
O	1.08	1.54	0.06	267	225		1988	2037		5682	5185	
O	1.09	1.48	0.07	270	221		2083	1966		5918	5069	
O	1.06	1.48	0.07	269	220		2104	2014		5924	5143	
O	1.12	1.54	0.07	266	216		2023	1949		5681	5004	
P	0.97	1.43	0.06	236	219		2100	2060		5200	5470	
P	1.12	1.59	0.06	235	220		2100	2030		5110	5430	
P	1.06	1.51	0.06	240	223		2140	2100		5240	5600	
P	1.11	1.54	0.06	237	227		2080	2090		5140	5450	
P	1.01	1.42	0.06	234	217		2080	2050		5080	5500	
P	0.97	1.42	0.05	236	221		2080	2060		5100	5510	
P	1.09	1.55	0.06	236	221		2060	2020		5150	5360	
P	1.09	1.55	0.07	233	217		2060	2020		5020	5380	
Q	1.16	1.64	0.08	266	228	310	2096	2115	2090	5913	5316	6220
Q	1.14	1.70	0.06	277	222	310	2145	2096	2040	6056	5256	6260
Q	1.08	1.55	0.06	274	227	310	2148	2135	2040	6011	5378	6230
Q	1.09	1.57	0.06	260	230	310	2070	2133	2040	5805	5403	6180
Q	1.11	1.64	0.06	274	229	310	2111	2161	2050	5933	5409	6210
Q	1.10	1.60	0.07	267	229	310	2105	2132	2110	5908	5419	6260
Q	1.05	1.49	0.07	270	225	310	2123	2118	2060	5984	5336	6250
Q	1.07	1.56	0.07	269	221	310	2112	2059	2070	5970	5234	6200
R	1.06	1.53	0.06	256	222	300	2250	2005	2300	5287	5409	6100
R	1.13	1.53	0.07	272	219	300	2270	1983	2300	5642	5366	6100
R	1.13	1.53	0.07	240	222	300	2250	1963	2200	5049	5373	6000
R	1.18	1.45	0.06	237	222	400	2206	1970	2300	5002	5405	6200
R	1.15	1.51	0.06	236	218	300	2271	1986	2200	4893	5306	6000
R	1.14	1.55	0.06	241	219	300	2276	1977	2100	5058	5290	5900
R	1.13	1.52	0.06	238	225	300	2189	1991	2000	4998	5499	6200
R	1.16	1.54	0.06	245	225	300	2253	1924	2100	5092	5412	5900

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	1.08	1.52	0.06	208	265		2050	1950		4710	5770	
T	1.10	1.54	0.07	218	281		2070	2020		4300	5940	
T	1.09	1.53	0.07	238	271		2140	1990		4370	5940	
T	1.09	1.53	0.06	248	225		2050	1960		4260	5950	
T	1.12	1.56	0.06	214	226		2110	2030		4560	5790	
T	1.11	1.54	0.07	183	231		2000	2020		4350	5870	
T	1.08	1.51	0.06	193	244		2090	1990		4690	5820	
T	1.13	1.57	0.07	192	269		2100	2090		4670	5900	
U	0.89	1.27	0.04	196			2058			4441		
U	0.74	1.06	0.05	202			2115			4563		
U	0.61	0.87	0.04	206			2127			4632		
U	1.06	1.48	0.05	193			1951			4330		
U	0.99	1.44	0.06	202			2095			4553		
U	0.96	1.37	0.06	196			2045			4471		
U	0.75	1.07	0.05	202			2125			4638		
U	0.55	0.78	0.03	193			1993			4359		
V				257	193		2200	1830		6160	4630	
V				256	193		2190	1820		6120	4610	
V				260	191		2210	1810		6120	4580	
V				264	191		2200	1820		6220	4600	
V				265	189		2210	1800		6210	4510	
V				266	190		2190	1810		6190	4560	
V				268	193		2160	1830		6160	4580	
V				265	192		2200	1810		6210	4610	
W	1.00	1.50	0.07						2036			5931
W	1.01	1.51	0.06						2088			5866
W	0.99	1.49	0.06						2033			5836
W	0.99	1.50	0.06						2059			5790
W	0.94	1.42	0.05						2080			5964
W	1.00	1.51	0.06						2044			5888
W	1.00	1.50	0.06						2045			5850
W	0.98	1.47	0.06						2052			5900
Y	1.04	1.54	0.07			200			2000			5800
Y	1.06	1.55	0.06			300			2000			5700
Y	1.06	1.57	0.06			300			2200			5800
Y	1.12	1.58	0.07			300			2000			5900
Y	1.11	1.63	0.08			300			2000			5700
Y	1.09	1.60	0.06			200			2000			5700
Y	1.05	1.55	0.06			300			2200			5900
Y	1.05	1.53	0.06			300			2100			5900

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	5.48	5.41	7.13	16.81	0.49	22.0	0.23	0.28	33.89	0.28	6.56	3.34	2.94
A	5.52	5.44	7.16	16.95	0.49	22.1	0.23	0.27	34.24	0.28	6.52	3.35	2.95
A	5.43	5.43	7.13	16.76	0.49	21.9	0.23	0.27	34.10	0.28	6.55	3.33	2.94
A	5.52	5.43	7.14	16.98	0.49	22.2	0.23	0.27	34.13	0.28	6.57	3.34	2.95
A	5.51	5.44	7.14	16.91	0.49	22.2	0.23	0.29	34.11	0.28	6.53	3.34	2.95
A	5.56	5.42	7.13	16.90	0.49	22.0	0.23	0.27	34.00	0.27	6.57	3.34	2.94
A	5.56	5.43	7.15	16.95	0.49	22.2	0.23	0.28	34.26	0.28	6.58	3.34	2.95
A	5.58	5.45	7.13	16.96	0.49	22.2	0.23	0.28	34.10	0.28	6.55	3.34	2.95
B													3.18
B													3.30
B													3.21
B													3.34
B													3.17
B													3.07
B													3.35
B													3.27
C	5.18	5.29	6.91	16.58	0.46	21.9	0.19	0.18	35.02	0.27	6.50		3.21
C	5.40	5.31	6.98	16.64	0.47	22.0	0.20	0.22	35.00	0.26	6.53		3.21
C	5.34	5.25	6.94	16.58	0.47	21.8	0.20	0.21	34.94	0.27	6.56		3.20
C	5.48	5.33	6.96	16.74	0.47	21.9	0.19	0.22	35.08	0.28	6.54		3.22
C	5.27	5.32	6.93	16.63	0.47	21.8	0.19	0.21	34.91	0.26	6.56		3.20
C	5.46	5.37	7.00	16.74	0.46	21.9	0.20	0.21	35.10	0.27	6.49		3.22
C	5.46	5.36	6.99	16.69	0.47	21.9	0.19	0.23	34.97	0.27	6.47		3.20
C	5.33	5.33	6.89	16.55	0.47	21.7	0.19	0.24	35.08	0.26	6.45		3.20
D	5.63	5.41	6.76	16.70	0.50	21.8	0.21		34.98	0.27	5.98		3.24
D	5.64	5.42	6.78	16.70	0.51	21.9	0.21		34.99	0.27	5.97		3.31
D	5.65	5.42	6.77	16.70	0.51	21.9	0.21		35.04	0.27	6.08		3.26
D	5.65	5.40	6.76	16.70	0.51	21.8	0.21		34.99	0.27	6.10		3.24
D	5.65	5.43	6.79	16.80	0.51	21.9	0.21		35.01	0.28	6.04		3.24
D	5.63	5.40	6.77	16.70	0.50	21.8	0.21		34.95	0.27	6.02		3.30
D	5.64	5.42	6.79	16.70	0.51	21.9	0.21		34.98	0.28	6.09		3.26
D	5.65	5.40	6.76	16.70	0.51	21.8	0.21		34.90	0.27	6.08		3.24

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
F	5.82	5.46	5.52	15.70	0.51	23.5	0.20	0.19	36.00	0.21	6.17	3.19	3.12
F	5.82	5.62	5.25	15.65	0.52	23.2	0.20	0.20	35.50	0.20	6.29	3.23	3.17
F	5.75	5.54	5.16	15.70	0.51	23.4	0.20	0.20	35.70	0.20	6.14	3.23	3.17
F	5.73	5.55	5.14	15.80	0.52	23.6	0.19	0.21	35.70	0.20	6.24	3.25	3.10
F	5.84	5.56	5.10	15.90	0.52	23.4	0.19	0.21	35.70	0.21	6.07	3.23	3.17
F	5.81	5.51	5.17	15.70	0.51	23.4	0.19	0.22	35.30	0.21	6.20	3.25	3.17
F	5.82	5.54	5.50	15.95	0.51	23.3	0.20	0.22	35.50	0.20	6.11	3.23	3.17
F	5.79	5.46	5.16	15.75	0.52	23.5	0.19	0.24	35.60	0.21	6.15	3.26	3.09
G												3.36	3.47
G												3.35	3.60
G												3.34	3.57
G												3.34	3.58
G												3.33	3.42
G												3.34	3.41
G												3.36	3.55
G												3.33	3.64
H													3.27
H													3.28
H													3.29
H													3.29
H													3.31
H													3.28
H													3.28
H													3.27
I	5.66	5.37	6.81	16.90	0.51	21.8	0.20	0.27	35.10	0.29	4.91		
I	5.68	5.37	6.77	16.90	0.50	21.9	0.20	0.27	35.00	0.30	4.83		
I	5.70	5.37	6.80	16.90	0.50	21.9	0.20	0.27	35.00	0.28	4.93		
I	5.66	5.36	6.81	16.90	0.50	21.8	0.20	0.28	35.00	0.29	4.93		
I	5.66	5.38	6.82	16.90	0.50	21.8	0.20	0.28	35.00	0.29	4.92		
I	5.64	5.42	6.82	16.90	0.50	21.8	0.20	0.28	35.00	0.31	4.85		
I	5.68	5.37	6.82	16.90	0.50	21.9	0.20	0.28	35.00	0.28	4.89		
I	5.68	5.37	6.80	16.90	0.50	21.9	0.20	0.27	35.00	0.29	4.85		
J	5.73	5.40	6.71	16.64	0.50	21.7	0.19	0.27	35.00	0.26	5.45	3.23	3.09
J	5.74	5.41	6.72	16.67	0.50	21.7	0.19	0.27	34.90	0.26	5.47	3.18	3.09
J	5.72	5.35	6.69	16.55	0.48	21.7	0.19	0.28	35.00	0.27	5.54	3.20	3.06
J	5.76	5.43	6.76	16.76	0.50	21.8	0.19	0.28	35.00	0.26	5.55	3.34	3.06
J	5.73	5.37	6.72	16.59	0.48	21.7	0.19	0.29	35.00	0.28	5.61	3.31	3.08
J	5.77	5.40	6.77	16.74	0.49	21.9	0.19	0.30	35.20	0.28	5.51	3.30	3.07
J	5.73	5.38	6.72	16.66	0.48	21.8	0.19	0.29	35.10	0.28	5.60	3.30	3.08
J	5.72	5.36	6.67	16.54	0.48	21.7	0.19	0.29	34.90	0.28	5.54	3.26	3.09
K												3.38	3.01
K												3.38	3.00
K												3.37	3.02
K												3.34	3.02
K												3.33	3.02
K												3.36	2.99
K												3.40	2.85
K												3.38	3.01
L	5.65	5.43	6.74	16.70	0.50	21.6	0.19	0.35	34.80	0.27	5.08		3.01
L	5.68	5.44	6.79	16.65	0.49	21.6	0.19	0.35	34.80	0.27	5.20		2.99
L	5.55	5.35	6.60	16.42	0.49	21.2	0.19	0.33	34.10	0.26	5.17		2.95
L	5.58	5.39	6.62	16.48	0.49	21.4	0.19	0.34	34.50	0.26	5.14		2.99
L	5.61	5.40	6.61	16.52	0.49	21.5	0.19	0.34	34.50	0.26	5.27		2.99
L	5.58	5.38	6.68	16.54	0.49	21.4	0.19	0.34	34.30	0.26	5.12		3.02
L	5.70	5.46	6.79	16.84	0.50	21.7	0.19	0.35	35.00	0.27	5.12		3.00
L	5.60	5.43	6.71	16.64	0.50	21.6	0.19	0.35	34.30	0.27	5.11		3.06
O												3.39	3.14
O												3.34	3.15
O												3.41	3.18
O												3.40	3.24
O												3.39	3.19
O												3.40	3.11
O												3.38	3.09
O												3.37	3.14
P												3.29	
P												3.29	
P												3.29	
P												3.30	
P												3.29	
P												3.27	
P												3.28	
P												3.29	
Q	5.60	5.33	7.04	16.99	0.49	22.1	0.19	0.23	34.70	0.26	5.77		2.99
Q	5.65	5.33	7.07	16.91	0.48	22.1	0.19	0.24	34.80	0.26	5.71		2.97
Q	5.68	5.35	7.10	17.09	0.47	22.1	0.19	0.23	34.90	0.25	5.73		2.99
Q	5.61	5.30	6.94	16.85	0.49	21.9	0.19	0.24	34.60	0.27	5.74		2.99
Q	5.62	5.31	7.01	16.92	0.50	22.1	0.19	0.26	34.70	0.26	5.76		3.00
Q	5.62	5.32	7.04	17.07	0.49	22.2	0.19	0.23	34.80	0.25	5.79		2.98
Q	5.62	5.33	7.04	17.01	0.49	22.2	0.19	0.23	34.80	0.25	5.79		2.97
Q	5.65	5.31	6.97	16.93	0.49	22.2	0.19	0.24	34.70	0.27	5.76		3.00
R												3.20	
R												3.34	
R												3.37	
R												3.38	
R												3.45	
R												3.42	
R												3.47	
R												3.37	

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
T												3.25	3.34
T												3.27	3.33
T												3.21	3.26
T												3.21	3.24
T												3.23	3.26
T												3.25	3.27
T												3.20	3.25
T												3.26	3.24
U												3.13	
U												3.22	
U												3.33	
U												3.25	
U												3.29	
U												3.26	
U												3.28	
U												3.25	
V	5.66	5.77	6.78	16.84	0.51	21.9	0.19	0.22	34.89	0.27	5.80		
V	5.65	5.75	6.77	16.80	0.50	21.9	0.19	0.21	34.88	0.27	5.80		
V	5.66	5.77	6.81	16.83	0.51	21.9	0.19	0.26	34.83	0.27	5.80		
V	5.65	5.74	6.79	16.88	0.50	21.9	0.20	0.20	34.85	0.28	5.70		
V	5.64	5.75	6.74	16.81	0.50	21.9	0.19	0.20	34.83	0.27	5.80		
V	5.66	5.73	6.70	16.81	0.51	22.0	0.19	0.23	35.01	0.27	5.80		
V	5.66	5.68	6.72	16.82	0.51	21.9	0.20	0.19	35.00	0.28	5.50		
V	5.66	5.71	6.78	16.83	0.51	21.9	0.19	0.22	34.96	0.28	5.70		
W	5.58	5.39		16.20	0.46	22.9	0.18	0.26	35.80	0.27	5.80		3.34
W	5.55	5.35		16.10	0.46	22.9	0.18	0.27	35.60	0.27	5.82		3.30
W	5.54	5.32		16.10	0.45	22.9	0.18	0.26	35.60	0.27	5.81		3.34
W	5.50	5.31		16.00	0.46	22.8	0.18	0.26	35.30	0.26	5.79		3.30
W	5.58	5.37		16.20	0.46	22.9	0.18	0.26	35.90	0.27	5.79		3.29
W	5.55	5.33		16.10	0.45	22.8	0.18	0.26	35.50	0.27	5.92		3.26
W	5.55	5.36		16.10	0.45	22.9	0.18	0.26	35.60	0.27	5.81		3.33
W	5.58	5.36		16.20	0.46	23.0	0.18	0.26	35.90	0.27	5.84		3.30
Y	5.62	5.34	6.83	16.50	0.50	21.6	0.18	0.23	34.00	0.26	6.13	3.40	
Y	5.68	5.33	6.81	16.50	0.50	21.6	0.18	0.24	34.20	0.27	6.22	3.33	
Y	5.69	5.34	6.87	16.50	0.49	21.8	0.17	0.23	34.30	0.27	5.99	3.34	
Y	5.67	5.33	6.88	16.50	0.50	21.7	0.18	0.24	34.30	0.27	6.19	3.38	
Y	5.68	5.33	6.82	16.40	0.49	21.6	0.18	0.24	34.10	0.26	6.06	3.39	
Y	5.72	5.37	6.86	16.60	0.50	21.7	0.17	0.24	34.30	0.27	6.04	3.40	
Y	5.72	5.32	6.83	16.60	0.50	21.9	0.18	0.25	34.00	0.26	6.09	3.41	
Y	5.66	5.37	6.89	16.50	0.50	21.8	0.17	0.25	34.40	0.26	6.17	3.35	

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:

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

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

Analyte	Method	unit	S ¹	σ_L ²	Sw ³	CSU ⁴
Pt	PbColl	g/t	0.050	0.030	0.033	0.009
Pd	PbColl	g/t	0.06	0.04	0.04	0.01
Au	PbColl	g/t	0.005	0.002	0.004	0.001
Co	M/ICP	ppm	13.7	10.2	6.05	3.01
Co	P	ppm	10.6	8.73	3.65	2.66
Co	XRF	ppm	15.1	17.91	3.05	7.33
Cu	M/ICP	ppm	83.3	55.3	36.9	14.7
Cu	P	ppm	92.9	71.1	38.3	20.9
Cu	XRF	ppm	60.7	42.3	47.2	17.3
Ni	M/ICP	ppm	399	309	113	86.5
Ni	P	ppm	291	249	72.3	75.4
Ni	XRF	ppm	236	256	66.4	97.3
Al ₂ O ₃	XRF	%	0.062	0.054	0.028	0.018
CaO	XRF	%	0.04	0.04	0.022	0.014
Cr ₂ O ₃	XRF	%	0.14	0.14	0.04	0.05
Fe ₂ O ₃	XRF	%	0.166	0.157	0.073	0.056
K ₂ O	XRF	%	0.008	0.007	0.005	0.002
MgO	XRF	%	0.208	0.196	0.095	0.070
MnO	XRF	%	0.009	0.009	0.001	0.003
Na ₂ O	XRF	%	0.022	0.022	0.009	0.008
SiO ₂	XRF	%	0.360	0.350	0.138	0.125
TiO ₂	XRF	%	0.009	0.007	0.006	0.002
LOI		%	0.48	0.47	0.06	0.16
S Comb/LECO		%	0.06	0.05	0.04	0.02
SG	pyc		0.14	0.12	0.04	0.04

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: AMIS0316 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.

6 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	0.80	0.50	31.4	64
Al	M/ICP	%	2.94	0.35	6.03	99
As	M/ICP	ppm	8.27	7.13	43.1	86
Ba	M/ICP	ppm	75.7	15.64	10.3	88
Be	M/ICP	ppm	0.20	0.05	12.5	27
Bi	M/ICP	ppm	1.09	3.51	162	47
Ca	M/ICP	%	3.70	0.33	4.45	104
Cd	M/ICP	ppm	1.04	3.43	165	52
Ce	M/ICP	ppm	10.2	2.92	14.3	47
Cr	M/ICP	ppm	30719	37782	61.5	48
Cs	M/ICP	ppm	2.96	0.45	7.68	32
Dy	M/ICP	ppm	1.06	0.08	3.82	16
Er	M/ICP	ppm	0.65			7
Eu	M/ICP	ppm	0.35			7
Fe	M/ICP	%	11.1	1.38	6.21	104
Ga	M/ICP	ppm	10.1	2.02	9.95	40
Gd	M/ICP	ppm	1.09	0.21	9.72	16
Ge	M/ICP	ppm	0.63	0.13	10.4	16
Hf	M/ICP	ppm	0.78	0.13	8.34	46
Ho	M/ICP	ppm	0.22	0.02	4.82	16
In	M/ICP	ppm	0.08	0.02	11.4	45
K	M/ICP	%	0.42	0.04	4.30	104
La	M/ICP	ppm	4.72	3.97	42.0	77
Li	M/ICP	ppm	23.6	3.54	7.50	73
Lu	M/ICP	ppm	0.09	0.02	12.2	23
Mg	M/ICP	%	12.9	1.17	4.53	95
Mn	M/ICP	ppm	1399	203	7.24	99
Mo	M/ICP	ppm	1.58	1.40	44.2	78
Na	M/ICP	%	0.18	0.09	25.5	104
Nb	M/ICP	ppm	1.93	0.35	9.13	43
Nd	M/ICP	ppm	5.06	0.18	1.74	14
P	M/ICP	ppm	306	96.8	15.8	100
Pb	M/ICP	ppm	13.6	4.10	15.0	93
Pr	M/ICP	ppm	1.29	0.05	1.79	15
Rb	M/ICP	ppm	17.3	3.99	11.5	52
Re	M/ICP	ppm	0.03	0.01	18.9	16
S	M/ICP	%	3.31	0.17	2.58	80
Sb	M/ICP	ppm	63.9	219	171	76
Sc	M/ICP	ppm	13.7	2.41	8.82	111
Se	M/ICP	ppm	7.62	3.86	25.3	49
Si	M/ICP	%	16.31	0.14	0.42	7
Sm	M/ICP	ppm	1.14	0.15	6.64	16
Sn	M/ICP	ppm	1.98	0.41	10.4	46
Sr	M/ICP	ppm	40.7	8.32	10.2	91
Ta	M/ICP	ppm	0.14	0.12	43.5	38
Tb	M/ICP	ppm	0.17	0.04	11.1	22
Te	M/ICP	ppm	1.90	0.54	14.3	45
Th	M/ICP	ppm	0.87	0.19	10.7	46
Ti	M/ICP	%	0.15	0.03	10.8	87
Tl	M/ICP	ppm	0.87	2.78	161	40
Tm	M/ICP	ppm	0.09	0.02	8.51	16
U	M/ICP	ppm	2.66	23.6	445	50
V	M/ICP	ppm	167	101	30.1	104
W	M/ICP	ppm	0.49	0.52	53.3	40
Y	M/ICP	ppm	5.44	0.76	6.97	72
Yb	M/ICP	ppm	0.58	0.05	4.43	23
Zn	M/ICP	ppm	141	84.5	30.0	92
Zr	M/ICP	ppm	28.1	8.95	15.9	80