



African Mineral Standards

MATRIX REFERENCE MATERIALS

Tel: +27 (0) 11 923 0800 Fax: +27 (0) 11 392 4715 web: www.amis.co.za
11 Gewel Street (off Hulley Road), D1 Isando Business Park, Kempton Park, 1609
P.O. Box 856, Isando, 1600, Gauteng, South Africa, a division of the Set Point Group

AMIS0331

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	1.70	±	0.16	g/t
Pd Pb Collection	10.22	±	0.88	g/t
Au Pb Collection	0.49	±	0.06	g/t
Co M/ICP	1294	±	107	ppm
Co P	1254	±	146	ppm
Cu M/ICP	4.499	±	0.229	%
Cu P	4.377	±	0.250	%
Cu XRF	4.339	±	0.395	%
Ni M/ICP	4.685	±	0.257	%
Ni P	4.566	±	0.303	%
Ni XRF	4.671	±	0.289	%
Specific Gravity	3.55	±	0.20	

PGM 3E= 12.41 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	3.82	±	0.22	%
CaO	2.64	±	0.20	%
Cr ₂ O ₃	0.17	±	0.02	%
Fe ₂ O ₃	42.38	±	1.48	%
MgO	3.17	±	0.16	%
SiO ₂	12.99	±	1.42	%
LOI	21.48	±	1.12	%
S Combustion / LECO	21.90	±	0.94	%

Provisional concentrations

K ₂ O	0.11	±	0.02	%
TiO ₂	0.38	±	0.04	%

Indicated Means

MnO	0.06	%
-----	------	---

1. Intended Use: AMIS0331 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: AMIS0331 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.

4. Appearance: The material is a very fine powder. It is colored a Dark Blueish Grey (Corstor 5PB 4/1).

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	1.72	9.98	0.50	1300	1250		43900	43200		45300	43800	
A	1.70	9.68	0.47	1310	1300		45600	44100		46800	45400	
A	1.76	10.30	0.49	1340	1310		45800	45000		46400	45800	
A	1.72	10.40	0.50	1280	1280		44700	44700		45200	45000	
A	1.72	9.88	0.49	1310	1290		45200	44500		46000	45300	
A	1.74	10.10	0.47	1290	1270		44300	43700		45500	44300	
A	1.76	9.98	0.50	1270	1290		44400	44200		46000	45200	
A	1.76	10.20	0.51	1290	1260		44900	44300		45500	45200	
B	1.61	9.73	0.51	1080	1230		38500	42200		32900	38500	
B	1.74	10.60	0.54	1080	1220		38900	41400		33300	37300	
B	1.78	10.60	0.52	1070	1210		38800	41200		32900	36900	
B	1.74	10.30	0.51	1050	1200		39400	41800		32400	37100	
B	1.62	10.50	0.51	1070	1230		39200	42100		33300	38000	
B	1.72	10.40	0.53	1050	1250		38500	42700		32600	38800	
B	1.69	10.70	0.54	1060	1250		39600	43200		32500	38600	
B	1.68	10.60	0.54	1040	1220		40100	41600		32600	37600	

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	1.71	10.20	0.52			1400			45600			49000
C	1.73	10.30	0.54			1390			44700			48100
C	1.65	10.20	0.47			1410			45400			48700
C	1.75	10.40	0.48			1410			45400			48800
C	1.68	9.98	0.45			1400			45000			48400
C	1.66	10.10	0.51			1410			45200			48600
C	1.70	10.20	0.52			1410			45600			49000
C	1.79	10.30	0.53			1390			44800			48100
D	1.68	10.10	0.52	1280	1160							
D	1.69	10.30	0.50	1270	1200							
D	1.72	10.80	0.53	1320	1210							
D	1.68	10.70	0.55	1320	1220							
D	1.77	10.50	0.58	1280	1250							
D	1.75	10.60	0.57	1280	1220							
D	1.73	10.60	0.50	1280	1200							
D	1.67	10.50	0.51	1260	1260							
E				1310	1290	1400	46700	45400	44900	47900	46300	46400
E				1280	1270	1400	44900	45400	45100	44700	44200	46400
E				1300	1330	1400	45700	47000	44900	45900	47000	46300
E				1340	1270	1400	47500	44500	45400	47900	44900	46400
E				1300	1280	1400	46200	44900	45100	45800	44900	46200
E				1360	1290	1400	48300	45700	44900	48800	45800	45900
E				1360	1290	1400	47700	45600	45100	48600	45400	46400
E				1330	1310	1400	46900	45700	45300	45700	46000	46000
F	1.82	10.40	0.47			1400			44900			45600
F	1.81	10.60	0.53			1400			43900			45500
F	1.72	10.30	0.49			1300			43900			45500
F	1.82	10.40	0.50			1400			44000			45600
F	1.75	10.40	0.49			1400			44900			45600
F	1.75	10.20	0.47			1400			45100			45600
F	1.78	10.40	0.46			1400			45000			45900
F	1.78	10.50	0.49			1400			44800			45500
G	1.64	10.20	0.46	1260	1270		45500	44100		47000		
G	1.70	10.30	0.54	1255	1290		45600	45100		46300		
G	1.73	10.25	0.48	1295	1290		45600	45300		46500		
G				1310	1290		46000	44800		47400		
G	1.69	10.45	0.50	1325	1300		46600	44800		47900		
G	1.74	10.45	0.52	1255	1290		46300	44400		46700		
G	1.51	9.54	0.44	1320	1290		45000	44900		46000		
G	1.76	10.50	0.52	1290	1300		45500	44900		46200		
H	1.88	10.90	0.53	1275	1206	991						
H	1.55	9.22	0.45	1210	1232	983						
H	1.57	9.28	0.44	1251	1227	994						
H	1.54	9.95	0.44	1214	1214	992						
H	1.55		0.48	1257	1217	994						
H	1.79	8.98	0.47	1290	1227	989						
H	1.78	9.38	0.49	1294	1209	997						
H	1.71	9.42	0.47	1288	1211	996						
I				1350			44900			48200		
I				1350			44800			48300		
I				1370			44900			48700		
I				1360			44700			48500		
I				1330			44900			48200		
I				1340			44900			48600		
I				1330			44900			48100		
I				1360			44700			48300		
K	1.81	10.79	0.58	1327	1354		45807			48951		
K	1.76	10.69	0.50	1291	1327		47196					
K	1.63	10.23	0.62	1273	1335		47934					
K	1.79	11.08	0.53	1323	1372		45528			48592		
K	1.77	10.85	0.50	1310	1279		45379			48525		
K	1.73	10.90	0.50	1276	1284		45377			48294		
K	1.74	10.75	0.49	1323	1304		45843			48432		
K	1.71	10.75	0.49	1297	1381		45431			48422		
L	1.74	10.30	0.56						41380			44250
L	1.71	10.30	0.56						42340			44700
L	1.74	10.50	0.59						41480			43900
L	1.68	10.20	0.60						41930			44470
L	1.65	10.30	0.66						41740			44320
L	1.70	10.40	0.65						41470			43910
L	1.72	10.50	0.68						41780			44400
L	1.66	10.30	0.69						41280			43600

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
M				1385	1112		44000	38200		50612	50600	
M				1384	1120		43900	38300		52574	52600	
M				1341	1119		43400	38500		51912	51900	
M				1332	1115		43100	38400		51501	51500	
M				1329	1133		44400	38100		52096	52100	
M				1416	1123		44100	38500		50126	50100	
M				1369	1129		44500	38300		50900	50900	
M				1388	1120		43900	38000		51623	51600	
O	1.60	9.67	0.44	1100	1000		45100	45000	40800	48700	48100	46600
O	1.61	9.80	0.45	1200	1000		45200	45000	40600	48700	48100	46600
O	1.59	9.74	0.43	1200	1000		45200	45000	40900	48700	48100	46400
O	1.60	9.75	0.46	1100	1000		45200	45000	40500	48500	48300	46400
O	1.59	9.41	0.45	1200	1100		45100	45000	40700	48700	48200	46500
O	1.52	9.53	0.46	1200	1000		45300	45100	40500	48500	48200	46500
O	1.64	9.89	0.45	1200	1100		45300	45000	40900	48600	48300	46600
O	1.55	9.52	0.45	1200	1000		45200	45100	40400	48600	48100	46100
P			0.48	1244			43900					
P			0.50	1260			44400					
P			0.47	1312			42600					
P			0.48	1244			42100					
P			0.50	1266			42500					
P			0.49	1345			42500					
P			0.50	1323			43000					
P			0.47	1290			43400					
Q				1500			45100			45500		
Q				1500			44800			46800		
Q				1500			44800			46300		
Q				1400			44700			45900		
Q				1500			44600			46400		
Q				1500			44500			45500		
Q				1600			44700			47100		
Q				1500			45000			46500		
R	1.63	10.00	0.50	1310	1310		46500	43600		45600	45800	
R	1.65	9.88	0.50	1290	1320		46200	43600		46000	46100	
R	1.66	9.96	0.52	1310	1320		46600	43700		46900	45700	
R	1.66	9.84	0.54	1330	1340		47400	43900		47000	46600	
R	1.68		0.53	1330	1330		47400	43400		47300	46700	
R	1.67		0.51	1320	1340		47300	44600		46800	47600	
R	1.70		0.49	1260	1330		45100	43200		45300	46300	
R	1.76		0.53	1310	1350		46600	44100		46300	46800	
S	1.78	9.66	0.50	1214	1148	1500			46300			49400
S	1.76	9.51	0.50	1247	1168	1500			45200			48800
S	1.77	9.55	0.51	1264	1187	1400			45600			48900
S	1.79	9.70	0.50	1233	1186	1400			45300			48500
S	1.78	9.54	0.50	1275	1194	1400			45500			48600
S	1.76	9.69	0.49	1253	1172	1300			45600			48200
S	1.75	9.28	0.50	1290	1162	1300			43900			47000
S	1.75	9.23	0.51	1297	1130	1400			44100			46500
T	1.63		0.49	1290	1280		42400	42200		45700	46100	
T	1.43	9.55	0.44	1310	1300		42900	42300		46200	45800	
T	1.43	9.79	0.48	1280	1270		42300	41900		45900	44800	
T	1.52		0.48	1260	1270		41600	41800		44400	45600	
T	1.54	9.75	0.44	1260	1280		41800	41900		44700	45900	
T	1.57		0.45	1250	1270		41200	43800		44600	45300	
T	1.60		0.48	1310	1280		43000	41900		46500	46700	
T	1.54	9.96	0.49	1260	1310		41400	42900		44700	46800	
U	1.77	10.80	0.52	1190	1200		41800	44400		44000	46500	
U	1.81	11.10	0.53	1170	1210		42600	44300		45100	47700	
U	1.77	10.80	0.49	1180	1220		43200	43500		46000	45600	
U	1.72	11.00	0.51	1180	1220		43700	44100		46100	46200	
U	1.78	10.70	0.53	1150	1200		43000	43200		44100	45500	
U	1.78	10.70	0.54	1170	1210		43800	43800		46200	46400	
U	1.81	10.80	0.50	1160	1230		44400	44900		47200	46900	
U	1.78	10.80	0.52	1170	1190		43300	43400		45400	45600	
V	1.71	10.42	0.51	1285	1400	1430		43840	40660		44430	47180
V	1.73	10.67	0.48	1315	1390	1430		44110	41540		44510	48210
V	1.80	10.77	0.47	1326	1380	1430		43880	41470		44390	47200
V	1.82	10.82	0.50	1314	1410	1430		44950	42660		44780	47360
V	1.82	10.78	0.50	1329	1370	1430		43950	41180		44310	47330
V	1.79	10.58	0.49	1321	1380	1420		43870	40170		44130	47110
V	1.74	10.47	0.48	1368	1350	1410		42890	41560		43050	46770
V	1.77	10.60	0.46	1365	1400	1420		43690	41750		44070	47010

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
W	1.32	10.40	0.47	1430	1220		44400	40300		43400	41900	
W	1.59	10.00	0.49	1290	1120		44500	42300		42900	43600	
W	1.45	9.56	0.45	1350	1120		43800	41800		42600	42700	
W	1.62	10.10	0.47	1390	1200		44800	41900		42800	43400	
W	1.57	10.00	0.52	1380	1210		45200	42300		43500	43500	
W	1.54	9.87	0.50	1510	1040		44700	39600		43100	40800	
W	1.56	9.76	0.37	1450	1310		43700	40500		42300	42400	
W	1.72	10.70	0.45	1420	1380		43900	40900		42300	43000	
X	1.65	9.63	0.55	1700			46850			47700		
X	1.61	9.59	0.53	1700			46400			47000		
X	1.74	10.09	0.56	1600			45900			47550		
X	1.77	10.21	0.54	1650			45100			45700		
X	1.59	9.69	0.50	1650			45550			46300		
X	1.69	9.99	0.53	1650			45700			46250		
X	1.65	9.80	0.52	1600			46000			45900		
X	1.67	10.08	0.59	1600			45300			46000		

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
A	3.93	2.71	0.17	42.47	0.12	3.26	0.06		13.41	0.39	21.40		3.53
A	3.93	2.72	0.17	42.44	0.12	3.26	0.06		13.39	0.39	21.40		3.58
A	3.93	2.71	0.17	42.43	0.12	3.25	0.06		13.39	0.39	21.40		3.58
A	3.93	2.72	0.17	42.49	0.12	3.26	0.06		13.44	0.39	21.50		3.54
A	3.94	2.71	0.17	42.45	0.12	3.24	0.06		13.41	0.39	21.50		3.53
A	3.93	2.72	0.16	42.45	0.12	3.24	0.06		13.39	0.39	21.50		3.54
A	3.95	2.71	0.16	42.43	0.12	3.26	0.06		13.38	0.39	21.50		3.57
A	3.93	2.72	0.17	42.41	0.12	3.24	0.06		13.36	0.39	21.50		3.51
B												21.70	4.53
B												22.03	4.39
B												21.95	4.44
B												21.97	4.43
B												21.85	4.53
B												21.93	4.81
B												21.91	4.64
B												21.91	4.73
C	4.00	2.49	0.17	43.34	0.12	2.90	0.06	0.84	13.21	0.37	21.56		4.16
C	3.56	2.55	0.17	43.13	0.14	2.94	0.06	0.80	13.38	0.38	21.65		4.14
C	3.34	2.54	0.20	43.20	0.12	2.94	0.06	0.88	13.36	0.36	21.64		4.16
C	3.84	2.53	0.16	43.07	0.13	2.87	0.07	0.84	13.22	0.34	21.63		4.16
C	3.49	2.49	0.16	43.19	0.12	2.91	0.06	0.88	13.28	0.39	21.68		4.16
C	4.00	2.56	0.20	43.06	0.12	2.88	0.06	0.88	13.26	0.38	21.56		4.15
C	3.28	2.53	0.17	43.07	0.13	2.87	0.07	0.80	13.23	0.38	21.55		4.16
C	3.30	2.56	0.20	43.14	0.12	2.86	0.06	0.80	13.30	0.36	21.52		4.13
D	3.87	2.67	0.17	42.50	0.12	3.24	0.06	0.36	13.30	0.42	21.00		
D	3.91	2.67	0.17	42.50	0.12	3.24	0.06	0.35	13.40	0.43	21.00		
D	3.90	2.67	0.16	42.40	0.12	3.25	0.06	0.33	13.40	0.42	20.90		
D	3.91	2.67	0.17	42.60	0.12	3.22	0.06	0.33	13.30	0.40	20.90		
D	3.91	2.66	0.17	42.40	0.12	3.25	0.06	0.35	13.30	0.41	21.00		
D	3.91	2.67	0.17	42.50	0.12	3.26	0.06	0.35	13.30	0.41	20.90		
D	3.90	2.66	0.16	42.50	0.12	3.23	0.06	0.33	13.30	0.42	21.00		
D	3.89	2.65	0.16	42.60	0.12	3.23	0.06	0.33	13.30	0.40	21.00		
E	3.94	2.72	0.18	43.10	0.12	3.21			13.50	0.42	21.46	22.10	3.93
E	3.96	2.71	0.18	43.10	0.11	3.20			13.40	0.38	20.69	22.10	3.94
E	3.96	2.72	0.18	43.10	0.12	3.24			13.50	0.41	21.34	22.50	3.92
E	3.93	2.69	0.18	43.00	0.11	3.20			13.50	0.37	20.77	22.30	3.92
E	3.89	2.68	0.18	42.90	0.12	3.20			13.35	0.37	21.29	22.20	3.92
E	3.88	2.67	0.18	42.80	0.12	3.18			13.20	0.38	21.08	22.40	3.95
E	3.93	2.70	0.18	43.20	0.12	3.20			13.20	0.39	21.23	22.50	3.92
E	3.88	2.69	0.18	43.00	0.12	3.19			13.30	0.38	21.12	22.50	3.92
F												21.30	
F												21.40	
F												21.40	
F												21.40	
F												21.50	
F												21.50	
F												21.60	
F												21.40	
G													3.58
G													3.58
G													3.61
G													3.58
G													3.58
G													3.59
G													3.58
G													3.60

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
H	5.00	3.35	0.23	54.60	0.16	3.92	0.07		16.80	0.49	22.11	21.90	3.55
H	5.04	3.35	0.23	54.60	0.16	3.92	0.07		16.80	0.49	22.06	22.10	3.56
H	5.00	3.30	0.23	54.60	0.15	3.90	0.07		16.70	0.49	22.08	21.60	3.54
H	5.05	3.29	0.23	54.60	0.15	3.94	0.07		16.60	0.48	22.07	21.90	3.55
H	5.01	3.31	0.23	54.60	0.15	3.91	0.07		16.80	0.49	22.19	21.60	3.57
H	4.99	3.36	0.24	54.90	0.16	3.91	0.07		16.90	0.50	22.23	22.20	3.55
H	5.03	3.33	0.23	54.50	0.15	3.91	0.07		16.80	0.49	22.26	20.90	3.56
H	5.05	3.22	0.22	54.60	0.14	3.91	0.07		16.70	0.48	22.11	21.80	3.55
K													3.36
K													3.32
K													3.45
K													3.41
K													3.47
K													3.38
K													3.30
K													3.34
L	3.69	2.42		40.90	0.10	3.33	0.04	0.28	12.00	0.35	22.00		3.69
L	3.81	2.47		41.70	0.10	3.18	0.04	0.29	12.30	0.35	21.90		3.73
L	3.78	2.43		41.00	0.10	3.21	0.04	0.29	12.30	0.35	22.00		3.69
L	3.79	2.44		41.40	0.10	3.21	0.04	0.29	12.10	0.34	22.00		3.66
L	3.81	2.46		41.40	0.10	3.22	0.04	0.30	12.40	0.35	22.00		3.75
L	3.79	2.43		41.20	0.10	3.09	0.04	0.28	12.30	0.35	21.90		3.70
L	3.72	2.42		41.20	0.10	3.30	0.04	0.28	12.00	0.34	22.00		3.65
L	3.74	2.39		40.70	0.10	3.14	0.04	0.28	12.10	0.34	22.00		3.67
O	3.67	2.85	0.17	42.05	0.09	3.09	0.06	0.25	12.21	0.39	20.63	21.40	3.52
O	3.56	2.77	0.16	42.21	0.09	3.07	0.07	0.27	11.78	0.38	20.77	21.10	3.53
O	3.59	2.80	0.16	41.52	0.10	3.02	0.06	0.24	11.92	0.38	20.66	21.60	3.52
O	3.60	2.76	0.16	42.12	0.09	3.08	0.06	0.27	11.71	0.38	20.79	21.90	3.51
O	3.55	2.76	0.16	42.21	0.09	2.96	0.07	0.26	11.65	0.38	20.43	21.60	3.52
O	3.62	2.80	0.16	42.25	0.09	3.06	0.07	0.27	11.88	0.38	20.82	21.20	3.52
O	3.68	2.84	0.16	41.95	0.09	3.09	0.07	0.26	12.13	0.39	20.35	21.90	3.52
O	3.61	2.84	0.16	42.04	0.10	3.13	0.07	0.26	11.95	0.39	20.24	21.70	3.52
Q	4.35	2.75				3.02			11.60				23.10
Q	4.01	2.67				3.01			12.40				22.70
Q	4.33	2.55				2.93			12.90				22.90
Q	4.26	2.95				3.07			12.20				22.60
Q	3.54	2.64				2.94			11.20				22.70
Q	3.80	2.81				3.03			11.80				22.80
Q	4.26	2.90				2.98			11.60				22.60
Q	4.24	3.01				3.00			11.20				22.60
R	3.70	2.61	0.16	30.80	0.11	3.24	0.05	0.26	12.85	0.35	22.20		3.51
R	3.57	2.54	0.15	30.60	0.10	3.08	0.05	0.25	12.45	0.33	22.40		3.50
R	3.76	2.65	0.16	29.80	0.11	3.28	0.05	0.26	12.75	0.35	22.40		3.51
R	3.79	2.67	0.16	30.70	0.11	3.31	0.05	0.26	13.00	0.36	22.20		3.44
R	3.70	2.66	0.16	32.00	0.11	3.23	0.05	0.25	12.95	0.35	22.40		3.49
R	3.57	2.53	0.15	33.10	0.10	3.13	0.05	0.24	12.35	0.34	22.40		3.49
R	3.60	2.55	0.15	34.20	0.10	3.14	0.05	0.25	12.60	0.34	22.30		3.42
R	3.63	2.56	0.16	31.00	0.10	3.17	0.05	0.24	12.65	0.34	22.30		3.49
S													18.90
S													19.70
S													19.50
S													19.80
S													20.40
S													20.60
S													19.80
S													19.70
T	3.81	2.52	0.16	41.40	0.20	3.08	0.07		14.40	0.37		22.10	3.40
T	3.81	2.61	0.16	41.30	0.20	3.08	0.05		14.20	0.37		22.80	3.37
T	3.80	2.64	0.16	41.30	0.20	3.09	0.05		14.00	0.36		21.60	3.41
T	3.79	2.58	0.15	41.40	0.20	3.09	0.05		14.30	0.37		22.30	3.42
T	3.78	2.69	0.16	41.00	0.20	3.08	0.05		14.00	0.36		21.60	3.45
T	3.83	2.72	0.16	41.40	0.20	3.13	0.05		14.00	0.37		22.10	3.41
T	3.80	2.62	0.16	41.20	0.20	3.10	0.05		14.20	0.36		22.40	3.35
T	3.83	2.63	0.16	41.50	0.20	3.11	0.05		14.30	0.37		23.40	3.40
V													21.60
V													21.50
V													21.60
V													21.30
V													21.40
V													21.40
V													21.70
V													21.70
W	3.86	2.65	0.17	43.31	0.12	3.19	0.05	0.26	13.20	0.39	21.04		3.69
W	3.92	2.65	0.17	43.59	0.13	3.24	0.06	0.27	13.30	0.35	21.02		3.71
W	3.86	2.66	0.17	43.12	0.13	3.21	0.05	0.28	13.20	0.38	20.97		3.67
W	3.88	2.66	0.17	43.29	0.13	3.22	0.05	0.26	13.30	0.38	20.96		3.67
W	3.86	2.66	0.17	43.33	0.12	3.21	0.05	0.28	13.30	0.38	20.98		3.71
W	3.89	2.66	0.17	43.13	0.12	3.22	0.05	0.29	13.40	0.37	20.97		3.70
W	3.87	2.66	0.17	42.83	0.12	3.20	0.05	0.26	13.20	0.41	20.96		3.68
W	3.89	2.66	0.17	43.02	0.12	3.21	0.05	0.26	13.20	0.40	21.04		3.71

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	0.080	0.041	0.054	0.011
Pd	PbColl	g/t	0.441	0.24	0.25	0.063
Au	PbColl	g/t	0.030	0.015	0.021	0.000
Co	M/ICP	ppm	53.74	32.84	27.04	8.570
Co	P	ppm	72.93	51.23	30.61	14.00
Cu	M/ICP	ppm	1144	788.1	565.4	225.8
Cu	P	ppm	1250	1035	525.5	332.9
Cu	XRF	ppm	1975	2185	506.1	828.6
Ni	M/ICP	ppm	1285	910.6	743.0	286.3
Ni	P	ppm	1517	1440	629.9	515.5
Ni	XRF	ppm	1446	1555	459.4	590.9
Al ₂ O ₃	XRF	%	0.114	0.111	0.040	0.040
CaO	XRF	%	0.104	0.087	0.041	0.028
Cr ₂ O ₃	XRF	%	0.008	0.007	0.004	0.003
Fe ₂ O ₃	XRF	%	0.741	0.759	0.170	0.269
K ₂ O	XRF	%	0.012	0.012	0.004	0.004
MgO	XRF	%	0.084	0.071	0.042	0.024
MnO	XRF	%	0.009	0.008	0.003	0.003
SiO ₂	XRF	%	0.708	0.630	0.192	0.200
TiO ₂	XRF	%	0.023	0.020	0.011	0.007
LOI		%	0.563	0.543	0.120	0.181
S	Comb/LECC	%	0.475	0.419	0.253	0.000
SG	pyc		0.103	0.097	0.027	0.033

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 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: AMIS0331 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 October 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	16.2	4.09	12.6	91
Al	M/ICP	%	2.08	0.16	3.77	109
As	M/ICP	ppm	67.5	29.9	22.2	113
Ba	M/ICP	ppm	27.1	14.2	26.2	95
Be	M/ICP	ppm	0.14	0.10	36.0	6
Bi	M/ICP	ppm	18.3	9.19	25.1	65
Ca	M/ICP	%	1.89	0.15	4.01	112
Cd	M/ICP	ppm	4.24	5.46	64.4	94
Ce	M/ICP	ppm	8.98	14.3	79.4	40
Co	XRF	ppm	1403	75.5	2.69	40
Cr	M/ICP	ppm	731	420	28.7	112
Cs	M/ICP	ppm	0.50	0.02	2.35	22
Dy	M/ICP	ppm	0.49	0.04	4.22	15
Er	M/ICP	ppm	0.30	0.03	4.35	15
Eu	M/ICP	ppm	0.15	0.01	3.07	14
Fe	M/ICP	%	30.1	2.03	3.37	78
Ga	M/ICP	ppm	9.42	20.9	111	40
Gd	M/ICP	ppm	0.57	0.11	10.1	23
Ge	M/ICP	ppm	1.36	0.10	3.80	8
Hf	M/ICP	ppm	0.41	0.05	5.6	23
Ho	M/ICP	ppm	0.10	0.01	4.22	15
In	M/ICP	ppm	0.23	0.05	10.6	37
K	M/ICP	%	0.10	0.01	6.41	110
La	M/ICP	ppm	3.14	2.77	44.1	59
Li	M/ICP	ppm	7.18	1.43	9.96	72
Lu	M/ICP	ppm	0.04	0.01	9.49	21
Mg	M/ICP	%	1.87	0.17	4.43	114
Mn	M/ICP	ppm	407	41.3	5.08	113
Mo	M/ICP	ppm	23.9	7.11	14.9	112
Na	M/ICP	%	0.25	0.09	19.4	111
Nb	M/ICP	ppm	1.62	0.43	13.2	40
Nd	M/ICP	ppm	42.4	91.3	108	29
P	M/ICP	ppm	130	390	150	75
Pb	M/ICP	ppm	53.0	26.7	25.2	100
Pr	M/ICP	ppm	0.65	0.05	4.16	15
Rb	M/ICP	ppm	4.73	2.28	24.1	37
Re	M/ICP	ppm	0.14	0.05	18.0	31
S	M/ICP	%	14.6	21.0	72.1	24
Sb	M/ICP	ppm	9.53	12.5	65.8	82
Sc	M/ICP	ppm	4.85	2.08	21.5	111
Se	M/ICP	ppm	81.4	29.8	18.3	45
Si	M/ICP	%	6.17	0.07	0.59	8
Sm	M/ICP	ppm	0.49	0.06	6.10	15
Sn	M/ICP	ppm	4.20	0.60	7.09	40
Sr	M/ICP	ppm	33.4	6.5	9.80	78
Ta	M/ICP	ppm	19.0	54.9	144	43
Tb	M/ICP	ppm	0.08	0.02	11.6	22
Te	M/ICP	ppm	13.7	2.66	9.71	42
Th	M/ICP	ppm	1.18	0.22	9.28	38
Ti	M/ICP	%	0.22	0.02	5.06	88
Tl	M/ICP	ppm	0.98	2.17	111	44
U	M/ICP	ppm	1.17	0.16	6.9	38
V	M/ICP	ppm	100	17.7	8.83	112
W	M/ICP	ppm	27.7	85.5	154	55
Y	M/ICP	ppm	2.49	0.71	14.2	78
Yb	M/ICP	ppm	0.26	0.08	14.4	22
Zn	M/ICP	ppm	544	75.3	6.92	97
Zr	M/ICP	ppm	14.9	15.8	52.9	80