



African Mineral Standards

MATRIX REFERENCE MATERIALS

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## AMIS0324

### ***Certified Reference Material***

**Nickel concentrate  
Nkomati Mine, South Africa**

### ***Certificate of Analysis***

**Recommended Concentrations and Limits<sup>1</sup>  
(at two Standard Deviations)**

#### ***Certified Concentrations<sup>2</sup>***

Pt Pb Collection	5.50	±	0.54	g/t
Pd Pb Collection	10.12	±	0.78	g/t
Au Pb Collection	0.84	±	0.08	g/t
Co M/ICP	3225	±	342	ppm
Co P	3066	±	215	ppm
Cu M/ICP	3.181	±	0.106	%
Cu P	3.110	±	0.166	%
Cu XRF	3.147	±	0.182	%
Ni M/ICP	5.585	±	0.428	%
Ni P	5.240	±	0.268	%
Specific Gravity	3.61	±	0.28	

PGM 3E = 16.46 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*

CaO	1.14	±	0.08	%
Cr <sub>2</sub> O <sub>3</sub>	0.42	±	0.04	%
Fe <sub>2</sub> O <sub>3</sub>	38.71	±	0.80	%
MgO	7.44	±	0.48	%
SiO <sub>2</sub>	15.74	±	0.78	%
LOI	23.44	±	2.26	%
S Combustion / LECO	27.27	±	1.34	%

## *Provisional Concentrations*

Al <sub>2</sub> O <sub>3</sub>	1.07	±	0.14	%
K <sub>2</sub> O	0.07	±	0.01	%
TiO <sub>2</sub>	0.08	±	0.02	%

## *Indicated Mean*

MnO	0.04	%
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**1. Intended Use:** AMIS0324 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 concentrates 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 AMIS0324 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 Dark Grey (Corstor).

**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 ( Al<sub>2</sub>O<sub>3</sub>, CaO, Cr<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, MnO, Na<sub>2</sub>O, SiO<sub>2</sub>, TiO<sub>2</sub>. 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 four laboratories were each given eight randomly selected packages of sample. Seventeen 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 17 out of 24 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Activation Laboratories Pty Ltd (ActLabs) CA
2. ALS Chemex Laboratory Group Johannesburg SA
3. ALS Chemex Laboratory Group Perth WA
4. Genalysis Laboratory Services (South Africa) Pty
5. Genalysis Laboratory Services (W Australia P)
6. Intertek Utama Services (Indonesia)
7. Labtium Inc Finland
8. OMAC Laboratories Limited (Ireland)
9. Set Point Laboratories (Isando) SA
10. SGS Australia Pty Ltd (Newburn) WA
11. SGS Geosol Laboratories Ltda (Brazil)
12. SGS Mineral Services Callao (Peru)
13. SGS Mineral Services Lakefield (Canada)
14. SGS South Africa (Pty) Ltd - Booyens JHB
15. SGS Toronto (Canada)
16. SGS Townsville (Australia)
17. 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
B	5.90	10.20	0.85	3330	3050	3360	31300	29700	32000	55700	50700	56900
B	5.82	10.30	0.88	3390	3130	3340	31400	31000	31900	55900	50500	56800
B	5.94	10.30	0.84	3260	3110	3360	31100	30700	32000	54100	50200	56900
B	5.90	10.30	0.82	3460	2990	3350	31900	31100	31800	54500	49200	56800
B	5.84	10.30	0.83	3370	2960	3360	31200	31000	31800	55500	49900	57000
B	5.90	10.30	0.84	3320	3020	3360	32000	29000	31900	55700	51000	57000
B	5.82	10.30	0.87	3280	3070	3340	31200	30900	31600	54500	51000	56800
B	5.66	10.10	0.84	3280	3010	3350	30800	29000	31700	54000	50800	56800
D	4.94	9.47	0.97						29560			51870
D	5.13	9.83	0.94						29930			52470
D	5.29	10.00	1.03						29670			52330
D	5.17	9.76	0.95						29900			52220
D	5.22	10.10	1.02						29900			52330
D	5.16	9.88	1.17						29300			51310
D	5.18	9.66	1.22						29380			51260
D	5.43	10.10	1.20						29430			51350

**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	4.90		0.78	3300	3100	3500	32300	32100	31400	57100	54500	59800
F	4.97		0.80	3300	3100	3400	32300	32100	31100	57000	54600	59900
F	4.81		0.82	3300	3100	3500	32300	32200	31400	57100	54600	59000
F	4.80		0.80	3400	3100	3500	32400	32200	31600	57100	54500	59800
F	4.97		0.82	3400	3100	3600	32300	32100	31700	57100	54600	60500
F	4.81		0.75	3300	3100	3600	32400	32100	31800	57100	54500	60600
F	4.90		0.78	3300	3000	3500	32400	32200	31400	57100	54500	60500
F	4.77		0.79	3300	3000	3400	32300	32100	31700	57100	54500	60400
G				3071	2933		30400	30500		52500	51400	
G				3110	2920		31400	30600		53400	51600	
G				3049	2953		31100	30700		53300	52100	
G				3105	2940		31000	30700		53100	52600	
G				3089	2951		31400	30900		53700	52500	
G				3098	2917		31200	30800		53100	51400	
G				3033	2980		31100	30900		52400	52000	
G				3053	2872		30400	30600		53700	51800	
I	5.52	9.90	0.79			3440			31900			56900
I	5.57	9.83	0.87			3440			32000			56900
I	5.66	10.10	0.80			3430			31900			57000
I	5.62	10.00	0.85			3440			39800			57000
I	5.62	9.90	0.90			3450			31800			56900
I	5.32	9.40	0.83			3440			32000			57100
I	5.54	9.72	0.92			3470			31800			57100
I	5.70	10.20	0.86			3450			31800			57000
K	5.43	9.84	0.83	2990	3120		35100	31500		59400	53200	
K	5.49	10.15	0.81	2990	3180		34900	32300		59400	54100	
K	5.44	9.82	0.81	2970	3080		34900	30900		59300	52200	
K	5.42	9.23	0.81	2980	3080		34800	31100		59700	52700	
K	5.32		0.82	3020	3140		35200	31900		60400	52800	
K	5.22		0.81	3010	3200		35300	32400		59700	54700	
K	5.33	9.58	0.84	2960	3170		34600	32100		58700	53500	
K	5.35		0.80	2970	3130		34600	31600		59300	53000	
L	5.48	9.81	0.84	3220	3080		32100	31700		53300	53300	
L	5.68	10.15	0.85	3190	3090		31500	31500		52400	53900	
L	5.72	10.35	0.88	3270	3110		31700	30900		55700	52600	
L	5.64	10.05	0.85	3330	3110		31100	31400		53900	53000	
L	5.71	10.20	0.86	3270	3130		31400	31700		54300	53600	
L	5.82	10.35	0.89	3160	3190		31200	31800		52500	53800	
L	5.75	10.35	0.88	3270	3140		31500	31800		52900	53900	
L	5.37	9.70	0.81	3250	3130		30800	31600		51300	54400	
M	5.85	10.39	0.81	3351	3240		31648	30150		58163	51554	
M	5.78	10.36	0.83	3361	3182		32164	29284		57860	50780	
M	5.83	10.40	0.87	3310	3196		32235	29349		57996	51473	
M	6.09	10.43	0.85	3384	3214		31771	29745		58308	51091	
M	5.84	10.37	0.83	3290	3212		31570	30208		57731	51302	
M	5.64	10.25	0.80	3355	3212		31476	29259		58144	50666	
M	5.95	10.33	0.86	3363	3170		31279	29480		58410	50749	
M	5.79	10.29	0.83	3369	3212		31916	28964		58045	51065	
N	5.19	9.85	0.84									
N	5.34	9.95	0.81									
N	5.23	9.73	0.81									
N	5.27	9.96	0.81									
N	5.28	9.94	0.83									
N	5.29	9.92	0.81									
N	5.22	9.60	0.85									
N	5.24	9.75	0.82									
O			0.92	3400			32100			56700		
O			0.94	3420			32300			56200		
O			0.95	3420			32300			56000		
O			0.85	3410			32100			56200		
O			0.88	3440			32700			56400		
O			0.89	3410			32500			56300		
O			0.82	3400			32500			56900		
O			0.82	3440			32300			56200		
P	4.99	10.70	0.79	2740	3150							
P	5.13	10.90	0.83	2910	3010							
P	4.93	10.50	0.76	3090	3130							
P	5.19	10.90	0.80	3300	3180							
P	5.05	10.50	0.76	3330	3200							
P	5.18	11.00	0.77	3380	3110							
P	5.14	10.90	0.80	3220	3170							
P	4.96	10.60	0.80	3250	2970							

**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
Q	5.60	10.30	0.87	3070	2980		32100	30800		53600	52000	
Q	5.64	10.40	0.89	2960	3010		32500	30600		54200	51800	
Q	5.69	10.30	0.86	2970	2950		31500	30800		53100	52100	
Q	5.68	10.50	0.90	2980	2870		32200	30100		54000	50600	
Q	5.57	10.10	0.84	2990	2920		31900	30900		55200	51700	
Q	5.73	10.50	0.88	2990	2950		31500	30900		54500	52200	
Q	5.87	10.80	0.93	2950	3040		32500	30600		55300	52400	
Q	5.86	10.80	0.93	2980	3010		32400	30000		55100	51600	
R												
R												
R												
R												
R												
R												
R												
R												
S	4.84		0.70	2566	2353	3300			32300			
S	4.89		0.71	2641	2423	3300			32100			
S	4.88		0.70	2560	2284	3400			32400			
S	4.89		0.71	2568	2129	3300			32300			
S	4.80		0.71	2524	2387	3400			32200			
S	4.85		0.72	2615	2481	3300			32200			
S	4.73		0.73	2526	2513	3300			31900			
S	4.83		0.73	2611	2304	3300			31700			
T	5.71	10.60	0.94			3000			32800			54900
T	5.55	10.50	0.85			3100			32300			54200
T	5.57	10.50	0.85			3200			31600			53100
T	5.86	11.00	0.95			3100			31400			52100
T	5.72	10.60	0.89			3100			31200			52200
T	5.73	10.60	0.89			3000			32500			54500
T	5.75	10.50	0.93			3100			31700			53300
T	5.79	10.70	0.93			3100			31600			53100
U	5.50	10.00	0.84	3400	2920			32100				
U	5.54	9.99	0.84	3430	2990			32300				
U	5.42	9.92	0.87	3430	3000			31900				
U	5.69	10.30	0.85	3380	3040			31300				
U	5.48	9.95	0.84	3390	2980			31900				
U	5.60	10.05	0.85	3330	3020			32000				
U	5.39	10.00	0.83	3370	2930			31100				
U	5.57	10.15	0.82	3360	2980			31100				
V												
V												
V												
V												
V												
V												
V												
V												
W	5.29	9.33	0.83	2660	2880			31000			52000	
W	5.14	9.35	0.85	2770	2930			30600			52000	
W	5.14	9.32	0.83	2920	2920			29700			50800	
W	5.43	9.35	0.85	3070	2880			31500			52500	
W	5.11	9.11	0.80	2840	2800			31700			53200	
W	5.09	9.48	0.82	2780	3000			30400			52400	
W	5.35	9.27	0.88	2880	2960			30600			52500	
W	5.12	9.18	0.85	3070	2750			30800			52300	
X				3386	3121	2137						
X				3360	3317	2164						
X				3377	3281	2155						
X				3361	3212	2133						
X				3284	3353	2153						
X				3362	3239	2162						
X				3256	3260	2150						
X				3237	3218	2157						

**Assay data: Major elements**

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	S Comb/LECO %	SG pyc
B	1.07	1.16	0.41	38.90	0.08	7.60	0.05		16.18	0.10	22.63		3.67
B	1.07	1.16	0.41	38.80	0.08	7.58	0.04		16.14	0.10	22.63		3.72
B	1.08	1.16	0.41	38.90	0.08	7.61	0.04		16.18	0.10	22.66		3.70
B	1.08	1.16	0.41	38.81	0.08	7.59	0.04		16.13	0.10	22.60		3.69
B	1.08	1.16	0.42	38.93	0.08	7.65	0.04		16.22	0.10	22.57		3.70
B	1.08	1.16	0.42	38.92	0.07	7.63	0.04		16.20	0.10	22.50		3.72
B	1.08	1.16	0.42	38.84	0.08	7.59	0.04		16.12	0.10	22.60		3.70
B	1.08	1.15	0.42	38.83	0.07	7.62	0.04		16.12	0.10	22.64		3.69
D	1.11	1.06	0.38	35.90	0.06	8.00	0.03	0.07	15.30	0.07			3.72
D	1.11	1.06	0.39	36.20	0.06	8.02	0.03	0.05	15.20	0.07			3.71
D	1.09	1.05	0.38	36.00	0.06	8.00	0.03	0.06	15.30	0.07			3.71
D	1.09	1.05	0.39	37.10	0.06	8.02	0.03	0.06	15.20	0.07			3.72
D	1.07	1.05	0.38	36.20	0.06	8.25	0.03	0.06	15.10	0.07			3.72
D	1.08	1.04	0.37	36.40	0.06	8.28	0.03	0.06	15.30	0.07			3.73
D	1.05	1.04	0.38	36.40	0.06	8.44	0.03	0.06	15.00	0.07			3.71
D	1.08		0.38	36.60	0.06	8.00	0.03	0.04	15.00	0.07			3.73
F	0.83	1.19	0.41	38.41	0.04	7.49	0.05	0.05	15.53	0.08		27.10	3.07
F	0.82	1.18	0.40	38.29	0.04	7.50	0.05	0.05	15.39	0.08		27.40	3.06
F	0.87	1.19	0.41	38.24	0.04	7.50	0.05	0.05	15.37	0.07		27.40	3.05
F	0.84	1.19	0.41	38.30	0.04	7.49	0.05	0.07	15.40	0.08		27.10	3.06
F	0.80	1.19	0.40	38.07	0.04	7.44	0.05	0.06	15.31	0.07		27.40	3.06
F	0.80	1.18	0.41	38.21	0.04	7.47	0.05	0.06	15.36	0.07		27.40	3.06
F	0.80	1.18	0.40	38.15	0.04	7.51	0.05	0.07	15.35	0.07		27.10	3.08
F	0.84	1.20	0.41	38.49	0.05	7.55	0.05	0.06	15.55	0.08		27.10	3.06
G												27.60	3.16
G												27.50	3.16
G												27.65	3.11
G												28.00	3.16
G												27.85	3.22
G												27.70	3.09
G												27.90	3.16
G												27.65	3.25
I	0.97	1.13	0.42	39.10	0.08	7.32	0.05		15.74	0.09	24.56	27.30	3.75
I	0.94	1.14	0.43	39.12	0.06	7.26	0.05		15.99	0.10	24.13	26.90	3.72
I	0.92	1.11	0.44	39.30	0.08	7.29	0.05		15.81	0.09	24.15	27.20	3.78
I	0.95	1.17	0.44	39.23	0.06	7.28	0.05		16.03	0.11	24.29	27.50	3.76
I	0.96	1.12	0.42	39.03	0.08	7.34	0.05		15.97	0.09	24.20	26.90	3.77
I	0.93	1.15	0.41	39.29	0.07	7.28	0.05		15.92	0.10	24.33	25.80	3.77
I	0.97	1.13	0.42	39.15	0.07	7.25	0.05		15.99	0.08	24.31	26.90	3.74
I	0.92	1.15	0.41	39.04	0.07	7.29	0.05		15.91	0.09	24.31	27.30	3.77
K	1.11	1.16	0.43	38.85	0.07	7.42	0.04	0.10	16.10	0.08	22.37		
K	1.12	1.16	0.43	38.65	0.07	7.39	0.04	0.11	16.15	0.08	22.29		
K	1.11	1.16	0.43	38.88	0.07	7.31	0.04	0.11	16.20	0.09	22.31		
K	1.09	1.14	0.42	38.12	0.07	7.18	0.04	0.10	16.00	0.08	22.61		
K	1.09	1.14	0.42	38.44	0.07	7.25	0.04	0.10	15.95	0.08	22.16		
K	1.10	1.16	0.43	38.55	0.07	7.25	0.04	0.11	16.10	0.08	22.34		
K	1.10	1.16	0.43	38.66	0.07	7.38	0.04	0.10	16.05	0.08	22.60		
K	1.11	1.16	0.43	39.05	0.07	7.45	0.04	0.12	16.15	0.08	22.04		
M											22.45	28.37	3.38
M											22.60	28.32	3.37
M											22.71	28.47	3.41
M											22.70	28.42	3.43
M											22.64	28.61	3.41
M											22.65	28.27	3.39
M											22.72	28.28	3.37
M											22.55	28.39	3.41
N													3.78
N													3.75
N													3.77
N													3.79
N													3.75
N													3.77
N													3.77
N													3.78
P	1.11	1.14	0.43	39.10	0.08	7.46	0.05	0.13	16.10	0.10	22.40		
P	1.11	1.13	0.43	39.10	0.08	7.46	0.05	0.12	16.10	0.09	22.60		
P	1.10	1.14	0.43	39.00	0.07	7.45	0.05	0.13	16.10	0.09	22.60		
P	1.11	1.14	0.43	39.10	0.07	7.45	0.05	0.13	16.10	0.09	22.40		
P	1.10	1.13	0.43	39.20	0.07	7.40	0.05	0.12	16.00	0.09	22.40		
P	1.11	1.13	0.43	39.00	0.07	7.45	0.05	0.14	16.00	0.10	22.60		
P	1.11	1.14	0.44	39.10	0.07	7.49	0.05	0.11	16.10	0.09	22.10		
P	1.12	1.15	0.44	39.20	0.07	7.45	0.05	0.12	16.10	0.09	22.50		
S												27.03	
S												26.98	
S												27.20	
S												27.17	
S												28.21	
S												27.12	
S												27.16	
S												27.22	

## 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
T												26.30	
T												26.20	
T												26.70	
T												26.80	
T												26.80	
T												26.80	
T												26.80	
T												26.80	
T												26.60	
U	1.05	1.06	0.39	26.20	0.07	7.17	0.04	0.07	15.75	0.08	25.30		3.46
U	1.08	1.09	0.40	25.50	0.07	7.41	0.04	0.07	16.20	0.08	25.30		3.46
U	1.08	1.10	0.40	24.50	0.07	7.48	0.04	0.07	16.25	0.08	25.00		3.49
U	0.96	1.02	0.33	31.50	0.06	6.75	0.03	0.06	14.90	0.07	25.20		3.48
U	0.93	0.99	0.32	30.60	0.06	6.73	0.03	0.06	14.70	0.07	25.20		3.49
U	0.86	0.94	0.29	28.90	0.06	6.42	0.03	0.06	14.00	0.06	25.40		3.47
U	0.95	0.97	0.34	31.80	0.06	6.62	0.03	0.06	14.50	0.07	25.30		3.47
U	1.03	1.06	0.40	29.70	0.06	7.29	0.04	0.07	15.90	0.08	25.50		3.46
W													3.50
W													3.49
W													3.48
W													3.49
W													3.51
W													3.50
W													3.49
W													3.48
X	1.16	1.09	0.46	38.30	0.08	7.28	0.04		15.30	0.08	24.35	26.10	3.59
X	1.17	1.07	0.45	38.30	0.07	7.23	0.04		15.40	0.08	24.44	26.90	3.61
X	1.16	1.09	0.45	38.30	0.08	7.26	0.04		15.40	0.08	24.39	26.10	3.60
X	1.14	1.09	0.46	38.20	0.08	7.20	0.04		15.30	0.08	24.41	26.10	3.58
X	1.14	1.09	0.47	38.30	0.07	7.25	0.04		15.40	0.08	24.49	26.60	3.59
X	1.14	1.08	0.46	38.00	0.07	7.17	0.04		15.30	0.08	24.83	27.40	3.57
X	1.14	1.09	0.46	38.10	0.07	7.22	0.04		15.30	0.08	24.60	26.50	3.61
X	1.14	1.09	0.46	38.30	0.08	7.26	0.04		15.40	0.08	24.28	26.20	3.60

### 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 <sup>1</sup>	$\sigma_L$ <sup>2</sup>	Sw <sup>3</sup>	CSU <sup>4</sup>
Pt	PbColl	g/t	0.269	0.206	0.108	0.061
Pd	PbColl	g/t	0.392	0.284	0.176	0.084
Au	PbColl	g/t	0.040	0.023	0.027	0.007
Co	M/ICP	ppm	171.5	131.98	64.26	38.69
Co	P	ppm	107.5	82.90	49.52	25.57
Cu	M/ICP	ppm	529.8	479.3	314.0	186.1
Cu	P	ppm	828.2	695.1	417.5	237.1
Cu	XRF	ppm	907.9	1061.3	299.5	435.5
Ni	M/ICP	ppm	2138	2136.8	614.2	759.5
Ni	P	ppm	1338	1291	532.6	461.4
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.069	0.072	0.026	0.027
CaO	XRF	%	0.044	0.048	0.010	0.018
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.023	0.025	0.006	0.009
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.397	0.460	0.150	0.189
K <sub>2</sub> O	XRF	%	0.007	0.006	0.005	0.002
MgO	XRF	%	0.235	0.218	0.092	0.078
MnO	XRF	%	0.007	0.007	0.002	0.003
SiO <sub>2</sub>	XRF	%	0.394	0.441	0.082	0.167
TiO <sub>2</sub>	XRF	%	0.010	0.010	0.004	0.004
LOI		%	1.133	1.286	0.145	0.486
S	Comb/LECO	%	0.666	0.683	0.284	0.261
SG	pyc		0.137	0.144	0.015	0.051

1. S - Std Dev for use on control charts.
2.  $\sigma_L$  - 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:** AMIS0324 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](http://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.

**26 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	15.4	1.93	6.27	61
Al	M/ICP	%	0.57	0.05	4.37	85
As	M/ICP	ppm	649	58.5	4.51	82
Ba	M/ICP	ppm	22.8	16.0	35.1	72
Be	M/ICP	ppm	0.12	0.12	51.3	16
Bi	M/ICP	ppm	8.72	3.82	21.9	50
Ca	M/ICP	%	0.79	0.06	4.12	91
Cd	M/ICP	ppm	4.29	2.19	25.5	80
Ce	M/ICP	ppm	6.35	0.84	6.62	40
Cr	M/ICP	ppm	1629	1235	37.9	88
Cs	M/ICP	ppm	0.53	0.07	6.84	30
Co	XRF	ppm	3342	302	4.52	40
Dy	M/ICP	ppm	0.38	0.07	9.52	22
Er	M/ICP	ppm	0.21	0.04	9.44	22
Eu	M/ICP	ppm	0.16	0.03	8.20	15
Fe	M/ICP	%	26.5	2.93	5.54	63
Ga	M/ICP	ppm	2.51	5.38	107	45
Gd	M/ICP	ppm	0.48	0.15	15.8	24
Ge	M/ICP	ppm	1.91	1.24	32.5	24
Hf	M/ICP	ppm	0.43	0.09	10.9	23
Ho	M/ICP	ppm	0.08	0.00	0.00	15
In	M/ICP	ppm	0.50	0.05	5.17	36
K	M/ICP	%	0.06	0.01	9.63	95
La	M/ICP	ppm	2.68	1.90	35.5	57
Li	M/ICP	ppm	4.29	1.98	23.1	77
Lu	M/ICP	ppm	0.06	0.09	83.3	22
Mg	M/ICP	%	4.33	0.38	4.36	91
Mn	M/ICP	ppm	299	32.6	5.46	80
Mo	M/ICP	ppm	6.25	6.86	54.8	64
Na	M/ICP	%	0.08	0.12	76.7	80
Nb	M/ICP	ppm	2.06	0.11	2.78	29
Nd	M/ICP	ppm	2.92	0.23	3.91	22
Ni	XRF	ppm	55849	5944	5.32	40
P	M/ICP	ppm	117	157	66.9	60
Pb	M/ICP	ppm	317	47.0	7.43	80
Pr	M/ICP	ppm	73.6	257	174	32
Rb	M/ICP	ppm	3.22	1.23	19.1	37
Re	M/ICP	ppm	0.10	0.02	11.1	23
S	M/ICP	%	27.9	0.98	1.75	16
Sb	M/ICP	ppm	29.7	18.8	31.7	69
Sc	M/ICP	ppm	2.87	1.93	33.6	80
Se	M/ICP	ppm	59.2	19.7	16.6	40
Si	M/ICP	%	7.37	0.16	1.09	8
Sm	M/ICP	ppm	0.53	0.13	12.7	24
Sn	M/ICP	ppm	10.7	24.7	116	48
Sr	M/ICP	ppm	17.6	3.92	11.2	72
Tb	M/ICP	ppm	0.07	0.02	15.5	28
Te	M/ICP	ppm	17.6	7.60	21.6	40
Th	M/ICP	ppm	3.02	1.37	22.6	40
Ti	M/ICP	%	0.04	0.01	9.35	77
Tl	M/ICP	ppm	1.83	6.08	166	43
Tm	M/ICP	ppm	0.04	0.00	0.00	7
U	M/ICP	ppm	0.46	0.09	9.85	36
V	M/ICP	ppm	25.1	10.0	19.9	72
W	M/ICP	ppm	0.30	0.00	0.00	16
Y	M/ICP	ppm	1.91	0.51	13.4	60
Yb	M/ICP	ppm	0.24	0.14	29.5	31
Zn	M/ICP	ppm	440	89.8	10.2	88
Zr	M/ICP	ppm	16.3	5.82	17.8	51