



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

AMIS0323

Certified Reference Material

**Chrome concentrate
Nkomati Mine South Africa**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Pt Pb Collection	1.07	±	0.12	g/t
Cr XRF	26.91	±	0.57	%
Cu M/ICP	787	±	40	ppm
Cu P	763	±	40	ppm
Ni M/ICP	1993	±	124	ppm
Ni P	1820	±	131	ppm
Specific Gravity	4.01	±	0.18	

Provisional Concentrations

Pd Pb Collection	0.63	±	0.08	g/t
Au Pb Collection	0.14	±	0.02	g/t
Co M/ICP	294	±	45	ppm
Co P	126	±	20	ppm

PGM 3E 1.84 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	12.24	±	0.21	%
Cr ₂ O ₃	39.14	±	0.80	%
Fe ₂ O ₃	25.00	±	0.28	%
K ₂ O	0.18	±	0.02	%
MgO	10.58	±	0.30	%
MnO	0.25	±	0.01	%
SiO ₂	9.16	±	0.20	%
TiO ₂	0.58	±	0.03	%
LOI	1.18	±	0.14	%

Provisional Concentration

CaO	0.48	±	0.06	%
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Indicated Mean

Na ₂ O	0.06	%
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1. Intended Use: AMIS0323 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of chrome 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 AMIS0323 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 Moderate Yellowish Brown (Corstor 5Y 5/4).

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. 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 five laboratories were each given eight randomly selected packages of sample. Twenty 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 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. BV Rustenburg (South Africa)
7. Genalysis Laboratory Services (South Africa) Pty
8. Genalysis Laboratory Services (W Australia P)
9. Intertek Utama Services (Indonesia)
10. Nkomati JV Laboratory SA
11. Samancor Ltd
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. 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	Cr F ppm	Cr M/ICP ppm	Cr P ppm	Cr XRF ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Ni M/ICP ppm	Ni P ppm	Ni XRF ppm
B	1.13	0.70	0.16	311	281	375				257943	790	782	983	2086	2008	2694
B	1.01	0.63	0.14	319	277	361				259996	786	789	959	2021	2043	2640
B	0.93	0.58	0.13	322	283	371				259996	787	792	1004	2024	2004	2757
B	1.03	0.65	0.14	318	294	377				252470	785	792	994	2022	2020	2727
B	1.08	0.64	0.13	313	283	379				263417	787	790	966	2005	2071	2641
B	1.09	0.65	0.14	316	278	364				257943	787	790	964	2004	2087	2623
B	0.97	0.61	0.13	316	273	375				263417	790	791	994	2089	2071	2710
B	0.92	0.56	0.15	317	279	369				264101	788	788	957	2055	2064	2606
C						350							680			2010
C						370							700			2070
C						370							720			2060
C						360							730			2040
C						360							690			2010
C						380							690			1910
C						370							710			2070
C						370							710			2060
D	1.14	0.71	0.15	279	121		261000				812	745		1900	1820	
D	1.23	0.73	0.12	281	127		269000				808	778		1870	1870	
D	1.12	0.70	0.12	274	125		266000				798	757		1850	1850	
D	1.17	0.71	0.13	291	125		259000				819	765		1920	1860	
D	1.11	0.70	0.15	286	122		267000				805	729		1940	1810	
D	1.16	0.71	0.13	294	124		264000				837	760		1950	1870	
D	1.18	0.72	0.14	294	125		258000				829	754		1950	1850	
D	1.17	0.70	0.11	290	126		261000				852	774		1960	1900	

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	Cr F ppm	Cr M/ICP ppm	Cr P ppm	Cr XRF ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Ni M/ICP ppm	Ni P ppm	Ni XRF ppm
E	1.13	0.66	0.15	210	110			132000			800	760		2020	1880	
E	1.05	0.64	0.13	220	110			134500			790	750		2000	1870	
E	1.10	0.64	0.13	220	120			143000			800	750		2040	1880	
E	1.09	0.65	0.14	240	120			157000			780	760		2010	1890	
E	1.11	0.65	0.13	230	120			155000			780	770		1980	1910	
E	1.11	0.67	0.14	210	120			131500			790	760		2000	1910	
E	1.14	0.67	0.14	220	120			141000			790	760		2000	1890	
E	1.06	0.64	0.12	220	120			149500			800	760		2020	1880	
F	0.69	0.38	0.10	298	121		272603			271983	732			1878	1798	
F	0.72	0.40	0.10	298	115		272261			271135	729			1891	1701	
F	0.69	0.38	0.13	299	121		274776			270663	729			1875	1688	
F	0.78	0.41	0.11	286	123		260531			270943	742			1917	1805	
F	0.69	0.37	0.11	291	118		263786			271614	731			1865	1752	
F	0.67	0.36	0.09	291	122		281918			270895	745			1905	1815	
F	0.82	0.44	0.10	287	121		268414			270273	750			1926	1639	
F	0.81	0.45	0.11	290	117		269566			270457	748			1914	1703	
G	1.10	0.59	0.18	279	118	300				275000	792	771	800	1782	1759	2100
G	1.04	0.57	0.20	267	120	400				275000	779	763	700	1719	1734	2000
G	1.05	0.57	0.16	274	118	300				275000	807	751	900	1815	1767	2000
G	1.02	0.55	0.19	279	118	200				273000	821	756	800	1781	1772	2100
G	1.06	0.56	0.19	273	120	400				264000	802	758	700	1761	1783	2000
G	1.01	0.56	0.26	273	121	400				269000	787	766	700	1752	1787	2000
G	1.05	0.55	0.16	264	119	300				265000	801	750	800	1715	1764	1900
G	1.03	0.55	0.21	284	117	300				275000	823	745	800	1798	1724	2000
H	1.01	0.62	0.13	265	112	306	258200	266000	4800	263000	778	771		1992	1889	2201
H	1.04	0.61	0.13	260	112	305	258900	265100	4800	257000	772	770		1990	1886	2175
H	1.01	0.59	0.13	260	110	309	262600	260000	4800	256000	777	769		1992	1890	2238
H	1.01	0.63	0.13	261	111	303	259400	265300	4800	252000	774	774		1990	1891	2214
H	1.10	0.63	0.14	264	113	318	259500	260100	5000	253000	776	780		2000	1900	2162
H	1.01	0.63	0.14	265	110	298	259000	260200	4800	250000	780	772		2008	1888	2169
H	1.04	0.61	0.16	262	110	282	260400	264400	4800	250000	770	769		1993	1880	2160
H	1.05	0.64	0.14	269	111	283	260000	262000	4800	247000	780	772		2008	1901	2162
J	0.94	0.59	0.15													
J	0.95	0.56	0.12													
J	0.96	0.59	0.12													
J	0.90	0.50	0.11													
J	0.99	0.59	0.13													
J	0.97	0.59	0.12													
J	0.89	0.63	0.11													
J	0.99	0.60	0.14													
M	1.11	0.66	0.14	296							779			1920		
M	1.05	0.64	0.14	295							731			1990		
M	1.10	0.67	0.15	281							771			1940		
M	1.11	0.67	0.16	264							781			1940		
M	1.08	0.64	0.14	292							756			1960		
M	1.10	0.67	0.16	276							768			1950		
M	1.08	0.66	0.14	265							722			1940		
M	1.08	0.66	0.14	278							766			1960		
N			0.14	322						266564	802			2060		
N			0.16	311						266770	791			2040		
N			0.15	323						266564	791			2030		
N			0.15	325						265128	802			2050		
N			0.14	314						267249	800			2030		
N			0.15	319						267454	787			1990		
N			0.14	322						266017	784			2000		
N			0.14	324						265470	783			1990		
O	1.07	0.68	0.14	286	145					269575	787	763		2030	1740	
O	1.08	0.68	0.13	281	144					270259	770	778		2050	1800	
O	1.07	0.67	0.14	278	150					269575	782	774		2000	1750	
O	1.08	0.66	0.13	274	145					270259	782	773		2000	1800	
O	1.09	0.68	0.13	266	136					269575	772	792		1990	1760	
O	1.10	0.66	0.14	271	146					270259	769	725		2080	1740	
O	1.09	0.67	0.14	267	153					269575	756	784		2010	1810	
O	1.08	0.62	0.13	264	139					269575	768	761		2090	1750	
Q	1.14	0.70	0.16			300				270000			900			2000
Q	1.14	0.66	0.16			300				275000			800			2100
Q	1.13	0.69	0.13			300				270000			800			2000
Q	1.10	0.66	0.13			300				273000			800			2100
Q	1.18	0.67	0.15			300				274000			800			2000
Q	1.19	0.68	0.13			300				270000			800			2100
Q	1.16	0.68	0.11			300				271000			800			2000
Q	1.11	0.66	0.17			300				272000			800			2100
S	1.08	0.63	0.15	266	125				3830		838	725		1920	1755	
S	1.07	0.61	0.14	274	125				3720		866	754		2030	1740	
S	1.12	0.64	0.15	267	126				3770		840	738		1950	1750	
S	1.10	0.62	0.15	278	125				3670		854	727		2030	1710	
S	1.11	0.63	0.14	269	122				3560		850	724		1990	1735	
S	0.99	0.59	0.13	275	124				3680		842	732		1980	1735	
S	0.97	0.56	0.13	271	125				3820		852	740		1980	1765	
S	1.12	0.62	0.14	272	124				3730		832	734		2020	1735	
T				325	130					262040	770	720		2040	1770	
T				302	140					264642	740	740		2037	1770	
T				315	140					259256	616	760		1997	1820	
T				322	140					264169	851	740		2034	1790	
T				353	140					271879	740	740		2097	1780	
T				300	140					266137	891	760		2077	1810	
T				329	140					269885	745	740		2031	1790	
T				334	140					270258	740	740		2044	1770	

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	Cr F ppm	Cr M/ICP ppm	Cr P ppm	Cr XRF ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Ni M/ICP ppm	Ni P ppm	Ni XRF ppm
U				310	130			237000		268891	770	740		2000	1820	
U				310	130			238000		267522	780	730		1990	1790	
U				300	130			243000		266154	780	750		1990	1840	
U				300	130			235000		267522	760	750		1940	1850	
U				310	130			246000		269575	770	760		2000	1870	
U				310	130			248000		265470	770	750		2000	1850	
U				300	130			246000		266838	770	760		1960	1860	
U				300	130			231000		267522	750	770		1920	1880	
W	1.01	0.60	0.13	325	139			265000		269575	815			2100	1960	
W	1.04	0.62	0.13	325	144			270000		270259	810			2100	1950	
W	1.00	0.58	0.13	330	145			263000		270259	810			2100	2040	
W	1.03	0.62	0.13	320	137			269000		270259	835			2060	1920	
W	1.03	0.60	0.13	325	137			265000		270259	820			2110	1900	
W	1.07	0.63	0.14	330	136			273000		268891	830			2140	1970	
W	1.01	0.61	0.14	325	145			268000		268891	825			2110	2030	
W	1.03	0.63	0.14	330	134			265000		269575	825			2120	1900	
X	0.87	0.48	0.09				255000			265743						
X	1.05	0.60	0.14				257000			265880						
X	0.79	0.45	0.11				251000			266085						
X	0.86	0.49	0.09				255000			266291						
X	0.91	0.52	0.12				257000			265538						
X	1.05	0.59	0.15				254000			266701						
X	0.92	0.54	0.15				261000			266770						
X	0.99	0.57	0.12				255000			266291						
Y				158	121			92400	3872		786	796		1907	1820	
Y				161	122			95100	3859		798	799		1990	1810	
Y				159	126			99400	3858		786	797		1909	1837	
Y				175	120			98500	3906		790	794		1827	1817	
Y				177	121			96300	3835		794	781		1899	1816	
Y				153	121			90100	3927		797	786		1860	1819	
Y				159	119			94300	3824		792	792		1847	1826	
Y				165	120			94700	3903		799	778		1879	1771	

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	12.20	0.45	37.70	24.20	0.18	10.50	0.30		8.78	0.56	3.37	0.82	4.03
B	12.10	0.45	38.00	23.60	0.18	10.20	0.28		9.01	0.55	1.55	0.84	4.03
B	12.80	0.45	38.00	23.90	0.19	10.50	0.30		9.27	0.55	1.58	0.83	4.04
B	12.40	0.44	36.90	24.20	0.18	9.98	0.32		9.09	0.54	1.53	0.84	4.03
B	12.70	0.47	38.50	24.10	0.19	10.30	0.32		9.51	0.56	1.57	0.85	4.04
B	12.70	0.49	37.70	23.60	0.18	10.30	0.32		9.04	0.55	1.55	0.83	4.03
B	12.10	0.47	38.50	24.10	0.19	10.40	0.29		9.29	0.56	1.52	0.85	4.03
B	11.80	0.46	38.60	24.30	0.18	10.50	0.30		8.86	0.56	1.43	0.84	4.04
C	12.13	0.42		24.27	0.17	10.79	0.25	0.04	8.90	1.06	1.12		3.90
C	12.23	0.43		25.13	0.17	10.97	0.26	0.03	9.10	0.77	1.12		3.88
C	12.09	0.42		25.43	0.18	10.93	0.25	0.04	9.00	0.67	1.10		3.85
C	12.25	0.43		24.95	0.18	10.90	0.25	0.02	9.00	0.79	1.16		3.90
C	12.14	0.43		24.33	0.17	10.84	0.25	0.02	9.00	1.07	1.15		3.88
C	12.24	0.43		24.83	0.19	10.86	0.24	0.03	8.90	0.79	1.18		3.90
C	12.07	0.44		24.99	0.18	10.86	0.25	0.04	8.90	0.80	1.15		3.87
C	12.14	0.44		24.97	0.18	10.91	0.26	0.04	8.90	0.73	1.15		3.91
E	13.05	0.46		27.78	0.19	11.50	0.24	0.14	10.40	0.62	1.09		3.89
E	13.10	0.46		28.49	0.19	11.55	0.25	0.13	9.96	0.63	1.08		3.88
E	13.20	0.47		28.76	0.19	11.70	0.25	0.15	9.97	0.63	1.06		3.87
E	12.90	0.46		27.83	0.19	11.40	0.23	0.13	9.66	0.61	1.06		3.91
E	13.30	0.47		28.75	0.19	11.80	0.24	0.16	10.05	0.64	1.05		3.83
E	13.40	0.47		28.69	0.20	11.80	0.24	0.16	10.05	0.64	1.06		3.89
E	13.15	0.47		28.46	0.19	11.65	0.24	0.14	9.89	0.63	1.06		3.89
E	13.20	0.47		28.11	0.19	11.60	0.24	0.13	9.93	0.62	1.07		3.89
F	12.14	0.50	39.75	25.13	0.19	10.47	0.27	0.03	9.20	0.59	1.19	0.79	3.90
F	12.23	0.51	39.63	24.99	0.19	10.32	0.27	0.03	9.30	0.60	1.16	0.79	3.98
F	12.36	0.50	39.56	24.94	0.19	10.47	0.26	0.04	9.16	0.59	1.19	0.82	3.98
F	12.29	0.50	39.60	24.94	0.19	10.39	0.27	0.04	9.26	0.59	1.14	0.78	3.98
F	12.23	0.51	39.70	25.04	0.19	10.64	0.27	0.04	9.25	0.59	1.18	0.78	4.00
F	12.17	0.50	39.59	24.98	0.19	10.51	0.27	0.04	9.29	0.59	1.15	0.78	3.91
F	12.27	0.51	39.50	25.03	0.19	10.36	0.27	0.04	9.24	0.59	1.20	0.79	3.94
F	12.29	0.51	39.53	24.97	0.19	10.38	0.27	0.02	9.26	0.60	1.19	0.82	4.07
G	12.12	0.52	38.46	24.95	0.20	10.51	0.25	0.17	9.03	0.58	1.16		
G	12.21	0.50	38.72	25.00	0.19	10.65	0.25	0.15	9.12	0.58	1.19		
G	12.07	0.48	38.53	24.95	0.21	10.52	0.25	0.15	9.08	0.58	1.19		
G	12.11	0.49	38.81	25.01	0.19	10.63	0.24	0.11	9.01	0.57	1.20		
G	12.42	0.51	38.84	25.22	0.19	10.64	0.25	0.16	9.16	0.58	1.16		
G	12.37	0.51	38.66	25.03	0.20	10.56	0.25	0.13	9.07	0.57	1.20		
G	12.43	0.52	39.00	25.08	0.20	10.70	0.25	0.10	9.22	0.58	1.22		
G	12.18	0.48	38.67	24.96	0.19	10.65	0.24	0.10	9.11	0.55	1.22		

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
H	12.21	0.51	39.60	25.00	0.11	10.40	0.25	0.03	8.40	0.58	1.21		4.00
H	12.47	0.51	39.43	25.10	0.11	10.51	0.25	0.02	8.45	0.58	1.20		4.01
H	12.21	0.51	39.65	25.13	0.11	10.35	0.25	0.01	8.45	0.57	1.19		4.00
H	12.41	0.52	39.77	25.08	0.11	10.52	0.25	0.02	8.50	0.58	1.22		4.00
H	12.26	0.50	39.71	24.95	0.11	10.33	0.25	0.02	8.36	0.58	1.17		4.01
H	12.29	0.50	39.64	25.01	0.11	10.48	0.25	0.02	8.34	0.57	1.18		4.00
H	12.49	0.53	39.72	25.04	0.11	10.45	0.25	0.02	8.37	0.58	1.19		4.00
H	12.59	0.50	39.57	24.97	0.12	10.53	0.25	0.03	8.38	0.57	1.19		4.01
L	12.41	0.51	40.65	26.63		10.99	0.26		9.75	0.61			
L	12.48	0.50	40.68	26.35		11.08	0.26		9.82	0.61			
L	12.42	0.44	40.45	26.73		11.02	0.27		9.89	0.61			
L	12.31	0.47	40.70	26.83		10.99	0.27		9.66	0.61			
L	12.40	0.45	40.68	26.62		11.05	0.27		9.74	0.61			
L	12.30	0.48	40.47	27.06		10.92	0.27		9.73	0.62			
L	12.29	0.43	40.64	26.76		11.07	0.27		9.76	0.61			
L	12.29	0.46	40.65	27.00		10.95	0.27		9.62	0.63			
M													4.14
M													4.12
M													4.16
M													4.17
M													4.15
M													4.13
M													4.12
M													4.14
N	12.20	0.50	38.96	24.82	0.18	10.56	0.25		9.16	0.59	0.90		
N	12.22	0.50	38.99	24.91	0.18	10.60	0.25		9.26	0.59	1.00		
N	12.18	0.51	38.96	24.99	0.18	10.63	0.25		9.13	0.58	1.10		
N	12.24	0.50	38.75	24.99	0.18	10.65	0.25		9.20	0.60	1.10		
N	12.16	0.51	39.06	24.99	0.18	10.66	0.25		9.08	0.57	1.10		
N	12.17	0.51	39.09	24.90	0.18	10.59	0.25		9.13	0.57	1.20		
N	12.18	0.51	38.88	24.90	0.18	10.66	0.25		9.14	0.58	1.10		
N	12.19	0.50	38.80	24.77	0.18	10.57	0.25		9.16	0.58	1.10		
O	12.10	0.43	39.40	25.10	0.19	10.60	0.25	0.06	9.17	0.58	1.31		
O	12.10	0.42	39.50	25.10	0.19	10.60	0.24	0.05	9.16	0.59	1.22		
O	12.10	0.43	39.40	25.10	0.19	10.60	0.25	0.05	9.14	0.60	1.23		
O	12.10	0.43	39.50	25.10	0.19	10.60	0.25	0.05	9.13	0.59	1.26		
O	12.10	0.43	39.40	25.10	0.18	10.60	0.24	0.06	9.21	0.59	1.26		
O	12.10	0.43	39.50	25.10	0.19	10.70	0.25	0.07	9.17	0.58	1.24		
O	12.10	0.42	39.40	25.10	0.18	10.50	0.25	0.06	9.14	0.59	1.27		
O	12.20	0.43	39.40	25.10	0.18	10.70	0.25	0.06	9.20	0.60	1.19		
Q	12.30	0.44	38.40	25.60	0.17	10.80	0.24	0.02	9.31	0.58	1.29		
Q	12.30	0.44	38.60	25.60	0.17	10.70	0.24	0.02	9.26	0.58	1.33		
Q	12.30	0.44	38.80	25.70	0.17	10.80	0.25	0.03	9.22	0.58	1.36		
Q	12.30	0.44	38.40	25.50	0.16	10.70	0.24	0.03	9.25	0.59	1.36		
Q	12.40	0.44	38.50	25.60	0.17	10.80	0.25	0.02	9.30	0.58	1.35		
Q	12.30	0.45	38.70	25.60	0.17	10.70	0.25	0.03	9.31	0.60	1.32		
Q	12.30	0.45	38.70	25.60	0.16	10.80	0.25	0.03	9.24	0.58	1.36		
Q	12.30	0.45	38.60	25.50	0.17	10.80	0.25	0.05	9.33	0.58	1.45		
R													4.04
R													4.12
R													4.09
R													4.05
R													4.11
R													4.04
R													4.07
R													4.06
S													4.10
S													4.09
S													4.09
S													4.09
S													4.09
S													4.08
S													4.09
S													4.09
T	11.95		38.30	24.87		10.48			9.16			0.74	
T	12.00		38.68	25.30		10.69			9.27			0.78	
T	11.81		37.89	24.63		10.61			9.08			0.79	
T	12.01		38.61	24.94		10.37			9.08			0.81	
T	12.31		39.74	25.08		10.32			9.15			0.79	
T	12.36		38.90	24.99		10.45			9.69			0.79	
T	11.98		39.45	24.51		10.51			9.25			0.79	
T	12.13		39.50	24.98		10.61			9.35			0.79	

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
U	12.35	0.49	39.30	25.10	0.19	10.80	0.25	0.21	9.27	0.58	1.14	0.76	3.97
U	12.25	0.48	39.10	24.90	0.17	10.60	0.24	0.21	9.13	0.58	1.13	0.77	3.98
U	12.25	0.48	38.90	24.80	0.19	10.70	0.25	0.20	9.21	0.58	1.14	0.75	3.91
U	12.30	0.48	39.10	25.00	0.17	10.65	0.24	0.20	9.23	0.58	1.21	0.75	3.96
U	12.35	0.48	39.40	25.20	0.19	10.80	0.25	0.22	9.24	0.59	1.25	0.78	3.90
U	12.25	0.48	38.80	25.00	0.17	10.65	0.24	0.19	9.15	0.57	1.22	0.76	3.90
U	12.35	0.48	39.00	24.90	0.19	10.75	0.25	0.21	9.20	0.57	1.15	0.77	3.86
U	12.35	0.48	39.10	24.90	0.19	10.75	0.25	0.21	9.22	0.58	1.25	0.76	3.95
W	12.20	0.50	39.40	24.90	0.19	10.50	0.25		9.15	0.59	1.17		4.15
W	12.20	0.49	39.50	24.90	0.19	10.50	0.25		9.16	0.59	1.17		4.17
W	12.20	0.50	39.50	24.90	0.19	10.50	0.25		9.15	0.59	1.16		4.17
W	12.20	0.50	39.50	24.90	0.19	10.50	0.25		9.16	0.58	1.18		4.11
W	12.20	0.50	39.50	24.90	0.19	10.60	0.25		9.15	0.58	1.17		4.11
W	12.20	0.50	39.30	24.80	0.19	10.50	0.25		9.16	0.59	1.16		4.14
W	12.10	0.49	39.30	24.90	0.19	10.50	0.25		9.16	0.58	1.18		4.13
W	12.20	0.50	39.40	24.90	0.19	10.50	0.25		9.15	0.58	1.17		4.13
X	12.24	0.51	38.84	25.02	0.18	10.52	0.25		9.21	0.53	1.58		4.04
X	12.24	0.49	38.86	24.97	0.17	10.47	0.25		9.18	0.53	1.59		4.02
X	12.24	0.48	38.89	24.86	0.18	10.49	0.25		9.17	0.53	1.55		4.03
X	12.26	0.51	38.92	24.85	0.19	10.56	0.25		9.46	0.54	1.56		4.02
X	12.18	0.50	38.81	24.91	0.18	10.51	0.25		9.26	0.53	1.50		4.02
X	12.20	0.48	38.98	25.00	0.19	10.48	0.25		9.10	0.53	1.58		4.02
X	12.32	0.48	38.99	24.87	0.19	10.45	0.26		9.11	0.52	1.57		4.04
X	12.22	0.49	38.92	24.91	0.17	10.51	0.25		9.11	0.52	1.51		4.02
Y													3.85
Y													3.90
Y													3.88
Y													3.89
Y													3.91
Y													3.92
Y													3.89
Y													3.90

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	0.061	0.042	0.038	0.013
Pd	PbColl	g/t	0.044	0.034	0.021	0.010
Au	PbColl	g/t	0.012	0.003	0.011	0.002
Co	M/ICP	ppm	22.39	17.91	7.132	5.223
Co	P	ppm	9.960	8.402	2.804	2.551
Cr	XRF	ppm	2845	1916	2065	684.8
Cu	M/ICP	ppm	19.92	14.38	9.12	4.264
Cu	P	ppm	19.99	15.51	11.04	5.060
Ni	M/ICP	ppm	62.0	43.52	29.42	12.42
Ni	P	ppm	65.64	52.40	26.71	16.06
Al ₂ O ₃	XRF	%	0.103	0.056	0.078	0.018
CaO	XRF	%	0.030	0.022	0.012	0.000
Cr ₂ O ₃	XRF	%	0.402	0.326	0.198	0.105
Fe ₂ O ₃	XRF	%	0.110	0.048	0.096	0.019
K ₂ O	XRF	%	0.008	0.005	0.006	0.002
MgO	XRF	%	0.145	0.104	0.073	0.031
MnO	XRF	%	0.005	0.002	0.004	0.001
Na ₂ O	XRF	%	0.050	0.055	0.013	0.021
SiO ₂	XRF	%	0.111	0.065	0.083	0.022
TiO ₂	XRF	%	0.015	0.012	0.007	0.004
LOI		%	0.081	0.069	0.034	0.022
SG	pycnometer		0.094	0.077	0.026	0.022

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: AMIS0323 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.

19 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	2.0	1.0	25.4	55
Al	M/ICP	%	6.1	1.5	12.6	80
As	M/ICP	ppm	138	50.3	18.2	69
Ba	M/ICP	ppm	32.7	8.6	13.1	75
Be	M/ICP	ppm	0.54	0.45	42.1	25
Bi	M/ICP	ppm	48.6	128	131	56
Ca	M/ICP	%	0.33	0.04	5.4	94
Cd	M/ICP	ppm	1.6	3.8	120	37
Ce	M/ICP	ppm	6.4	0.63	5.0	22
Co	XRF	ppm	336	77.6	11.5	39
Cr	F	ppm	261611	11758	2.2	31
Cr	M/ICP	ppm	201735	141807	35.1	40
Cr	P	ppm	4140	1006	12.1	24
Cs	M/ICP	ppm	0.62	0.06	5.0	23
Cu	XRF	ppm	817	219	13.4	32
Dy	M/ICP	ppm	0.53	0.11	10.2	16
Er	M/ICP	ppm	0.29	0.04	7.8	16
Eu	M/ICP	ppm	0.21	0.03	6.5	16
Fe	M/ICP	%	15.6	3.6	11.6	64
Ga	M/ICP	ppm	48.4	43.5	44.9	44
Gd	M/ICP	ppm	0.62	0.09	7.0	21
Hf	M/ICP	ppm	0.72	0.28	19.6	31
Ho	M/ICP	ppm	0.11	0.01	4.9	15
In	M/ICP	ppm	0.03	0.01	19.6	22
K	M/ICP	%	0.16	0.02	6.7	88
La	M/ICP	ppm	3.3	1.8	27.0	48
Li	M/ICP	ppm	36.1	8.5	11.7	64
Lu	M/ICP	ppm	0.05	0.02	20.5	23
Mg	M/ICP	%	6.0	1.2	9.9	88
Mn	M/ICP	ppm	1868	405	10.8	88
Mo	M/ICP	ppm	3.9	8.4	107	64
Na	M/ICP	%	0.04	0.04	41.7	88
Nb	M/ICP	ppm	3.4	7.7	112	36
Nd	M/ICP	ppm	2.9	0.16	2.7	16
Ni	XRF	ppm	2146	427	9.9	37
P	M/ICP	ppm	105	31.5	15.0	63
Pb	M/ICP	ppm	20.7	11.4	27.5	81
Pr	M/ICP	ppm	0.79	0.07	4.3	16
Rb	M/ICP	ppm	8.10	1.32	8.2	38
S	M/ICP	%	0.81	0.08	4.89	72
Sb	M/ICP	ppm	63.1	212	168	56
Sc	M/ICP	ppm	6.9	3.17	23.0	80
Se	M/ICP	ppm	12.5	13.7	54.6	24
Si	M/ICP	%	4.5	0.09	1.04	7
Sm	M/ICP	ppm	0.64	0.13	10.2	16
Sn	M/ICP	ppm	3.5	8.7	125	38
Sr	M/ICP	ppm	13.0	7.4	28.4	64
Ta	M/ICP	ppm	8.3	28.2	170	32
Tb	M/ICP	ppm	0.10	0.03	17.6	23
Te	M/ICP	ppm	0.73	0.18	12.3	31
Th	M/ICP	ppm	0.83	0.29	17.2	31
Ti	M/ICP	%	0.32	0.06	9.6	72
Tl	M/ICP	ppm	3.4	14.2	208	30
U	M/ICP	ppm	14.2	56.5	199	40
V	M/ICP	ppm	728	205	14.1	72
W	M/ICP	ppm	2.6	7.6	148	30
Y	M/ICP	ppm	2.2	1.41	31.7	62
Yb	M/ICP	ppm	0.87	1.95	113	32
Zn	M/ICP	ppm	725	203	14.0	72
Zr	M/ICP	ppm	22.4	17.2	38.3	72