



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

AMIS0315

Certified Reference Material

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

Certificate of Analysis

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

Certified Concentrations²

Pt Pb Collection	1.01	±	0.10	g/t
Pd Pb Collection	1.35	±	0.14	g/t
Cu M/ICP	1716	±	104	ppm
Cu P	1686	±	188	ppm
Cu XRF	1711	±	171	ppm
Ni P	4055	±	471	ppm
Ni XRF	4406	±	480	ppm
Specific Gravity	3.13	±	0.18	

Provisional Concentrations

Au Pb Collection	0.063	±	0.014	g/t
Co M/ICP	213	±	28	ppm
Co P	183	±	23	ppm
Co XRF	228	±	50	ppm
Ni M/ICP	4232	±	589	ppm

PGM 3E = 2.42 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	6.17	±	0.08	%
CaO	5.78	±	0.10	%
Cr ₂ O ₃	5.39	±	0.18	%
Fe ₂ O ₃	15.64	±	0.24	%
K ₂ O	0.57	±	0.02	%
MgO	19.57	±	0.28	%
MnO	0.19	±	0.01	%
SiO ₂	39.43	±	0.34	%
TiO ₂	0.35	±	0.01	%
S Combustion / LECO	2.55	±	0.08	%

Provisional Concentrations

Na ₂ O	0.46	±	0.10	%
LOI	5.02	±	1.14	%

1. **Intended Use:** AMIS0315 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 AMIS0315 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.

AMIS0315 is made from Main Mineralised Zone (MMZ) material, which is a heterogeneous unit consisting mainly of altered pyroxenites and harzburgites with calc-silicate xenoliths.

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. 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. Nineteen 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 19 out of 25 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. 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 (Ireland)
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 Lakefield (Canada)
16. SGS Toronto (Canada)
17. SGS Townsville (Australia)
18. SGS Vancouver (Canada)
19. Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 are set out below. 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
C	1.03	1.46	0.06	200	190		1700	1760		4330	4260	
C	0.98	1.44	0.07	200	200		1750	1820		4430	4450	
C	0.98	1.41	0.06	210	200		1750	1810		4480	4440	
C	0.97	1.42	0.05	200	190		1710	1780		4380	4370	
C	0.99	1.41	0.06	210	200		1750	1800		4430	4410	
C	0.96	1.39	0.05	200	190		1700	1760		4390	4310	
C	0.94	1.38	0.07	200	190		1690	1820		4310	4410	
C	0.99	1.43	0.06	200	190		1690	1750		4330	4350	
E	1.05	1.38	0.07	207	190		1760	1730			4440	
E	1.04	1.35	0.07	206	200		1780	1700			4410	
E	1.03	1.37	0.06	205	200		1750	1730			4500	
E	1.03	1.36	0.06	204	200		1760	1680			4380	
E	1.05	1.37	0.08	206	200		1780	1690			4460	
E	1.04	1.38	0.07	206	200		1760	1660			4360	
E	0.99	1.31	0.06	202	200		1730	1710			4320	
E	1.01	1.35	0.06	212	190		1790	1650			4330	

Assay data (cont): Economic elements

Lab Code	Pt PbColl g/t	Pd PbColl g/t	Au PbColl g/t	Co M/ICP ppm	Co P ppm	Co XRF ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Ni M/ICP ppm	Ni P ppm	Ni XRF ppm
F	0.93	1.17	0.06	207	169		1710	1660		3960	3700	
F	0.90	1.15	0.07	184	166		1530	1590		3510	3720	
F	0.90	1.15	0.06	185	171		1540	1710		3640	3750	
F	0.83	1.04	0.05	191	168		1530	1610		3740	3780	
F	0.86	1.11	0.06	193	170		1570	1590		3700	3740	
F	0.84	1.06	0.06	197	168		1590	1620		3770	3700	
F	0.91	1.13	0.06	192	168		1530	1640		3650	3710	
F	0.95	1.21	0.06	189	167		1600	1600		3640	3640	
G	0.95	1.21	0.07	210	179		1720	1810		4190	4160	
G	0.99	1.32	0.08	208	179		1700	1790		4050	4130	
G	0.81	1.24	0.05	215	179		1750	1825		4200	4150	
G	0.98	1.30	0.07	205	176		1700	1785		4080	4160	
G	0.96	1.24	0.07	212	177		1730	1815		4040	4110	
G	0.99	1.27	0.07	214	177		1765	1805		4160	4160	
G	0.98	1.28	0.09	208	177		1725	1770		4050	4050	
G	1.00	1.27	0.08	211	178		1720	1820		4090	4120	
H	0.81	1.10	0.06	236	195		1700	1860		4290	4370	
H	0.83	1.12	0.05	233	185		1660	1610		4330	4300	
H	0.83	1.07	0.06	225	193		1670	1760		4200	4340	
H	0.83	1.12	0.05	227	189		1680	1720		4120	4370	
H	0.75	1.07	0.06	229	192		1620	1740		4180	4290	
H	0.79	1.11	0.06	219	197		1740	1900		4050	4200	
H	0.79	1.10	0.05	221	185		1710	1740		4140	4000	
H	0.83	1.04	0.06	224	192		1730	1760		4150	4210	
J	1.01	1.35	0.07	229	217		1630	1740		4000	3160	
J	1.06	1.42	0.07	234	181		1630	1730		3880	4280	
J	1.07	1.44	0.06	239	173		1690	1770		4090	4300	
J	1.07	1.42	0.06	197	166		1640	1730		4160	4130	
J	1.03	1.40	0.06	180	176		1640	1700		3920	4100	
J	1.08	1.44	0.07	191	201		1650	1800		3950	4370	
J	1.06	1.41	0.07	210	200		1700	1710		4070	3080	
J	1.04	1.39	0.07	226	218		1650	1710		4060	3090	
K	0.74	1.01	0.05	174			1712			3450		
K	0.77	1.03	0.05	168			1674			3388		
K	0.57	0.78	0.04	160			1618			3280		
K	0.74	0.98	0.05	168			1605			3247		
K	0.38	0.48	0.02	173			1682			3408		
K	0.97	1.29	0.05	171			1691			3426		
K	0.83	1.11	0.06	168			1663			3374		
K	0.86	1.17	0.06	169			1714			3428		
L	0.98	1.35	0.05			200			1700			4300
L	1.04	1.42	0.07			200			1600			4300
L	1.03	1.40	0.07			200			1700			4300
L	1.02	1.40	0.07			200			1600			4300
L	1.01	1.35	0.08			300			1700			4300
L	1.02	1.37	0.07			200			1600			4300
L	1.02	1.39	0.06			200			1700			4300
L	1.02	1.40	0.06			200			1700			4300
O	1.07	1.42	0.07	209	181		1620	1559		4084	3706	
O	1.07	1.42	0.06	202	175		1505	1475		3790	3603	
O	1.07	1.45	0.07	212	181		1596	1544		3967	3722	
O	1.05	1.43	0.06	207	183		1575	1565		4020	3725	
O	1.05	1.44	0.06	210	184		1581	1533		4019	3718	
O	1.05	1.43	0.07	210	170		1578	1498		3977	3556	
O	1.06	1.45	0.08	205	183		1570	1533		3915	3717	
O	1.08	1.46	0.07	210	177		1582	1529		4018	3650	
P	1.02	1.32	0.06	196	194		1710	1780		3810	4400	
P	1.06	1.38	0.06	199	178		1670	1630		3830	4030	
P	0.98	1.36	0.06	202	177		1710	1640		3860	3880	
P	0.91	1.24	0.05	195	177		1670	1610		3760	3870	
P	0.93	1.26	0.06	195	177		1680	1640		3750	3990	
P	0.99	1.29	0.06	198	177		1680	1620		3830	3960	
P	1.05	1.38	0.07	194	178		1650	1630		3710	4000	
P	0.95	1.26	0.06	191	176		1650	1620		3710	3930	

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	0.95	1.41	0.06	241	174	260	1790	1560	1670	4741	4033	4600
Q	0.99	1.41	0.07	248	172	260	1817	1541	1630	4851	3980	4620
Q	0.96	1.34	0.06	242	172	250	1811	1542	1610	4788	3966	4440
Q	1.02	1.38	0.06	239	176	260	1750	1536	1570	4695	3896	4530
Q	0.97	1.40	0.07	236	176	260	1764	1576	1650	4712	4015	4590
Q	0.99	1.48	0.06	234	171	260	1769	1520	1670	4748	3840	4580
Q	1.03	1.37	0.06	235	169	260	1796	1511	1640	4804	3813	4530
Q	1.02	1.36	0.06	234	172	260	1798	1522	1630	4798	3845	4590
R	1.11	1.22	0.07	216	178	200	1735	1760	2000	4009	3934	4600
R	1.05	1.20	0.06	226	177	200	1848	1744	1800	4202	3872	4700
R	1.04	1.18	0.06	227	175	200	1860	1722	1800	4215	3881	4600
R	1.00	1.21	0.06	228	173	200	1867	1778	1900	4270	3883	4500
R	1.04	1.20	0.06	216	176	200	1762	1734	1900	4023	3943	4600
R	1.05	1.27	0.06	229	184	200	1861	1798	1800	4239	3966	4700
R	1.08	1.25	0.06	228	180	200	1878	1792	1800	4184	3988	4400
R	1.05	1.19	0.06	225	178	200	1838	1783	1800	4212	3879	4500
S	0.82	1.07	0.05	230			1680			4430		
S	0.92	1.23	0.05	230			1670			4380		
S	0.91	1.30	0.06	230			1680			4410		
S	0.97	1.30	0.06	220			1630			4320		
S	0.98	1.29	0.06	230			1670			4330		
S	0.73	0.96	0.05	250			1740			4470		
S	0.91	1.20	0.06	230			1740			4520		
S	0.95	1.26	0.06	230			1740			4390		
T	1.00	1.32	0.07			263			1850			4780
T	1.06	1.39	0.08			263			1830			4770
T	1.08	1.41	0.07			258			1830			4770
T	1.01	1.35	0.10			257			1820			4760
T	1.06	1.42	0.07			259			1810			4720
T	1.04	1.41	0.06			263			1840			4780
T	1.04	1.38	0.06			258			1840			4800
T	1.01	1.36	0.06			259			1830			4790
U	1.09	1.41	0.07	230	187		1800	1750		4400	4080	
U	1.05	1.37	0.08	210	180		1710	1720		4320	3980	
U	0.98	1.32	0.06	230	189		1760	1810		4390	4090	
U	1.05	1.42	0.07	225	188		1770	1740		4370	4080	
U	1.03	1.40	0.06	225	181		1720	1680		4310	3910	
U	1.09	1.44	0.07	225	187		1730	1740		4420	4000	
U	1.01	1.41	0.07	220	196		1810	1810		4330	4220	
U	1.01	1.37	0.06	230	187		1730	1760		4320	4070	
V				207	145		1740	1430		4600	3280	
V				211	146		1750	1450		4600	3330	
V				213	150		1730	1480		4560	3390	
V				215	148		1770	1470		4590	3360	
V				216	146		1740	1460		4550	3350	
V				214	148		1760	1460		4610	3340	
V				218	146		1730	1460		4580	3330	
V				215	147		1740	1480		4580	3370	
W	0.94	1.37	0.07						1622			4274
W	0.96	1.39	0.06						1605			4228
W	0.99	1.39	0.06						1580			4214
W	0.98	1.41	0.06						1631			4306
W	0.92	1.32	0.07						1663			4318
W	0.95	1.38	0.05						1625			4304
W	0.94	1.34	0.06						1623			4265
W	0.91	1.32	0.05						1644			4291
X				210	170	230	1640	1640	1760	4230	3960	4360
X				210	160	220	1630	1590	1680	4100	3810	4360
X				210	170	230	1650	1720	1670	4210	4220	4340
X				200	160	230	1640	1590	1680	4140	3780	4330
X				200	170	230	1620	1610	1720	4120	3920	4330
X				210	180	230	1710	1740	1740	4380	4200	4390
X				220	170	230	1710	1720	1720	4330	4140	4380
X				210	180	230	1670	1770	1740	4300	4180	4400

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
Y	0.99	1.35	0.06	200	200	217	1700	1700	1700	4500	4100	4000
Y	1.01	1.37	0.06	200	200	219	1800	1600	1700	4600	4100	4000
Y	1.01	1.34	0.07	200	200	211	1800	1600	1700	4500	4100	4000
Y	1.00	1.34	0.06	200	200	217	1800	1600	1700	4600	4100	4000
Y	1.04	1.34	0.06	200	200	221	1800	1600	1700	4600	4100	4000
Y	1.01	1.36	0.07	200	200	228	1700	1600	1700	4700	4000	4000
Y	1.01	1.33	0.06	200	200	219	1800	1600	1700	4500	4000	4000
Y	0.99	1.34	0.07	200	200	218	1700	1600	1700	4600	4000	4000

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
C	6.19	5.77	5.34	15.65	0.57	19.80	0.19	0.55	39.50	0.34	4.51		2.97
C	6.23	5.82	5.41	15.76	0.58	19.95	0.19	0.55	39.80	0.34	4.26		2.99
C	6.20	5.79	5.31	15.68	0.58	19.85	0.19	0.55	39.60	0.35	4.36		3.00
C	6.20	5.76	5.27	15.62	0.58	19.75	0.19	0.54	39.50	0.34	4.25		2.97
C	6.07	5.69	5.20	15.36	0.57	19.50	0.18	0.54	38.90	0.33	4.26		3.00
C	6.13	5.73	5.24	15.51	0.57	19.70	0.18	0.54	39.30	0.34	4.31		2.98
C	6.15	5.75	5.28	15.63	0.57	19.75	0.19	0.55	39.40	0.34	4.27		2.97
C	6.13	5.75	5.24	15.53	0.57	19.70	0.18	0.54	39.30	0.33	4.22		3.01
E	6.16	5.72	4.87	15.30	0.57	20.50	0.19	0.37	39.20	0.32		2.55	3.13
E	6.13	5.74	4.80	15.20	0.57	20.40	0.19	0.38	38.80	0.31		2.58	3.13
E	6.30	5.93	4.73	15.45	0.59	20.60	0.20	0.39	39.50	0.32		2.61	3.13
E	6.25	5.81	4.86	15.15	0.58	20.40	0.20	0.38	39.10	0.31		2.58	3.14
E	6.29	5.86	4.58	15.35	0.58	20.50	0.19	0.38	39.40	0.33		2.58	3.07
E	6.01	5.68	4.88	14.95	0.56	20.50	0.19	0.37	38.00	0.31		2.58	3.13
E	6.29	5.85	5.24	15.50	0.58	20.40	0.20	0.39	39.20	0.33		2.60	3.13
E	6.24	5.84	4.96	15.25	0.58	20.40	0.19	0.39	39.10	0.31		2.61	3.13
F												2.58	3.05
F												2.58	3.43
F												2.56	3.53
F												2.56	3.61
F												2.59	3.60
F												2.58	3.48
F												2.57	3.48
F												2.56	3.46
G													3.21
G													3.21
G													3.22
G													3.23
G													3.17
G													3.21
G													3.21
G													3.19
H	6.12	5.79	5.36	15.80	0.58	19.50	0.20	0.48	39.50	0.36	3.97		
H	6.16	5.79	5.36	15.80	0.58	19.50	0.19	0.48	39.60	0.36	3.95		
H	6.14	5.79	5.36	15.80	0.58	19.60	0.20	0.47	39.60	0.36	3.94		
H	6.13	5.78	5.36	15.70	0.58	19.50	0.19	0.48	39.50	0.37	3.97		
H	6.13	5.78	5.40	15.80	0.58	19.50	0.20	0.48	39.40	0.37	3.97		
H	6.16	5.77	5.35	15.80	0.58	19.50	0.20	0.48	39.50	0.36	4.00		
H	6.15	5.77	5.35	15.80	0.58	19.60	0.19	0.48	39.60	0.36	3.93		
H	6.17	5.77	5.37	15.80	0.58	19.40	0.20	0.48	39.50	0.37	4.08		
J												2.37	3.27
J												2.43	3.21
J												2.36	3.23
J												2.39	3.22
J												2.39	3.22
J												2.37	3.26
J												2.39	3.23
J												2.41	3.22

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
K												2.46	
K												2.49	
K												2.46	
K												2.50	
K												2.48	
K												2.47	
K												2.42	
K												2.51	
L	6.17	5.82	5.43	15.50	0.57	19.50	0.18	0.46	38.90	0.34	4.87	2.58	
L	6.22	5.81	5.44	15.60	0.57	19.60	0.18	0.47	39.10	0.34	4.96	2.58	
L	6.24	5.79	5.41	15.50	0.57	19.50	0.18	0.44	38.90	0.34	4.86	2.59	
L	6.21	5.76	5.38	15.50	0.57	19.40	0.19	0.45	38.70	0.34	4.93	2.59	
L	6.18	5.77	5.41	15.50	0.57	19.40	0.19	0.46	38.70	0.35	4.85	2.59	
L	6.20	5.75	5.36	15.40	0.57	19.40	0.18	0.45	38.70	0.34	4.83	2.57	
L	6.15	5.78	5.41	15.50	0.57	19.40	0.17	0.45	38.90	0.34	4.90	2.58	
L	6.14	5.77	5.40	15.40	0.57	19.30	0.18	0.44	38.60	0.34	4.95	2.60	
O													3.11
O													3.05
O													3.10
O													3.18
O													3.17
O													3.09
O													3.00
O													3.13
P												2.51	
P												2.55	
P												2.51	
P												2.51	
P												2.51	
P												2.52	
P												2.52	
Q	6.14	5.79	5.55	15.78	0.57	19.91	0.19	0.45	39.50	0.35	4.77		3.00
Q	6.21	5.80	5.56	15.78	0.57	19.96	0.19	0.45	39.50	0.36	4.78		3.01
Q	6.16	5.74	5.48	15.55	0.57	19.78	0.19	0.44	39.20	0.37	4.82		3.01
Q	6.11	5.72	5.47	15.52	0.57	19.72	0.19	0.45	39.20	0.37	4.84		2.99
Q	6.15	5.75	5.52	15.68	0.58	19.79	0.19	0.46	39.20	0.35	4.88		2.99
Q	6.16	5.77	5.52	15.72	0.57	19.87	0.18	0.44	39.40	0.35	4.88		3.00
Q	6.13	5.75	5.50	15.68	0.57	19.83	0.19	0.44	39.20	0.35	4.89		3.00
Q	6.10	5.76	5.49	15.60	0.58	19.76	0.19	0.45	39.20	0.37	4.87		3.01
R												2.47	
R												2.57	
R												2.59	
R												2.59	
R												2.57	
R												2.58	
R												2.62	
R												2.64	
S													3.23
S													3.14
S													3.18
S													3.29
S													3.15
S													3.18
S													3.22
S													3.03
T	6.09	5.72	5.25	15.81	0.54	19.16	0.20	0.25	39.19	0.37	5.92		3.15
T	5.97	5.78	5.50	15.61	0.56	19.51	0.20	0.43	39.78	0.35	5.85		3.16
T	5.81	5.72	5.46	15.51	0.56	19.55	0.19	0.42	39.41	0.35	5.89		3.16
T	5.84	5.72	5.46	15.51	0.55	19.57	0.20	0.40	39.11	0.36	5.86		3.16
T	5.87	5.73	5.48	15.55	0.56	19.64	0.20	0.47	39.34	0.34	5.93		3.15
T	6.03	5.77	5.49	15.65	0.55	19.57	0.19	0.44	39.35	0.36	5.88		3.17
T	5.98	5.69	5.45	15.54	0.55	19.50	0.19	0.37	39.59	0.35	5.85		3.15
T	5.68	5.65	5.43	15.41	0.56	19.45	0.19	0.42	39.48	0.34	5.84		3.16

Assay data (cont): Major elements

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb LECO %	SG pyc
U	6.16	5.84	5.36	15.70	0.58	19.50	0.21		39.42	0.35	5.28		3.19
U	6.18	5.84	5.36	15.68	0.58	19.50	0.20		39.41	0.35	5.29		3.25
U	6.18	5.85	5.37	15.70	0.58	19.49	0.20		39.41	0.35	5.30		3.21
U	6.18	5.84	5.38	15.66	0.58	19.50	0.20		39.43	0.35	5.29		3.20
U	6.18	5.84	5.39	15.65	0.58	19.52	0.20		39.49	0.35	5.29		3.20
U	6.18	5.86	5.38	15.70	0.58	19.53	0.20		39.52	0.35	5.29		3.20
U	6.18	5.86	5.38	15.73	0.58	19.53	0.20		39.48	0.35	5.30		3.25
U	6.18	5.85	5.37	15.66	0.58	19.52	0.20		39.45	0.35	5.31		3.22
V	6.14	6.04	5.33	15.72	0.59	19.57	0.19	0.42	39.47	0.36	5.10		
V	6.13	6.08	5.32	15.62	0.58	19.57	0.19	0.44	39.40	0.35	5.10		
V	6.16	6.12	5.44	15.72	0.59	19.65	0.19	0.42	39.55	0.36	5.10		
V	6.14	6.11	5.36	15.72	0.59	19.60	0.19	0.44	39.52	0.35	5.20		
V	6.19	6.06	5.25	15.71	0.59	19.64	0.19	0.43	39.64	0.35	4.90		
V	6.14	6.12	5.33	15.70	0.59	19.65	0.19	0.44	39.34	0.35	5.20		
V	6.14	6.06	5.43	15.69	0.58	19.62	0.19	0.41	39.42	0.35	5.10		
V	6.12	6.09	5.30	15.64	0.58	19.54	0.19	0.42	39.31	0.35	5.10		
W	6.13	5.66		16.10	0.52	19.80	0.18	0.48	39.50	0.34	5.32		3.22
W	6.12	5.66		14.80	0.52	19.90	0.18	0.49	39.50	0.34	5.32		3.27
W	6.11	5.65		14.80	0.52	19.80	0.18	0.48	39.60	0.34	5.27		3.24
W	6.19	5.72		15.00	0.52	20.00	0.18	0.49	39.80	0.34	5.22		3.26
W	6.16	5.74		15.00	0.52	20.00	0.18	0.49	40.00	0.35	5.29		3.24
W	6.21	5.73		15.00	0.52	20.00	0.18	0.48	40.00	0.35	5.24		3.23
W	6.15	5.71		14.90	0.52	20.00	0.18	0.48	39.70	0.34	5.25		3.20
W	6.16	5.72		15.00	0.52	19.90	0.18	0.49	40.00	0.35	5.33		3.25
X	6.21	5.79	5.24	15.50	0.55	19.40	0.19	0.47	39.50	0.36	4.87	2.50	3.01
X	6.22	5.78	5.22	15.48	0.55	19.40	0.19	0.47	39.60	0.35	4.84	2.47	3.06
X	6.20	5.76	5.22	15.43	0.55	19.40	0.19	0.49	39.50	0.36	4.85	2.50	3.06
X	6.22	5.77	5.24	15.42	0.55	19.35	0.19	0.49	39.40	0.36	4.84	2.49	3.05
X	6.21	5.76	5.21	15.40	0.56	19.35	0.19	0.49	39.40	0.35	4.89	2.59	3.04
X	6.22	5.81	5.28	15.56	0.57	19.40	0.19	0.47	39.40	0.34	4.87	2.51	3.03
X	6.21	5.80	5.29	15.57	0.56	19.45	0.19	0.48	39.60	0.36	4.82	2.51	3.04
X	6.23	5.81	5.29	15.58	0.57	19.40	0.19	0.44	39.40	0.34	4.84	2.53	3.04
Y	6.03	5.86	5.50	15.73	0.56	19.76	0.22	0.50	40.22	0.35	5.84	2.58	3.11
Y	6.01	5.89	5.52	15.77	0.56	19.70	0.22	0.52	40.60	0.36	5.83	2.56	3.10
Y	6.00	5.87	5.52	15.73	0.56	19.74	0.22	0.51	40.41	0.35	5.81	2.58	3.10
Y	6.01	5.82	5.46	15.59	0.56	19.43	0.22	0.50	40.08	0.35	5.80	2.56	3.11
Y	5.96	5.88	5.51	15.81	0.57	19.69	0.22	0.51	40.68	0.35	5.84	2.57	3.11
Y	6.09	5.83	5.46	15.64	0.57	19.66	0.22	0.52	40.51	0.35	5.78	2.57	3.10
Y	6.00	5.88	5.52	15.88	0.57	19.73	0.23	0.52	40.50	0.35	5.71	2.58	3.10
Y	6.01	5.82	5.46	15.63	0.57	19.53	0.22	0.52	40.50	0.35	5.79	2.58	3.10

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	0.049	0.029	0.031	0.008
Pd	PbColl	g/t	0.070	0.048	0.033	0.013
Au	PbColl	g/t	0.007	0.003	0.006	0.001
Co	M/ICP	ppm	13.9	9.19	6.44	2.45
Co	P	ppm	11.3	7.93	5.46	2.26
Co	XRF	ppm	24.9	30.6	3.0	12.5
Cu	M/ICP	ppm	51.9	33.1	31.9	9.7
Cu	P	ppm	93.8	67.4	42.3	19.1
Cu	XRF	ppm	85.4	89.1	33.5	34.0
Ni	M/ICP	ppm	294	219.9	77.0	59.2
Ni	P	ppm	235	171	97.8	48.5
Ni	XRF	ppm	240	269	49.0	102
Al ₂ O ₃	XRF	%	0.037	0.021	0.030	0.008
CaO	XRF	%	0.050	0.035	0.032	0.012
Cr ₂ O ₃	XRF	%	0.09	0.08	0.05	0.03
Fe ₂ O ₃	XRF	%	0.12	0.09	0.08	0.03
K ₂ O	XRF	%	0.011	0.009	0.005	0.003
MgO	XRF	%	0.14	0.11	0.07	0.04
MnO	XRF	%	0.007	0.006	0.004	0.002
Na ₂ O	XRF	%	0.05	0.04	0.01	0.01
SiO ₂	XRF	%	0.19	0.09	0.16	0.04
TiO ₂	XRF	%	0.007	0.004	0.005	0.002
LOI		%	0.57	0.53	0.05	0.17
S Comb/LECO		%	0.04	0.04	0.03	0.01
SG	pyc		0.09	0.07	0.03	0.02

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: AMIS0315 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.

06 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	0.79	0.49	30.6	63
Al	M/ICP	%	3.19	0.45	7.05	96
As	M/ICP	ppm	9.40	5.73	30.5	75
Ba	M/ICP	ppm	115	17.4	7.60	82
Be	M/ICP	ppm	0.28	0.10	18.1	31
Bi	M/ICP	ppm	1.26	3.26	129	61
Ca	M/ICP	%	4.00	0.41	5.10	88
Cd	M/ICP	ppm	0.48	0.66	69.0	44
Ce	M/ICP	ppm	12.6	2.24	8.89	40
Cr	M/ICP	ppm	23488	18227	38.8	40
Cs	M/ICP	ppm	2.81	0.39	6.95	32
Dy	M/ICP	ppm	1.40	0.14	4.95	16
Er	M/ICP	ppm	0.78	0.10	6.47	16
Eu	M/ICP	ppm	0.48	0.05	5.16	15
Fe	M/ICP	%	10.4	1.23	5.93	102
Ga	M/ICP	ppm	10.1	1.20	5.93	41
Gd	M/ICP	ppm	1.60	0.22	6.85	16
Ge	M/ICP	ppm	0.68	0.44	32.6	16
Hf	M/ICP	ppm	1.04	0.13	6.29	46
Ho	M/ICP	ppm	0.29	0.03	4.45	15
In	M/ICP	ppm	0.06	0.01	10.6	39
K	M/ICP	%	0.48	0.05	5.22	96
La	M/ICP	ppm	5.71	2.47	21.6	64
Li	M/ICP	ppm	24.3	3.75	7.72	69
Lu	M/ICP	ppm	0.10	0.05	25.9	24
Mg	M/ICP	%	11.4	0.95	4.13	85
Mn	M/ICP	ppm	1434	179	6.23	97
Mo	M/ICP	ppm	2.34	0.77	16.5	66
Na	M/ICP	%	0.34	0.03	4.72	96
Nb	M/ICP	ppm	3.80	0.71	9.30	43
Nd	M/ICP	ppm	6.58	0.31	2.38	15
P	M/ICP	ppm	1454	238	8.19	88
Pb	M/ICP	ppm	15.5	4.63	15.0	83
Pr	M/ICP	ppm	1.64	0.13	3.93	15
Rb	M/ICP	ppm	20.0	4.87	12.2	53
Re	M/ICP	ppm	0.02	0.01	17.3	15
S	M/ICP	%	2.51	0.23	4.50	72
Sb	M/ICP	ppm	63.7	212	166	62
Sc	M/ICP	ppm	14.5	1.84	6.35	101
Se	M/ICP	ppm	6.36	3.67	28.9	48
Si	M/ICP	%	18.4	0.19	0.52	7
Sm	M/ICP	ppm	1.51	0.14	4.56	16
Sn	M/ICP	ppm	1.46	0.57	19.4	47
Sr	M/ICP	ppm	66.9	12.6	9.39	88
Ta	M/ICP	ppm	0.18	0.07	19.9	46
Tb	M/ICP	ppm	0.20	0.11	28.1	24
Te	M/ICP	ppm	1.44	0.97	33.7	40
Th	M/ICP	ppm	1.11	0.21	9.48	45
Ti	M/ICP	%	0.19	0.05	12.3	83
Tl	M/ICP	ppm	0.21	0.04	8.54	37
Tm	M/ICP	ppm	0.11	0.02	8.43	16
U	M/ICP	ppm	1.36	14.2	520	49
V	M/ICP	ppm	168	79.9	23.8	102
W	M/ICP	ppm	0.90	0.24	13.2	43
Y	M/ICP	ppm	6.89	1.00	7.23	66
Yb	M/ICP	ppm	0.73	0.15	10.1	24
Zn	M/ICP	ppm	140	67.3	24.0	96
Zr	M/ICP	ppm	35.2	6.80	9.66	77