



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0384

Certified Reference Material

Ni 2.16% Cu 1.03% Co 0.12% Ultramafic AU *Certificate of Analysis*

Recommended Concentrations and Limits^{1, 2} *(at two Standard Deviations)*

Certified Concentrations

Ni Fus	21687	±	1509	ppm
Ni M/ICP	21662	±	1653	ppm
Ni P	21109	±	1199	ppm
Cu Fus	9970	±	442	ppm
Cu M/ICP	10303	±	474	ppm
Cu P	9979	±	439	ppm
Co Fus	1247	±	97	ppm
Co M/ICP	1271	±	90	ppm
Specific Gravity	3.86	±	0.14	

Provisional Concentrations

Co P	1223	±	198	ppm
Pd Pb Collection	0.089	±	0.016	g/t
Au Pb Collection	0.048	±	0.010	g/t

Indicated Mean

Pt Pb Collection 0.020 g/t

PGM 3E = 0.157 g/t

1. Manufacturers recommended limits for use of the material as control samples, based on two standard deviations, calculated using "Between Laboratory" statistics for treatment of the data for trivial, non-trivial and technically invalid results. See sections 1, 10 and 13.

2. There is additional certified major element data presented on p2 and uncertified trace element data presented as an appendix.

Major Element



Directors: GJ Horsfield (CEO), MD Evers (CFO)(British), A Buddingh, W Erasmus, Gerber, SJ Ingram
M McWha, N Robinson, V Singh (Alt), MH Snelling, D Steenkamp (Alt), J Vassiloudis

Recommended Concentrations and Limits (at two Standard Deviations)

Certified Concentrations

Al ₂ O ₃	3.95	±	0.14	%
CaO	0.87	±	0.06	%
Fe ₂ O ₃	56.11	±	3.48	%
K ₂ O	0.58	±	0.04	%
MgO	3.13	±	0.24	%
SiO ₂	19.20	±	0.34	%
TiO ₂	0.23	±	0.03	%
S Comb/LECO	22.86	±	0.82	%

Provisional Concentrations

Cr ₂ O ₃	0.11	±	0.03	%
MnO	0.09	±	0.01	%
Na ₂ O	0.33	±	0.06	%
LOI	9.92	±	1.62	%

1. Intended Use: AMIS0384 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 AMIS0384 was provided by SGS Minerals from the Savannah Nickel Mine (previously known as the Sally Malay Mine) which is owned and operated by Panoramic Resources Limited. The Sally Malay deposit is situated about 100 kilometres north of Halls Creek in Western Australia.

3. Mineral and Chemical Composition: The Sally Malay nickel deposit is hosted by one of an extensive suite of mafic and ultramafic intrusives within the late Palaeoproterozoic Halls Creek Mobile Zone in northern Western Australia, formed on the eastern margin of the Kimberley Block. The late Palaeoproterozoic host intrusive comprises a rhythmically layered body of olivine gabbro, troctolite, norite and minor anorthosites and other ultramafics, with ultramafic basal zones containing nickel sulphides. This intrusive was emplaced into granulite facies rocks, as were most of the mineralised intrusives in the district.

The ore is dominantly composed of pyrrhotite /chalcopyrite /pentlandite and occurs as two, steeply

dipping lenses of massive sulphide (>40% total sulphide) of 3 to 40 metres in thickness, hosted by the basal norite zone within the layered ultramafic complex.

4. Appearance: The material is a very fine powder. It is colored Greyish Black.

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. Fusion AAS.
5. Majors (Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, SiO₂, TiO₂. LOI.) XRF fusion.
6. S – combustion analysis.
7. SG – gas pycnometer

8. Information requested:

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported.
4. All results for individual PGM's to be reported in ppb.
5. All results for base metals to be reported in ppm.
6. Report all QC data, to include replicates, blanks and certified reference materials used.

9. Method of Certification: Twenty four laboratories were each given eight randomly selected packages of sample. Twenty of the laboratories submitted results in time for certification.

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a “t test” of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data. Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The “between-laboratory” standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory quality control.

This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed “Certified”, RSD’s of between near 5 % and 15 % are termed “Provisional”, and RSD’s over 15 % are termed “Informational”.

10. Participating Laboratories: The 20 out of 24 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. ALS Chemex Laboratory Group Brisbane Australia
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. ALS OMAC (Ireland)
7. Genalysis Laboratory Services (South Africa) Pty
8. Genalysis Laboratory Services (W Australia) P
9. Genalysis Zambia
10. Intertek Utama Services (Indonesia)
11. Labtium Inc Finland
12. Nkomati JV Laboratory SA
13. Set Point Laboratories (Isando) SA
14. SGS Australia Pty Ltd (Newburn) WA
15. SGS Geosol Laboratories Ltda (Brazil)
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booyens JHB
19. SGS Vancouver (Canada)
20. Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 are set out below.

Assay data – Economic Elements

Lab Code	Pt Pb Coll g/t	Pd Pb Coll g/t	Au Pb Coll g/t	Co Fusion ppm	Co M/ICP ppm	Co P ppm	Cu Fusion ppm	Cu M/ICP ppm	Cu P ppm	Ni Fusion ppm	Ni M/ICP ppm	Ni P ppm
C					1258	1309		10479	9857		20582	20244
C					1230	1291		10555	9898		20994	20408
C					1226	1331		10591	9874		20411	20048
C					1231	1334		10620	9880		20326	19982
C					1255	1301		10472	9917		20501	20062
C					1251	1331		10623	9866		21147	20030
C					1245	1312		10648	9910		20991	20107
C					1256	1311		10674	9897		20976	20105
D	0.02	0.09	0.05		1330	1325		10360			22630	
D	0.02	0.09	0.05		1360	1345		10580			23080	
D	0.01	0.09	0.05		1370	1252		10530			22920	
D	0.02	0.10	0.06		1340	1245		10450			22860	
D	0.03	0.09	0.05		1330	1229		10350			22460	
D	0.03	0.09	0.05		1340	1170		10560			22930	
D	0.03	0.10	0.06		1340	1225		10490			22790	
D	0.02	0.10	0.05		1330	1213		10380			22540	
E				1270	1230	1360	10200	9750		21300	22500	
E				1280	1290	1360	9690	10300		21300	23300	
E				1260	1340	1450	9970	10400		21100	22200	
E				1260	1300	1380	9990	9600		21500	23300	
E				1270	1290	1360	9840	9800		21600	23200	
E				1250	1160	1360	10200	10500		21500	21700	
E				1310	1260	1360	9760	9700		21700	22900	
E				1300	1180	1310	10500	10500		21800	21200	

Assay data (cont) – Economic Elements

Lab Code	Pt Pb Coll g/t	Pd Pb Coll g/t	Au Pb Coll g/t	Co Fusion ppm	Co M/ICP ppm	Co P ppm	Cu Fusion ppm	Cu M/ICP ppm	Cu P ppm	Ni Fusion ppm	Ni M/ICP ppm	Ni P ppm
F	0.01	0.08	0.05	1330	1270	1270	10250	10250	10150	22800	21700	21500
F		0.06	0.03	1330	1250	1270	10000	10350	10300	22000	21500	21700
F	0.02	0.08	0.04	1360	1250	1280	10500	10350	10100	22800	21600	21700
F	0.02	0.08	0.05	1260	1270	1260	9660	10400	9940	21300	21500	21200
F	0.02	0.08	0.05	1380	1270	1280	10150	10400	10100	23000	21700	21200
F	0.01	0.09	0.06	1300	1230	1270	9950	10200	10400	21700	21300	21700
F	0.02	0.08	0.05	1310	1220	1240	9990	10050	9970	21700	21000	21300
F	0.01	0.07	0.04	1370	1260	1210	9970	10450	10100	21900	21700	21300
H					1300			10550	10250		21600	21400
H					1290			10350	9800		21400	20600
H					1310			10500	10000		21600	21000
H					1280			10500	10000		21500	21000
H					1280			10400	9950		21500	20900
H					1280			10350	9980		21400	20900
H					1300			10500	10100		21700	21200
H					1290			10450	10000		21500	21000
I					1215			10100			20300	
I					1205			10000			20200	
I					1217			10400			20700	
I					1221			10200			20500	
I					1208			10400			20500	
I					1209			10000			20200	
I					1206			10000			20300	
I					1210			10200			20500	
K	0.02	0.08	0.04	1220	1210	1150	10200	10000	9840	21800	21900	20300
K	0.04	0.08	0.05	1260	1230	1170	10100	10000	9880	22100	21900	20300
K	0.02	0.10	0.04	1240	1230	1190	10000	10000	10300	21800	22000	20800
K	0.04	0.10	0.05	1240	1220	1210	10200	10200	10200	21800	21800	20900
K	0.02	0.10	0.04	1220	1210	1190	10100	10000	10100	22100	21900	20700
K	0.02	0.10	0.05	1240	1230	1160	10200	10200	9880	21900	21900	20200
K	0.04	0.12	0.04	1260	1210	1170	10200	10000	10100	22300	21700	20300
K	0.02	0.10	0.05	1260	1210	1210	10200	10200	9990	22000	21700	20800
L	0.01	0.08	0.09		1300	1220		10700	9880		22100	21100
L	0.02	0.08	0.09		1270	1210		10800	9880		21700	21100
L	0.01	0.09	0.09		1270	1210		10600	9880		21800	21000
L	0.01	0.08	0.08		1300	1210		10600	9810		22100	21000
L	0.01	0.09	0.08		1320	1210		10800	9820		22400	20900
L	0.01	0.08	0.09		1290	1210		10400	9800		21800	21000
L	0.01	0.08	0.08		1280	1210		10500	9900		22000	21000
L	0.01	0.08	0.08		1290	1210		10600	9840		21900	21000
M	0.04	0.10	0.07	1250			10300			21600		
M	0.03	0.10	0.06	1270			10500			21800		
M	0.03	0.10	0.08	1240			10300			21600		
M	0.03	0.10	0.08	1270			10500			21800		
M	0.03	0.10	0.07	1260			10400			21700		
M	0.03	0.10	0.07	1230			10200			21300		
M	0.03	0.10	0.07	1240			10300			21400		
M	0.03	0.09	0.07	1270			10400			21600		
N	0.03	0.09	0.05		1300	1290		10200	10450		21600	22100
N	0.02	0.09	0.05		1300	1240		10200	9860		21600	21300
N	0.02	0.09	0.05		1300	1280		10200	10350		21700	21900
N	0.02	0.09	0.04		1280	1260		10200	10350		21400	21600
N	0.02	0.09	0.04		1270	1320		10050	10650		21100	22800
N	0.02	0.09	0.05		1300	1300		10300	10400		21800	22500
N	0.02	0.09	0.05		1280	1290		10150	10450		21300	22000
N	0.02	0.09	0.05		1270	1260		10150	10150		21400	21400
O	0.13	0.17	0.07	1152	1378	1249		11549			23410	
O		0.11	0.06	1176	1354	1226		11818			23296	
O	0.05	0.11	0.08	1171	1320	1246		12030			23261	
O	0.05	0.12	0.08	1172	1300	1258		11734			23225	
O	0.05	0.13	0.07	1168	1327	1249		11798			23200	
O		0.12	0.07	1180	1364	1267		11897			23692	
O	0.06	0.13	0.09	1156	1338	1211		11748			23650	
O	0.05	0.15	0.05	1179	1325	1290		11670			23752	
P	0.02	0.10	0.05		1270	1330		10000	9870		21100	21500
P	0.02	0.10	0.06		1230	1350		9860	9930		20800	21400
P	0.03	0.10	0.05		1310	1350		10350	10050		21800	21500
P	0.02	0.10	0.05		1300	1330		10200	9850		21800	21000
P	0.02	0.10	0.06		1290	1330		10150	9950		21500	21200
P	0.02	0.10	0.05		1240	1350		9790	10000		20600	21500
P	0.03	0.10	0.05		1250	1350		9830	9970		20800	21000
P	0.02	0.10	0.05		1290	1330		10050	9940		21400	21000

Assay data (cont) – Economic Elements

Lab Code	Pt Pb Coll g/t	Pd Pb Coll g/t	Au Pb Coll g/t	Co Fusion ppm	Co M/ICP ppm	Co P ppm	Cu Fusion ppm	Cu M/ICP ppm	Cu P ppm	Ni Fusion ppm	Ni M/ICP ppm	Ni P ppm
Q				1072		1079	9759		9578	20158		19000
Q				1014		1070	9915		9807	20245		19300
Q				1030		1111	9756		9817	20369		19400
Q				1049		1081	9951		9786	21141		19300
Q				1056		1097	9759		9795	20237		19500
Q				1047		1080	9796		9497	20095		19400
Q				1091		1087	9684		9648	20325		19700
Q				1016		1077	9676		9648	20857		19500
R				1200	1200			9600			23100	
R					1200			9700			23200	
R					1200			9600			22600	
R					1300			9600			22700	
R					1200			9700			22700	
R					1300			9700			22800	
R					1200			9700			22900	
R					1200		9700	9700			22800	
S				1300		1090	10000		9940	21800		
S				1300		1050	10000		9780	22100		
S				1300		1080	9800		9960	20900		
S				1300		925	10100			22100		
S				1200		1080	9200			19600		
S				1300		1050	10000			22200		
S				1200		1070	9800		9780	20800		
S				1300		1070	10100			22300		
T	0.02	0.08	0.05		1300	1300		10350	10200		21600	22000
T	0.02	0.09	0.06		1320	1310		10400	10250		22200	21800
T	0.02	0.08	0.04		1320	1320		10400	10200		22100	22000
T	0.02	0.08	0.04		1310	1300		10450	10200		21900	21600
T	0.02	0.09	0.04		1330	1330		10600	10100		22300	21900
T	0.02	0.09	0.06		1310	1340		10350	10400		22100	22300
T	0.02	0.09	0.05		1310	1320		10400	10350		21700	22000
T	0.02	0.08	0.05		1370	1300		10150	10400		22700	21800
U				1200		1074	10100		8805	21800		
U				1100		1047	10400		8605	21900		
U				1200		1048	10100		8781	22300		
U				1100		1091	10000		8832	21700		
U				1100		1077	9900		8908	22100		
U				1200		1036	10200		8640	21800		
U				1200		1060	9800		8839	21700		
U				1200		1062	9900		9063	21900		
V	0.02	0.09	0.05	1241	1401	1116	9933	10488		20568		
V	0.02	0.09	0.06	1223	1419	1166	10121	10364		20323		
V	0.02	0.09	0.06	1262	1408	1173	10049	10289		21535		
V	0.02	0.09	0.05	1280	1391	1127	10000	10333		21598		
V	0.02	0.09	0.05	1291	1432	1118	9627	10458		20345		
V	0.02	0.09	0.04	1289	1446	1163	10066	10458		21804		
V	0.02	0.09	0.05	1277	1403	1163	9933	10236		21435		
V	0.02	0.09	0.05	1242	1420	1098	9746	10348		20919		
W	0.01	0.09	0.04		1210			9830			20800	
W	0.01	0.08	0.05		1220			9930			20400	
W	0.01	0.08	0.04		1220			9920			21100	
W	0.01	0.08	0.05		1210			9810			20800	
W	0.01	0.08	0.05		1220			9920			21000	
W	0.02	0.09	0.06		1210			9830			20900	
W	0.01	0.08	0.05		1210			9840			20700	
W	0.01	0.08	0.04		1230			9970			21000	
X	0.03	0.13	0.03		1044	927		10442	9650		17249	15950
X	0.04	0.12	0.04		1069	923		10410	9560		17375	15950
X	0.03	0.13	0.04		1016	940		10230	9680		16808	15860
X	0.03	0.13	0.03		1011	956		10410	9850		16889	16280
X	0.03	0.12	0.03		1046	943		10380	9930		17096	16210
X	0.03	0.13	0.03		1036	937		10390	9520		17105	15660
X	0.03	0.12	0.03		1047	962		10860	9870		17224	16450
X	0.03	0.12	0.03		1055	958		10930	9690		17312	16560

Assay data (cont) Major Oxides

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
C	3.84	0.88	0.10	57.4		2.72			18.9				
C	3.90	1.04	0.09	57.3		2.76			19.1				
C	3.87	0.96	0.08	57.7		2.74			19.0				
C	3.85	1.10	0.08	57.1		2.74			19.1				
C	3.78	1.08	0.09	56.9		2.74			18.9				
C	3.92	1.14	0.09	57.8		2.79			19.0				
C	3.93	1.18	0.09	57.7		2.78			19.4				
C	3.90	1.01	0.12	58.1		2.79			19.4				
D	3.97	0.87	0.12	56.9	0.59	3.22	0.10	0.28	19.3	0.22	9.98	22.9	3.78
D	3.95	0.87	0.12	57.1	0.59	3.20	0.10	0.28	19.3	0.23	10.1	23.1	3.77
D	3.94	0.87	0.12	56.7	0.59	3.21	0.10	0.28	19.2	0.22	10.1	22.4	3.76
D	3.96	0.89	0.12	56.7	0.60	3.25	0.10	0.29	19.4	0.23	10.0	23.1	3.76
D	3.95	0.86	0.12	56.7	0.59	3.20	0.10	0.27	19.2	0.22	9.86	23.2	3.78
D	3.94	0.87	0.12	56.7	0.58	3.20	0.10	0.27	19.1	0.22	9.94	23.1	3.76
D	3.96	0.86	0.12	56.8	0.59	3.25	0.09	0.29	19.3	0.22	9.90	22.7	3.77
D	3.97	0.86	0.12	56.9	0.59	3.22	0.10	0.28	19.2	0.22	9.87	22.8	3.80
E	3.98	0.86	0.12	56.1	0.58	3.18	0.10	0.35	19.1	0.24	8.13	23.2	
E	3.96	0.86	0.12	56.1	0.58	3.16	0.10	0.35	19.1	0.24	8.52	23.2	
E	3.97	0.86	0.12	56.1	0.58	3.16	0.09	0.34	19.0	0.24	8.37	23.2	
E	3.96	0.86	0.12	56.0	0.58	3.16	0.10	0.35	19.0	0.24	8.53	23.1	
E	4.03	0.86	0.12	56.1	0.58	3.16	0.10	0.36	19.1	0.24	8.29	23.6	
E	3.99	0.86	0.12	56.2	0.57	3.20	0.10	0.33	19.1	0.25	7.61	22.4	
E	3.96	0.86	0.12	56.0	0.58	3.18	0.10	0.35	19.1	0.25	8.28	22.9	
E	3.96	0.86	0.12	56.0	0.58	3.18	0.10	0.36	19.0	0.25	8.56	22.8	
F	4.02	0.95	0.12	58.2	0.60	3.20	0.09	0.32	19.8	0.23		24.6	
F	3.92	0.97	0.12	56.9	0.60	3.12	0.09	0.32	19.3	0.23		24.7	
F	4.06	0.95	0.12	58.6	0.60	3.20	0.09	0.32	20.0	0.24		24.5	
F	3.77	0.96	0.12	54.6	0.60	3.01	0.09	0.32	18.5	0.22		24.7	
F	3.93	0.98	0.13	57.0	0.60	3.13	0.10	0.32	19.2	0.23		24.8	
F	3.85	1.02	0.12	55.5	0.60	3.08	0.09	0.32	18.8	0.22		24.7	
F	3.86	1.00	0.12	55.5	0.60	3.06	0.09	0.31	18.7	0.22		24.7	
F	3.88	0.99	0.12	55.9	0.60	3.08	0.09	0.32	18.8	0.22		24.4	
H	4.03	0.88	0.13	55.9	0.59	3.30	0.12	0.32	19.5	0.27		25.0	3.81
H	4.01	0.87	0.13	56.0	0.59	3.28	0.12	0.31	19.5	0.26		24.4	3.74
H	3.94	0.85	0.12	55.5	0.59	3.23	0.12	0.32	19.3	0.26		23.8	3.85
H	3.98	0.86	0.13	55.3	0.59	3.25	0.12	0.32	19.2	0.28		24.3	3.82
H	3.95	0.87	0.13	55.8	0.59	3.27	0.12	0.32	19.4	0.28		25.0	3.85
H	3.97	0.87	0.13	55.3	0.59	3.25	0.12	0.31	19.4	0.28		25.8	3.74
H	3.98	0.86	0.13	55.9	0.58	3.30	0.12	0.32	19.5	0.25		24.7	3.81
H	3.93	0.87	0.13	56.0	0.58	3.27	0.12	0.32	19.2	0.24		27.2	3.74
I													3.84
I													3.80
I													3.57
I													3.78
I													3.76
I													3.77
I													3.80
I													3.86
K	3.97	0.86	0.11	56.0	0.58	3.27	0.10	0.34	19.3	0.24	10.9	22.8	3.81
K	3.96	0.86	0.11	56.1	0.59	3.27	0.10	0.34	19.2	0.25	10.9	23.1	3.85
K	4.00	0.87	0.12	56.1	0.59	3.29	0.10	0.34	19.3	0.24	10.8	23.1	3.83
K	3.97	0.87	0.12	56.2	0.59	3.30	0.10	0.34	19.3	0.25	10.8	22.9	3.83
K	3.98	0.87	0.12	56.2	0.58	3.30	0.10	0.34	19.3	0.25	10.9	22.9	3.82
K	3.97	0.87	0.11	56.1	0.58	3.27	0.10	0.34	19.3	0.24	10.9	22.9	3.86
K	3.97	0.87	0.12	56.2	0.58	3.27	0.10	0.34	19.3	0.24	10.9	22.8	3.86
K	3.99	0.87	0.12	56.1	0.58	3.29	0.10	0.34	19.3	0.25	10.9	22.8	3.84
L												22.0	3.96
L												22.2	3.95
L												22.3	4.06
L												22.3	4.04
L												22.0	3.88
L												22.3	3.97
L												22.3	3.98
L												21.8	3.92
M												22.9	
M												23.0	
M												23.0	
M												23.0	
M												23.0	
M												22.8	
M												22.9	
M												22.9	

Assay data (cont) Major Oxides

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
N												23.8	3.99
N												23.1	3.87
N												23.7	4.01
N												22.9	3.98
N												23.5	3.83
N												23.6	3.86
N												22.9	3.86
N												23.6	3.83
O	4.08	0.89	0.13	55.7	0.56	3.19	0.10	0.40	19.6	0.24	10.3	22.9	3.87
O	4.08	0.88	0.13	55.8	0.56	3.19	0.10	0.38	19.3	0.24	10.1	22.6	3.88
O	4.08	0.88	0.13	55.8	0.55	3.16	0.10	0.37	19.1	0.24	10.3	22.7	3.87
O	3.96	0.87	0.11	55.6	0.55	3.13	0.10	0.37	19.1	0.23	10.2	22.3	3.90
O	4.00	0.89	0.14	55.9	0.55	3.17	0.10	0.38	19.3	0.24	10.1	22.4	3.88
O	3.98	0.89	0.14	55.1	0.55	3.14	0.10	0.35	19.1	0.23	10.2	22.7	3.90
O	4.07	0.90	0.13	56.0	0.56	3.20	0.10	0.38	19.5	0.23	10.2	22.2	3.88
O	3.94	0.89	0.14	55.8	0.55	3.15	0.10	0.37	19.2	0.23	10.2	22.1	3.87
P			0.10		0.57	3.03	0.09	0.34				22.4	3.87
P			0.10		0.54	3.02	0.09	0.34				22.9	3.90
P			0.10		0.59	3.12	0.10	0.35				22.2	3.88
P			0.10		0.58	3.12	0.10	0.35				22.8	3.89
P			0.10		0.58	3.08	0.09	0.34				22.9	3.90
P			0.10		0.55	2.98	0.09	0.34				22.5	3.88
P			0.10		0.55	2.98	0.09	0.34				23.0	3.85
P			0.10		0.58	3.07	0.09	0.34				22.7	3.85
Q												23.0	3.52
Q												22.6	3.54
Q												22.9	3.57
Q												23.2	3.59
Q												23.2	3.52
Q												22.6	3.55
Q												23.3	3.58
Q												22.8	3.54
S												22.3	3.92
S												21.9	3.91
S												22.5	3.94
S												22.3	3.91
S												22.6	3.90
S												22.5	3.93
S												22.7	3.92
S												22.6	3.91
T												23.7	3.80
T												24.4	3.78
T												24.4	3.83
T												23.9	3.80
T												24.4	3.75
T												24.8	3.78
T												24.2	3.82
T												24.4	3.78
U												22.8	
U												23.8	3.91
U												23.4	4.02
U												23.7	3.98
U												23.5	4.01
U												23.7	3.97
U												22.5	4.10
U												23.6	3.94
V			0.09		0.58	2.96	0.09	0.31		0.20		23.6	3.90
V			0.09		0.57	2.90	0.09	0.30		0.20		23.9	3.82
V			0.09		0.57	2.92	0.09	0.30		0.20		23.4	3.83
V			0.09		0.56	2.90	0.08	0.30		0.20		23.6	3.89
V			0.09		0.58	2.97	0.09	0.31		0.20		23.8	3.93
V			0.09		0.57	2.93	0.09	0.30		0.20		23.2	3.89
V			0.09		0.56	2.87	0.09	0.30		0.20		23.4	3.84
V			0.09		0.58	2.99	0.08	0.31		0.21		23.4	3.79
W												22.8	
W												22.9	
W												22.6	
W												22.7	
W												22.7	
W												22.9	
W												22.9	
W												22.6	
X	3.74	0.84	0.07	55.2	0.54	3.01	0.08		17.9	0.23	10.1	22.6	3.87
X	3.84	0.84	0.07	55.8	0.54	3.02	0.09		17.9	0.23	9.94	22.6	3.83
X	3.78	0.84	0.07	55.8	0.53	2.98	0.08		17.8	0.23	9.87	22.4	3.84
X	3.78	0.82	0.07	54.8	0.54	2.93	0.08		17.5	0.23	9.95	22.8	3.87
X	3.83	0.85	0.07	55.7	0.54	3.00	0.08		17.9	0.23	10.0	22.4	3.83
X	3.77	0.83	0.07	54.9	0.53	2.94	0.08		17.5	0.22	9.89	22.7	3.86
X	3.89	0.84	0.07	54.8	0.54	2.95	0.08		17.8	0.23	9.88	22.5	3.88
X	3.85	0.83	0.07	54.9	0.53	2.94	0.09		17.6	0.23	10.0	22.6	3.83

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	S _w ³	CSU ⁴
Pt	Pb Coll	g/t	0.006	0.005	0.002	0.002
Pd	Pb Coll	g/t	0.008	0.006	0.004	0.002
Au	Pb Coll	g/t	0.005	0.002	0.004	0.001
Co	Fusion	ppm	48.3	36.8	28.9	12.8
Co	M/ICP	ppm	44.8	31.8	20.3	9.1
Co	P	ppm	98.9	74.2	24.5	20.0
Cu	Fusion	ppm	221.2	163.0	141.2	57.0
Cu	M/ICP	ppm	236.8	166.5	113.3	47.5
Cu	P	ppm	219.4	154.4	125.6	48.6
Ni	Fusion	ppm	754.4	628.8	403.1	215.0
Ni	M/ICP	ppm	826.4	606.3	331.0	171.3
Ni	P	ppm	599.7	580.4	224.6	207.2
Al ₂ O ₃	XRF	%	0.071	0.057	0.044	0.021
CaO	XRF	%	0.044	0.048	0.012	0.018
Cr ₂ O ₃	XRF	%	0.015	0.014	0.006	0.005
Fe ₂ O ₃	XRF	%	0.736	0.653	0.380	0.236
K ₂ O	XRF	%	0.015	0.015	0.006	0.005
MgO	XRF	%	0.121	0.114	0.036	0.038
MnO	XRF	%	0.007	0.007	0.004	0.002
Na ₂ O	XRF	%	0.025	0.025	0.006	0.009
SiO ₂	XRF	%	0.174	0.112	0.142	0.047
TiO ₂	XRF	%	0.013	0.014	0.005	0.005
LOI		%	0.809	1.107	0.096	0.495
S	Comb/LECO	%	0.415	0.250	0.255	0.071
SG	pyc		0.067	0.044	0.036	0.013

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 S_w - Within Lab Stc Dev, for use to calculate a measure of precision.

4 CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.

13. Certified values: The Certified, Provisional and Indicated values listed on p1 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Dr Barry Smees.

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: AMIS0384 is a new material.

16. Period of validity: The certified values are valid for this product, while still sealed in its original packaging, until notification to the contrary. The stability of the material will be subject to continuous testing for the duration of the inventory. Should product stability become an issue, all customers will be notified and notification to that effect will be placed on the www.amis.co.za website.

17. Minimum sample size: The majority of laboratories reporting used a 0.5g sample size for the ICP and a 30g sample size for the fire assay. These are the recommended minimum sample sizes for the use of this material.

18. Availability: This product is available in Laboratory Packs containing 1kg of material or Explorer Packs containing custom weights (from 50 to 250g) of material. Laboratory Packs are sealed bottles delivered in sealed foil pouches. Explorer Packs contain material in standard geochem envelopes, nitrogen flushed and vacuum sealed in foil pouches.

19. Recommended use: The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods; notwithstanding the underlying assumption that what the good inter-laboratory labs reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should therefore set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

20. Legal Notice: This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

16 January 2014

Revision: 002

Date of revision: 27 January 2020

Reason for new report: Amendment of COA name

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	2.3	0.51	11.2	46
Al	M/ICP	%	2.1	0.21	5.1	62
As	M/ICP	ppm	6.9	3.4	24.7	20
Be	M/ICP	ppm	0.78	0.66	42.4	16
Ca	M/ICP	%	0.59	0.07	5.6	63
Cd	M/ICP	ppm	1.5	0.12	4.0	23
Ce	M/ICP	ppm	32.1	3.0	4.7	16
Cr	M/ICP	ppm	659	171	13.0	64
Cs	M/ICP	ppm	0.73	0.09	6.2	16
Dy	M/ICP	ppm	1.5	0.11	3.7	8
Er	M/ICP	ppm	0.84	0.06	3.8	8
Fe	M/ICP	%	39.2	3.0	3.8	56
Ga	M/ICP	ppm	6.6	0.75	5.6	16
Hf	M/ICP	ppm	0.53	0.14	12.9	24
Ho	M/ICP	ppm	0.31	0.02	3.3	8
In	M/ICP	ppm	0.26	0.03	6.4	22
K	M/ICP	%	0.48	0.04	4.5	62
La	M/ICP	ppm	16.5	2.3	7.0	24
Li	M/ICP	ppm	5.7	1.1	9.3	30
Mg	M/ICP	%	1.8	0.19	5.3	56
Mn	M/ICP	ppm	726	90.3	6.2	56
Mo	M/ICP	ppm	6.2	1.2	9.6	24
Na	M/ICP	%	0.24	0.03	6.2	56
Nb	M/ICP	ppm	3.8	2.1	28.1	29
P	M/ICP	ppm	131	25.6	9.8	45
Pb	M/ICP	ppm	21.8	10.8	24.7	50
Pr	M/ICP	ppm	3.2	0.06	1.0	8
Rb	M/ICP	ppm	22.8	5.4	11.8	24
Re	M/ICP	ppm	0.14	0.06	21.0	24
S	M/ICP	%	21.3	3.0	7.1	24
Sb	M/ICP	ppm	3.5	11.1	160	32
Sc	M/ICP	ppm	5.5	1.0	9.2	60
Se	M/ICP	ppm	35.8	9.4	13.1	24
Si	M/ICP	%	9.0	0.08	0.5	8
Sm	M/ICP	ppm	1.9	0.11	2.8	8
Sn	M/ICP	ppm	1.9	0.21	5.4	22
Sr	M/ICP	ppm	42.9	5.4	6.3	38
Ta	M/ICP	ppm	0.74	1.8	120	23
Tb	M/ICP	ppm	0.24	0.02	3.9	8
Te	M/ICP	ppm	1.5	0.26	8.7	23
Th	M/ICP	ppm	3.5	0.55	7.9	24
Ti	M/ICP	%	0.13	0.02	7.4	32
Tl	M/ICP	ppm	0.22	0.04	8.1	15
U	M/ICP	ppm	1.7	0.19	5.7	24
V	M/ICP	ppm	85.3	26.7	15.7	56
W	M/ICP	ppm	0.48	0.33	34.1	16
Y	M/ICP	ppm	8.5	0.66	3.9	31
Yb	M/ICP	ppm	0.8	0.05	2.8	8
Zn	M/ICP	ppm	118	64.1	27.2	53
Zr	M/ICP	ppm	17.9	2.3	6.4	15