

# AMIS0458

## *Certified Reference Material*

### Platinum (PGM), Merensky Ore Waterval, South Africa

#### *Certificate of Analysis*

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

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

Pt Pb Collection	66.33	±	4.79	g/t
Pd Pb Collection	28.76	±	2.59	g/t
Au Pb Collection	3.33	±	0.33	g/t
Co M/ICP	547	±	60	ppm
Cu M/ICP	1.54	±	0.17	%
Cu XRF	1.67	±	0.17	%
Ni M/ICP	2.45	±	0.15	%
Ni XRF	2.63	±	0.27	%
Specific Gravity	3.31	±	0.11	

##### *Provisional Concentrations*

Co P	506	±	66	ppm
Pb M/ICP	238	±	38	ppm

##### *Informational Concentration*

Cr M/ICP 3585 ppm

<sup>3E</sup> (Pt, Pd, Au (all Pb Collection)) = 98.42 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 <sub>2</sub> O <sub>3</sub>	4.810	±	0.170	%
CaO	3.570	±	0.100	%
Cr <sub>2</sub> O <sub>3</sub>	0.690	±	0.020	%
Fe <sub>2</sub> O <sub>3</sub>	20.490	±	0.550	%
MgO	17.800	±	0.300	%
SiO <sub>2</sub>	41.700	±	0.990	%
LOI	4.670	±	0.450	%

## ***Provisional Concentrations***

MnO	0.140	±	0.020	%
K <sub>2</sub> O	0.070	±	0.010	%
TiO <sub>2</sub>	0.190	±	0.020	%

## ***Informational Concentration***

Na <sub>2</sub> O	0.350	%
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**1. Intended Use:** AMIS0458 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of PGE, Cu and Ni ores; derived from the Merensky Reef, or from other mafic rocks with a similar grade and matrix

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 Section 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:** AMIS0458 was made from material supplied by Anglo Platinum, using Merensky Reef underground sample material from the Bushveld complex.

**3. Mineral and Chemical Composition:** The Merensky Reef comprises components of feldspathic pyroxenite, pyroxenite and anorthosite. Peak PGE values are associated with a thin chromitite stringer. Mineralization in this Merensky Reef comprises 2-5% disseminated or net textured magmatic sulphides, predominantly pyrrhotite, pentlandite, chalcopyrite and pyrite. The PGE's occur as micron-sized satellite grains around but rarely within the sulphides.

4. **Appearance:** The material is a very fine powder. It is colored Dark Bluish Grey (5BP 4/1)

5. **Handling instructions:** The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

6. **Method of Preparation:** The material was crushed, dry-milled and air-classified to <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 scientifically 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. Pt, Pd, Au, Rh, Ru, Ir. NiS collection, ICP-OES or ICP-MS
3. Multi element scan to include Co, Cu and Ni. Multi-acid total digestion, including HF, ICP-OES or ICP-MS
4. Co, Cu and Ni. Aqua regia digestion with ICP-OES or ICP-MS
5. Co, Cu and Ni. Pressed pellet XRF
6. 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
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. Report all QC data, to include replicates, blanks and certified reference materials used.

9. **Method of Certification:** Eighteen laboratories were each given eight scientifically 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 18 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Vancouver
2. ALS Ammtec (Australia)
3. Bureau Veritas (Namibia)
4. BV Rustenburg (South Africa)

5. Genalysis Laboratory Services (W Australia P)
6. Intertek Utama Services (Indonesia)
7. Mintek (South Africa)
8. Set Point Laboratories (Isando) SA
9. SGS Ankara (Turkey)
10. SGS Geosol Laboratories Ltda (Brazil)
11. SGS Mineral Services Lakefield (Canada)
12. SGS South Africa (Pty) Ltd - Booyens JHB
13. SGS Vancouver (Canada)
14. Suntech Geometallurgical SA
15. Ultra Trace (Pty) Ltd WA
16. Zimplats Ngezi Lab
17. Zimplats SMC Lab

**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 PbColl g/t	Pd PbColl g/t	Au PbColl g/t	Co M/ICP ppm	Co P ppm	Cr M/ICP ppm	Cu M/ICP ppm	Cu XRF ppm	Ni M/ICP ppm	Ni XRF ppm	Pb M/ICP ppm
A				518	475						
A				515	495						
A				513	495						
A				522	491						
A				526	496						
A				514	519						
A				548	497						
A				545	488						
B	67.3	29.3	3.30						26600		
B	67.8	30.8	3.48						25700		
B	68.9	30.8	3.38						25000		
B	69.3	29.8	3.33						25100		
B	66.9	30.5	3.44						25500		
B	66.2	30.1	3.36						25500		
B	68.5	30.4	3.48						25200		
B	70.4	30.9	3.53						25800		
C	61.4	28.8	3.49				15680	16870	25210	28160	
C	64.2	29.0	3.44				15535	16790	25495	28010	
C	63.0	28.5	3.50				15375	16880	25365	28080	
C	64.2	30.2	3.30				15015	16900	24900	28020	
C	61.5	29.4	3.36				15030	16880	24800	28000	
C	59.3	29.9	3.54				15550	16820	25270	27900	
C	58.9	28.5	3.42				15340	16870	24880	28080	
C	62.0	28.4	3.33				15330	16840	25220	28010	
D			3.65	550	527	3560					253
D			3.83	544	527	3642					254
D			3.41	566	514	3581					262
D			3.50	560	486	3496					266
D			3.52	564	528	3463					265
D			3.50	557	529	3445					270
D			3.54	554	532	3577					262
D			3.92	562	540	3548					273
E	64.0	28.0	3.30			4600	13900		23700		216
E	66.0	28.0	3.27			4498	13700	18200	25800	26200	216
E	64.0	27.0	3.27			4606	14800	18300	24600	26200	216
E	65.0	28.0	3.30			4489	14700	18200	24700	26200	218
E	64.0	27.0	3.26			4435	13500	18200	23700	26200	210
E	64.0	28.0	3.24			4368	14800	18300	25000	26400	203
E	66.0	28.0	3.26			4479	14300	18200	24000	26200	206
E	64.0	27.0	3.23			4849	13400		23300		220

**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	Cr M/ICP ppm	Cu M/ICP ppm	Cu XRF ppm	Ni M/ICP ppm	Ni XRF ppm	Pb M/ICP ppm
F	62.2	27.6	3.24	511	451	2615					257
F	63.1	27.9	2.95	481	448	2595					264
F	63.7	28.4	3.15	492	450	2256					235
F	63.8	28.1	3.11	498	451	2437					278
F	62.3	27.5	2.99	497	454	2363					265
F	65.6	28.7	3.20	498	448	2559					274
F	66.8	29.7	3.22	478	448	2608					245
F	68.9	30.5	3.42	485	454	2423					248
G	67.6	26.6	3.26	628	551	2750		16100		24900	
G	63.7	26.0	3.27	631	522	3390		15900		24800	
G	63.0	25.6	3.16	640	526	2840		16100		25300	
G	64.0	25.8	3.23	629	538	2750		16000		24800	
G	64.0	26.2	3.31	638	526	3370		16200		25300	
G	64.4	26.2	3.24	628	537	3100		16000		25000	
G	61.4	25.3	3.14	638	528	3570		16200		25000	
G	63.7	26.3	3.28	641	531	3580		15900		25000	
H	66.8	29.3	3.12	550			14340		23801		
H	66.9	30.2	2.97	553			14237		24026		
H	66.5	28.6	2.84	545			14174		23960		
H	63.3	27.5	2.72	546			14360		24208		
H	65.5	28.7	2.82	550			14412		23945		
H	65.6	28.4	2.89	546			14423		24074		
H	65.5	28.5	2.84	553			14402		23848		
H	67.9	30.8	3.15	552			14381		24439		
I	66.1	29.2	3.32								
I	66.1	27.8	3.41								
I	67.2	29.8	3.42								
I	67.0	28.1	3.35								
I	66.0	28.6	3.29								
I	66.3	28.3	3.34								
I	65.3	28.4	3.36								
I	67.9	28.5	3.53								
J	66.5	29.2	3.34				15195	15560	24335	27240	
J	66.2	28.0	3.40				15150	15900	23975	28020	
J	63.1	27.6	3.19				14800	15920	23720	28020	
J	62.8	27.5	3.21				14820	15840	23690	27810	
J	63.9	27.7	3.26				14635	15820	23605	27910	
J	63.9	29.2	3.29				14710	15810	23700	27790	
J	66.0	29.2	3.25				14825	15810	23850	27830	
J	65.6	28.7	3.32				14770	15880	23475	27820	
K	67.7	29.1	3.27	600	529	4650	16200		25000		227
K	68.1	29.1	3.46	595	513	4750	16100		24900		242
K	69.3	29.5	3.45	600	517	4750	16400		25200		250
K	68.5	29.1	3.54	600	515	4700	16500		25300		238
K	67.4	28.3	3.52	595	519	4750	16100		24700		234
K	68.7	29.3	3.54	590	542	4750	16100		24700		232
K	67.5	28.9	3.15	600	525	4750	16200		25000		241
K	67.9	28.9	3.30	595	542	4700	16200		24800		236
L	44.5	18.3	1.77								
L	44.8	18.3	1.79								
L	44.8	18.3	1.77								
L	44.5	18.3	1.79								
L	44.5	18.3	1.79								
L	44.5	18.3	1.80								
L	44.5	18.3	1.79								
L	44.5	18.3	1.79								

**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	Cr M/ICP ppm	Cu M/ICP ppm	Cu XRF ppm	Ni M/ICP ppm	Ni XRF ppm	Pb M/ICP ppm
M				541			16400		24800		
M				561			16400		24800		
M				556			16200		25100		
M				562			16300		24700		
M				555			16200		25200		
M				542			16200		25200		
M				555			16200		25200		
M				547			16000		24900		
N	67.2	26.9	3.58		470			16800		26700	
N	68.9	27.2	3.75		474			18000		27000	
N	66.3	26.0	3.44		477			17000		25900	
N	68.0	26.8	3.53		481			16900		25300	
N	67.4	26.8	3.38		476			17700		27200	
N	68.3	27.3	3.55		471			17600		26300	
N	69.7	27.1	3.55		472			17900		27100	
N	68.0	26.9	3.53		478			17300		25800	
O	71.1	29.8	3.60					16400		24600	240
O	66.7	28.8	3.31					16300		24600	260
O	69.2	29.6	3.53					16200		24600	220
O	69.0	29.8	3.43					16200		24500	200
O	67.4	29.7	3.53					16400		24500	240
O	69.1	29.3	3.68					16400		24500	200
O	65.1	28.7	3.41					16400		24500	220
O	68.4	30.5	3.62					16300		24400	240
Q			3.02	539		3230					235
Q			2.97	516		3234					233
Q			2.94	524		3318					258
Q			3.22	499		2924					226
Q			3.36	516		3258					226
Q			2.98	515		3287					239
Q			3.23	517		3645					232
Q			2.99	512		3048					224
R	69.3	30.7	3.06	559	535	3256	16340		23484		239
R	69.3	31.3	3.23	561	542	3266	16152		23879		240
R	68.8	30.9	3.13	578	541	3376	16442		23990		244
R	69.2	30.9	3.15	563	536	3758	16188		23542		230
R	69.8	30.7	3.09	577	545	3533	16340		23480		244
R	69.6	30.0	3.01	569	539	3347	15980		23462		234
R	68.8	30.1	3.03	565	551	3282	16353		23196		235
R	70.9	30.1	3.11	568	544	3335	16256		23542		238

**Assay data – Major Oxides**

Lab Code	Al <sub>2</sub> O <sub>3</sub> XRF %	CaO XRF %	Cr <sub>2</sub> O <sub>3</sub> XRF %	Fe <sub>2</sub> O <sub>3</sub> XRF %	K <sub>2</sub> O XRF %	MgO XRF %	MnO XRF %	Na <sub>2</sub> O XRF %	SiO <sub>2</sub> XRF %	TiO <sub>2</sub> XRF %	LOI %	SG pyc
B									41.7			
B									40.6			
B									41.3			
B									41.7			
B									42.8			
B									41.3			
B									45.6			
B									41.9			

Assay data (Cont.) – Major Oxides

Lab Code	Al <sub>2</sub> O <sub>3</sub> XRF %	CaO XRF %	Cr <sub>2</sub> O <sub>3</sub> XRF %	Fe <sub>2</sub> O <sub>3</sub> XRF %	K <sub>2</sub> O XRF %	MgO XRF %	MnO XRF %	Na <sub>2</sub> O XRF %	SiO <sub>2</sub> XRF %	TiO <sub>2</sub> XRF %	LOI %	SG pyc
D	4.73	3.50	0.70	20.4	0.08	17.9	0.14	0.31	41.1	0.18	4.76	3.27
D	4.75	3.51	0.70	20.4	0.07	18.0	0.15	0.30	41.2	0.19	4.73	3.28
D	4.81	3.53	0.71	20.6	0.08	18.0	0.15	0.31	41.5	0.18	4.75	3.28
D	4.77	3.52	0.70	20.5	0.08	18.0	0.14	0.31	41.3	0.18	4.75	3.28
D	4.77	3.52	0.71	20.5	0.07	18.0	0.15	0.31	41.3	0.18	4.71	3.29
D	4.73	3.51	0.70	20.4	0.07	17.9	0.15	0.30	41.3	0.19	4.73	3.27
D	4.75	3.52	0.70	20.4	0.08	17.9	0.14	0.31	41.2	0.19	4.69	3.28
D	4.73	3.50	0.70	20.3	0.08	17.9	0.14	0.30	41.2	0.19	4.70	3.28
E	4.70	3.64	0.70			17.9	0.16	0.20	41.2	0.18	4.65	3.36
E	4.70	3.60	0.70			17.8	0.16	0.20	41.2	0.19	4.60	3.35
E	4.70	3.56	0.71			17.7	0.16	0.20	41.0	0.18	4.89	3.36
E	4.80	3.60	0.69			17.8	0.16	0.30	41.1	0.19	4.48	3.36
E	4.70	3.59	0.70			17.8	0.16	0.30	41.4	0.18	4.62	3.37
E	4.70	3.60	0.70			17.9	0.16	0.30	41.3	0.19	4.44	3.35
E	4.70	3.58	0.69			17.7	0.16	0.30	41.2	0.18	4.62	3.36
E	4.70	3.56	0.69			17.8	0.16	0.20	41.1	0.18	4.54	3.36
F	4.84	3.64	0.69	20.7	0.08	18.0	0.15	0.37	41.8	0.20	5.03	3.34
F	4.87	3.59	0.68	20.5	0.07	18.2	0.15	0.38	41.8	0.19	5.04	3.33
F	4.89	3.61	0.69	20.5	0.07	18.3	0.15	0.38	41.8	0.19	5.07	3.33
F	4.85	3.68	0.70	20.8	0.08	18.0	0.15	0.36	42.2	0.20	5.01	3.34
F	4.87	3.65	0.70	20.7	0.07	18.1	0.15	0.36	42.1	0.20	5.05	3.32
F	4.87	3.57	0.68	20.4	0.07	17.9	0.14	0.36	42.2	0.19	5.10	3.34
F	4.86	3.66	0.70	20.7	0.07	18.0	0.15	0.37	42.0	0.19	5.03	3.32
F	4.87	3.71	0.70	20.8	0.07	18.1	0.15	0.39	41.8	0.20	5.04	3.33
H	4.61	3.41	0.64	19.2		14.2	0.13		42.8	0.17	3.38	3.24
H	5.07	3.34	0.63	18.8		14.1	0.13		42.3	0.17	3.35	3.23
H	4.01	3.43	0.64	19.3		14.2	0.13		43.3	0.17	3.53	3.24
H	5.48	3.34	0.65	18.8		14.3	0.13		42.5	0.17	3.73	3.23
H	5.32	3.33	0.62	18.8		14.1	0.13		42.2	0.17	3.56	3.24
H	5.08	3.39	0.63	19.1		14.3	0.13		42.9	0.17	3.62	3.23
H	4.91	4.20	0.82	23.4		17.6	0.16		53.3	0.21	3.43	3.24
H	5.05	4.16	0.81	23.1		17.7	0.16		53.5	0.20	3.68	3.24
I	3.97	3.05	0.58	17.3	0.06	15.4	0.13	0.26	35.0	0.17	4.81	
I	4.02	3.07	0.59	17.4	0.06	15.4	0.13	0.26	35.2	0.16	4.84	
I	4.03	3.06	0.58	17.4	0.06	15.5	0.13	0.25	35.2	0.16	4.82	
I	4.00	3.04	0.58	17.4	0.06	15.3	0.13	0.24	35.0	0.16	4.83	
I	4.01	3.04	0.58	17.4	0.06	15.3	0.13	0.25	35.0	0.16	4.87	
I	4.00	3.04	0.59	17.3	0.06	15.4	0.13	0.24	35.0	0.16	4.62	
I	4.02	3.04	0.60	17.4	0.06	15.4	0.13	0.24	35.0	0.16	4.68	
I	3.99	3.03	0.58	17.3	0.06	15.3	0.13	0.25	35.0	0.17	4.67	
K	4.84	3.62	0.69	20.2	0.08	17.8	0.13	0.40	41.8	0.19	4.66	3.34
K	4.81	3.61	0.69	20.2	0.07	17.8	0.14	0.39	41.7	0.19	4.64	3.34
K	4.83	3.62	0.69	20.2	0.08	17.8	0.14	0.39	41.7	0.19	4.65	3.35
K	4.82	3.61	0.69	20.3	0.08	17.8	0.14	0.39	41.8	0.19	4.66	3.36
K	4.81	3.61	0.69	20.2	0.07	17.8	0.13	0.40	41.7	0.19	4.67	3.34
K	4.83	3.60	0.69	20.2	0.07	17.8	0.14	0.40	41.7	0.19	4.67	3.32
K	4.83	3.60	0.69	20.2	0.07	17.8	0.14	0.39	41.7	0.19	4.64	3.34
K	4.82	3.60	0.69	20.2	0.07	17.8	0.14	0.40	41.7	0.19	4.62	3.35
M	5.56	3.48	0.65	20.6	0.07	17.4	0.17	0.38	41.0	0.17	4.70	
M	5.57	3.45	0.65	20.6	0.07	17.3	0.17	0.38	41.1	0.17	4.60	
M	5.62	3.46	0.65	20.9	0.07	17.5	0.17	0.39	41.2	0.17	4.50	
M	5.56	3.47	0.63	20.5	0.07	17.4	0.17	0.38	41.1	0.17	4.70	
M	5.60	3.44	0.66	20.8	0.07	17.3	0.17	0.38	41.0	0.17	4.50	
M	5.60	3.47	0.66	20.9	0.07	17.5	0.17	0.38	41.2	0.17	4.60	
M	5.63	3.49	0.65	20.6	0.08	17.6	0.18	0.38	41.0	0.17	4.60	
M	5.63	3.50	0.65	20.6	0.08	17.5	0.18	0.39	41.3	0.17	4.60	
N	4.86	3.61	0.69	20.4	0.07	17.6	0.14	0.47	42.1	0.21	4.74	
N	4.80	3.62	0.69	20.2	0.08	17.8	0.14	0.54	42.1	0.22	4.74	
N	4.72	3.62	0.68	19.6	0.07	17.3	0.14	0.47	42.2	0.22	4.68	
N	4.77	3.58	0.68	20.1	0.07	17.5	0.14	0.52	41.7	0.19	4.70	
N	4.82	3.60	0.69	20.0	0.07	17.7	0.14	0.49	42.1	0.23	4.78	
N	4.84	3.63	0.67	20.1	0.07	17.8	0.14	0.49	42.1	0.18	4.76	
N	4.86	3.59	0.70	19.9	0.07	17.6	0.14	0.53	42.0	0.19	4.70	
N	4.81	3.58	0.68	20.0	0.07	17.6	0.15	0.47	41.8	0.22	4.65	

## Assay data (Cont.) – Major Oxides

Lab Code	Al <sub>2</sub> O <sub>3</sub> XRF %	CaO XRF %	Cr <sub>2</sub> O <sub>3</sub> XRF %	Fe <sub>2</sub> O <sub>3</sub> XRF %	K <sub>2</sub> O XRF %	MgO XRF %	MnO XRF %	Na <sub>2</sub> O XRF %	SiO <sub>2</sub> XRF %	TiO <sub>2</sub> XRF %	LOI %	SG pyc
O	4.78	3.60	0.68	20.5		18.0	0.15	0.32	41.9	0.19	4.45	3.27
O	4.80	3.58	0.68	20.5		17.9	0.15	0.33	41.8	0.19	4.37	3.25
O	4.80	3.58	0.68	20.5		17.9	0.15	0.32	41.8	0.19	4.44	3.27
O	4.78	3.57	0.68	20.5		17.9	0.15	0.33	41.8	0.18	4.45	3.26
O	4.78	3.58	0.68	20.4		17.8	0.15	0.32	41.6	0.19	4.39	3.26
O	4.76	3.57	0.68	20.4		17.9	0.15	0.34	41.6	0.19	4.31	3.24
O	4.78	3.58	0.68	20.5		17.8	0.15	0.33	41.7	0.19	4.07	3.25
O	4.79	3.56	0.68	20.4		17.8	0.15	0.33	41.7	0.18	4.45	3.26
Q											5.36	3.34
Q											5.48	3.17
Q											5.58	3.18
Q											4.69	3.14
Q											5.11	3.18
Q											5.08	3.16
Q											5.37	3.28
Q											4.99	3.15
R	4.83	3.57	0.69	20.9	0.07	17.8	0.15	0.40	41.9	0.20	4.23	3.38
R	4.83	3.56	0.69	20.9	0.08	17.7	0.15	0.38	42.0	0.20	4.23	3.38
R	4.83	3.56	0.69	20.9	0.07	17.8	0.15	0.42	42.0	0.20	4.29	3.41
R	4.82	3.57	0.70	20.9	0.07	17.7	0.15	0.42	41.8	0.20	4.32	3.39
R	4.86	3.57	0.70	20.9	0.07	17.8	0.15	0.42	42.0	0.20	4.30	3.38
R	4.82	3.57	0.70	20.9	0.08	17.8	0.15	0.40	42.0	0.20	4.35	3.40
R	4.88	3.56	0.70	20.8	0.08	17.7	0.15	0.41	41.9	0.20	4.33	3.40
R	4.82	3.55	0.70	20.9	0.07	17.7	0.15	0.40	42.2	0.20	4.17	3.39

### 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	2.40	1.64	1.39	0.49
Pd	PbColl	g/t	1.30	0.92	0.67	0.27
Au	PbColl	g/t	0.166	0.107	0.097	0.031
Co	M/ICP	ppm	29.9	29.84	8.57	10.61
Co	P	ppm	32.8	35.8	9.96	13.60
Cr	M/ICP	ppm	760	843	187	319.6
Cu	M/ICP	ppm	835	904	222	342.9
Cu	XRF	ppm	826	978	211	400.7
Ni	M/ICP	ppm	729	658	373	237
Ni	XRF	ppm	1373	1634	324	669
Pb	M/ICP	ppm	18.87	17.09	11.35	6.64
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.083	0.059	0.060	0.022
CaO	XRF	%	0.052	0.049	0.022	0.017
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.009	0.008	0.006	0.003
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.277	0.290	0.107	0.110
K <sub>2</sub> O	XRF	%	0.0062	0.006	0.004	0.002
MgO	XRF	%	0.153	0.141	0.061	0.051
MnO	XRF	%	0.010	0.008	0.005	0.003
Na <sub>2</sub> O	XRF	%	0.071	0.066	0.020	0.022
SiO <sub>2</sub>	XRF	%	0.494	0.386	0.259	0.126
TiO <sub>2</sub>	XRF	%	0.013	0.009	0.007	0.003
LOI		%	0.227	0.192	0.080	0.062
SG	pyc		0.054	0.061	0.009	0.023

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 Std 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 Informational values listed on p1 and p2 of this certificate fulfil the AMIS statistical criteria regarding agreement for certification and have been independently validated by Ms Margaret Fairhurst.

**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:** AMIS0458 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 (a part of Torre Industries), Nozibele Mbangula, and Margaret M. Fairhurst; accept no liability for any decisions or actions taken following the use of the reference material.

08 October 2015

**Certifying Officers:**



**African Mineral Standards:** \_\_\_\_\_

**Nozibele Mbangula**



**Geochemist:** \_\_\_\_\_

**Margaret M. Fairhurst, PG, MAusIMM**

**Appendix – uncertified element statistics**

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	4.9	1.3	13.1	64
Al	M/ICP	%	2.6	0.25	4.9	68
As	M/ICP	ppm	6.6	2.5	18.7	40
Au	NiS	g/t	3.3	0.26	3.9	16
Ba	M/ICP	ppm	24.1	4.7	9.7	70
Bi	M/ICP	ppm	7.7	11.3	73.7	32
Ca	M/ICP	%	2.5	0.18	3.5	69
Cd	M/ICP	ppm	1.4	2.7	95.0	40
Ce	M/ICP	ppm	3.8	0.46	6.0	16
Co	XRF	ppm	688	166	12.1	40
Cr	P	ppm	461.6	83.5	9.0	24
Cs	M/ICP	ppm	0.20	0.0	0.0	16
Cu	P	ppm	15303	602	2.0	24
Fe	M/ICP	%	14.1	1.3	4.5	70
Ga	M/ICP	ppm	13.4	24.0	89.7	24
Hf	M/ICP	ppm	0.28	0.1	22.5	24
In	M/ICP	ppm	0.07	0.03	21.3	23
Ir	NiS	g/t	1.7	0.33	9.6	39
K	M/ICP	%	0.07	0.01	7.5	70
La	M/ICP	ppm	1.9	0.66	17.6	48
Li	M/ICP	ppm	5.7	1.0	8.6	62
Mg	M/ICP	%	10.5	0.62	3.0	65
Mn	M/ICP	ppm	1130	138	6.1	72
Mo	M/ICP	ppm	1.9	0.94	24.3	44
Na	M/ICP	%	0.26	0.02	4.6	70
Nb	M/ICP	ppm	0.79	0.39	24.8	32
Ni	P	ppm	22627	1499	3.3	24
P	M/ICP	ppm	106	94.9	44.6	48
P <sub>2</sub> O <sub>5</sub>	XRF	%	0.02	0.02	42.0	16
Pb	P	ppm	262	9.7	1.9	14
Pd	NiS	g/t	28.6	2.7	4.7	40
Pt	NiS	g/t	67.5	6.5	4.8	39
Rb	M/ICP	ppm	2.5	0.42	8.3	23
Re	M/ICP	ppm	0.07	0.01	10.1	15
Rh		g/t	5.4	0.71	6.6	44
Ru	NiS	g/t	8.9	0.69	3.9	37
S	M/ICP	%	6.1	1.6	13.3	40
Sb	M/ICP	ppm	4.6	8.5	91.6	31
Sc	M/ICP	ppm	19.1	1.8	4.6	62
Se	M/ICP	ppm	27.0	16.7	30.9	32
Sr	M/ICP	ppm	55.9	8.9	7.9	66
Te	M/ICP	ppm	10.4	5.0	24.3	30
Th	M/ICP	ppm	1.2	0.25	10.3	24
Ti	M/ICP	%	0.11	0.01	4.3	70
Tl	M/ICP	ppm	0.36	0.10	13.4	16
U	M/ICP	ppm	1.0	0.18	9.2	23
V	M/ICP	ppm	116	12.7	5.5	69
W	M/ICP	ppm	0.55	0.10	9.3	23
Y	M/ICP	ppm	3.4	0.70	10.5	64