

## AMIS0448

### *Certified Reference Material*

## Platinum (PGM) Platreef Ore Bushveld Complex, South Africa

### *Certificate of Analysis*

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

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

Pt Pb Collection	1.899	±	0.203	g/t
Pd Pb Collection	1.98	±	0.14	g/t
Co M/ICP	104	±	7	ppm
Co P	68.6	±	5.1	ppm
Cu M/ICP	1286	±	114	ppm
Cu P	1287	±	90	ppm
Ni P	2163	±	131	ppm
Specific Gravity	3.05	±	0.11	

#### *Provisional Concentrations*

Au Pb Collection	1.31	±	0.15	g/t
Ni M/ICP	2375	±	270	ppm

#### *Informational Concentration*

Cr M/ICP 2454 ppm

<sup>3E</sup> (Pt, Pd, Au (all Pb Collection)) = 5.189 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>	9.50	±	0.14	%
CaO	7.02	±	0.09	%
Cr <sub>2</sub> O <sub>3</sub>	0.50	±	0.02	%
Fe <sub>2</sub> O <sub>3</sub>	10.27	±	0.20	%
K <sub>2</sub> O	0.38	±	0.01	%
MgO	16.68	±	0.19	%
MnO	0.20	±	0.01	%
Na <sub>2</sub> O	1.14	±	0.08	%
SiO <sub>2</sub>	50.45	±	0.50	%
TiO <sub>2</sub>	0.19	±	0.01	%

## *Provisional Concentration*

LOI 3.18 ± 0.66 %

**1. Intended Use:** AMIS0448 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of low grade PGM, Cu and Ni ores, hosted by the Platreef or other mafic rocks with a similar grade and matrix; when measured in parallel to the unknown to be characterised.

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:** This standard was made using Platreef material from the northern limb of the Bushveld Complex. This specific material was supplied by Anglo Platinum Limited and was obtained from the open pit Mogalakwena Mine (previously named PPRust Mine).

**3. Mineral and Chemical Composition:** Platreef is a Pt/Pd/Ni/Cu ore. Mineralization in this Platreef comprises 2-5% disseminated or net textured magmatic sulphides, mainly pyrrhotite, pentlandite and chalcopyrite. 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 Medium Light Grey (10Y 6/2)

**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:** Twenty 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 20 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
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**

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 P ppm	Ni M/ICP ppm	Ni P ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc	
A	1.79	1.92	1.13																				
A	1.83	1.95	1.11																				
A	1.75	1.90	1.13																				
A	1.79	1.92	1.08																				
A	1.84	1.96	1.06																				
A	1.82	1.94	1.08																				
A	1.80	1.91	1.05																				
A	1.73	1.85	1.02																				
B	1.74	1.86	1.22	97.0	70.0	2535	1248	1334	2153	2128	9.60	7.03	0.51	10.3	0.38	16.7	0.20	0.75	50.4	0.19	3.08	3.08	
B	1.74	1.93	1.24	103	71.0	2621	1273	1324	2219	2148	9.70	7.04	0.51	10.3	0.38	16.8	0.20	0.74	50.6	0.19	2.94	3.10	
B	1.71	1.92	1.21	106	66.0	2703	1317	1275	2300	2061	9.70	7.05	0.51	10.6	0.39	16.8	0.20	0.76	50.5	0.19	2.96	3.08	
B	1.68	1.86	1.22	105	66.0	2613	1306	1277	2261	2058	9.70	7.08	0.52	10.3	0.38	16.8	0.20	0.75	50.8	0.19	3.03	3.10	
B	1.70	1.94	1.26	95.0	66.0	2576	1198	1312	2119	2097	9.60	7.08	0.51	10.3	0.38	16.9	0.20	0.72	50.8	0.19	3.02	3.10	
B	1.69	1.89	1.23	92.0	69.0	2550	1196	1296	2050	2085	9.60	7.08	0.55	10.3	0.38	16.7	0.20	0.72	50.6	0.19	2.98	3.09	
B	1.67	1.86	1.25	97.0	69.0	2502	1265	1301	2168	2112	9.60	7.05	0.56	10.3	0.38	16.8	0.20	0.75	50.6	0.19	2.84	3.07	
B	1.76	1.96	1.26	94.0	68.0	2536	1213	1321	2083	2137	9.60	7.04	0.53	10.3	0.38	16.7	0.20	0.76	50.5	0.19	2.96	3.09	
D	1.95	1.99	1.33	84.0	64.5	1782	1251	1243	2403	2430	9.48	6.94	0.50	10.0	0.37	16.7	0.20	1.21	49.4	0.19	3.26	3.03	
D	1.94	1.97	1.30	86.0	65.3	1751	1237	1178	2429	2469	9.41	6.96	0.49	10.1	0.36	16.7	0.20	1.20	49.4	0.20	3.43	3.07	
D	1.93	1.99	1.32	88.0	67.6	1778	1203	1283	2425	2346	9.35	6.94	0.49	10.1	0.37	16.5	0.19	1.17	49.4	0.19	3.41	3.03	
D	1.89	1.95	1.25	89.0	65.4	2050	1251	1275	2436	2394	9.47	6.96	0.50	10.1	0.37	16.6	0.20	1.22	49.5	0.20	3.26	3.04	
D	1.83	1.89	1.24	89.0	69.7	1735	1237	1218	2456	2405	9.38	6.95	0.50	10.1	0.37	16.6	0.20	1.21	49.3	0.20	3.44	3.07	
D	2.06	2.00	1.25	82.0	67.0	1744	1203	1212	2423	2326	9.37	6.99	0.49	10.1	0.37	16.5	0.19	1.20	49.6	0.19	3.53	3.04	
D	1.88	1.93	1.29	89.0	67.9	1723	1247	1217	2427	2360	9.44	6.94	0.49	10.1	0.36	16.5	0.20	1.27	49.3	0.19	3.47	3.05	
D	1.87	1.97	1.23	88.0	66.4	1905	1255	1179	2428	2486	9.42	6.95	0.49	10.1	0.37	16.7	0.20	1.21	49.4	0.19	3.46	3.06	
E	2.14	2.00	1.33	98.0	63.0	2615	1327	1351	2361	2097											3.60	3.04	
E	2.02	1.96	1.31	98.0	66.0	2582	1260	1489	2375	2125											3.59	3.00	
E	2.32	1.98	1.34	96.0	63.0	2579	1227	1462	2307	2022											4.20	3.00	
E	2.38	2.12	1.44	98.0	64.0	2667	1358	1448	2348	2103											3.90	2.95	
E	1.99	1.97	1.29	98.0	64.0	2747	1259	1497	2364	2072											4.18	2.98	
E	2.42	2.18	1.48	99.0	65.0	2440	1323	1283	2389	2160											3.89	2.93	
E	1.90	1.98	1.25	101	69.0	2623	1299	1449	2414	2252											3.77	2.88	
E	1.89	1.93	1.29	103	65.0	2804	1321	1424	2493	2133											3.59	2.83	
F	2.06	1.99	1.24																				
F	2.03	2.02	1.24																				
F	2.04	2.03	1.25																				
F	2.05	2.00	1.25																				
F	2.03	2.00	1.24																				
F	2.05	2.03	1.24																				
F	2.03	2.01	1.24																				
F	2.06	2.02	1.24																				
G	2.07	2.18	1.43						2680														
G	1.94	2.04	1.38						2600														
G	2.11	2.25	1.44						2530														
G	1.95	2.12	1.40						2640														
G	1.93	2.06	1.39						2650														
G	1.98	2.29	1.46						2670														
G	2.10	2.21	1.43						2610														
G	1.96	1.98	1.29						2540														
H	1.91	1.87	1.39	118	70.3	1369	1491	1482	2248	2178	9.55	7.07	0.51	10.3	0.39	16.7	0.19	1.16	50.9	0.19	3.23		
H	2.05	2.02	1.41	122	71.6	1616	1496	1488	2208	2216	9.50	7.03	0.50	10.2	0.38	16.6	0.19	1.19	50.6	0.19	3.05		
H	2.02	2.01	1.42	115	70.6	1402	1438	1488	2129	2215	9.55	7.10	0.50	10.3	0.38	16.8	0.19	1.18	50.9	0.19	3.31		
H	2.11	2.12	1.46	116	72.5	1380	1466	1508	2171	2245	9.56	7.06	0.51	10.2	0.39	16.6	0.19	1.15	50.6	0.20	3.24		
H	2.10	2.08	1.50	120	72.4	1389	1475	1504	2194	2255	9.62	7.09	0.50	10.3	0.38	16.7	0.19	1.17	50.8	0.21	3.29		
H	1.93	1.94	1.37	114	73.5	1403	1446	1522	2142	2263	9.56	7.11	0.51	10.3	0.39	16.8	0.19	1.14	51.0	0.20	3.22		
H	1.95	1.89	1.37	118	73.3	1601	1482	1518	2185	2256	9.60	7.08	0.51	10.3	0.39	16.7	0.19	1.10	51.0	0.18	3.26		
H	1.87	1.88	1.22	115	72.1	1628	1482	1502	2169	2253	9.47	7.05	0.49	10.2	0.38	16.6	0.19	1.17	50.4	0.18	3.30		

Assay Data (cont)

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 P ppm	Ni M/ICP ppm	Ni P ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
I	1.84	1.98	1.31	102	70.8	2432	1318	1267	2372	1995	9.55	6.99	0.51	10.5	0.38	16.6	0.20	1.19	50.5	0.18	2.79	3.02
I	1.89	1.94	1.31	103	68.7	2434	1339	1235	2366	1922	9.53	6.99	0.51	10.5	0.38	16.6	0.20	1.20	50.5	0.20	2.83	3.17
I	1.86	2.00	1.32	104	71.0	2445	1329	1255	2366	1965	9.61	7.01	0.51	10.5	0.38	16.6	0.20	1.20	50.6	0.19	2.82	3.21
I	1.79	1.97	1.31	104	68.5	2410	1285	1228	2387	1891	9.51	6.96	0.50	10.4	0.38	16.6	0.20	1.19	50.6	0.19	2.79	3.15
I	1.88	2.02	1.33	103	69.8	2413	1324	1264	2356	1931	9.52	6.97	0.50	10.4	0.39	16.5	0.20	1.19	50.7	0.19	2.81	3.18
I	1.85	1.99	1.33	102	72.4	2521	1318	1284	2361	1941	9.60	7.00	0.51	10.5	0.38	16.6	0.20	1.20	50.6	0.20	2.82	3.15
I	1.90	2.01	1.34	103	70.4	2368	1315	1246	2366	1924	9.50	7.00	0.51	10.5	0.39	16.6	0.20	1.20	50.8	0.19	2.74	3.12
I	1.88	1.99	1.31	104	71.4	2241	1286	1281	2378	1977	9.58	7.01	0.50	10.4	0.38	16.6	0.19	1.20	50.5	0.19	2.75	3.15
J	1.94	2.09	1.32	104	68.0	2150	1430	1290	2100	2110	9.52	7.15	0.50	10.2	0.38	16.7	0.20	1.10	50.1	0.19	3.57	
J	1.93	2.10	1.31	105	67.0	2310	1390	1290	2130	2090	9.50	7.16	0.51	10.2	0.39	16.8	0.20	1.12	50.4	0.19	3.56	
J	1.92	2.11	1.32	105	65.0	2380	1360	1280	2110	2090	9.39	7.15	0.50	10.2	0.39	16.7	0.20	1.11	50.3	0.19	3.59	
J	1.99	2.15	1.38	104	68.0	2240	1480	1300	2160	2150	9.50	7.13	0.52	10.2	0.38	16.7	0.20	1.09	50.3	0.20	3.59	
J	1.99	2.14	1.35	107	67.0	2190	1360	1270	2140	2090	9.51	7.18	0.50	10.3	0.37	16.8	0.19	1.11	50.6	0.19	3.59	
J	2.02	2.15	1.35	105	67.0	2410	1390	1260	2140	2090	9.50	7.18	0.51	10.2	0.38	16.7	0.19	1.11	50.3	0.19	3.59	
J	2.00	2.13	1.32	102	66.0	2260	1370	1290	2100	2070	9.51	7.19	0.50	10.3	0.38	16.7	0.19	1.10	50.3	0.20	3.57	
J	2.01	2.15	1.35	107	67.0	2410	1400	1290	2130	2100	9.52	7.16	0.50	10.2	0.38	16.8	0.21	1.12	50.3	0.19	3.50	
K	1.95	2.05	1.32	107	67.0		1330	1310	2420	2220	9.56	7.07	0.49	10.4	0.38	16.7	0.19	1.19	50.5	0.19	3.21	
K	1.95	2.08	1.33	105	68.0		1310	1300	2420	2210	9.60	7.06	0.50	10.4	0.38	16.8	0.20	1.18	50.6	0.19	3.14	
K					69.0		1310	1310	2360	2200	9.62	7.06	0.49	10.4	0.39	16.8	0.19	1.15	50.4	0.19	3.15	
K				102	68.0		1320	1290	2380	2210	9.66	7.06	0.50	10.4	0.38	16.7	0.20	1.16	50.6	0.19	3.11	
K	1.92	2.05	1.34	106	66.0		1330	1320	2550	2210	9.63	7.06	0.49	10.4	0.38	16.8	0.20	1.14	50.8	0.19	3.07	
K	1.83	1.97	1.33	106	69.0		1350	1320	2500	2250	9.70	7.07	0.50	10.4	0.37	16.8	0.20	1.11	50.6	0.19	3.18	
K	1.82	1.94		104	67.0		1320	1280	2430	2180	9.56	7.03	0.50	10.3	0.38	16.6	0.20	1.11	50.4	0.20	3.03	
K	1.97	2.08	1.34	106	66.0		1320	1280	2440	2100	9.54	7.06	0.49	10.4	0.38	16.7	0.20	1.14	50.4	0.19	2.99	
L	1.78	1.90	1.21				1300		2515													
L	1.78	1.96	1.23				1305		2510													
L	1.62	1.88	1.15				1285		2505													
L	1.73	1.90	1.17				1265		2445													
L	2.00	1.96	1.18				1225		2350													
L	1.86	1.83	1.12				1165		2250													
L	2.05	2.00	1.22				1185		2265													
L	1.86	1.80	1.14				1215		2340													
N	1.81	1.89	1.20				1240		2495													
N	1.87	1.96	1.22				1280		2510													
N	1.74	1.81	1.16				1265		2490													
N	1.70	1.78	1.14				1260		2520													
N	1.92	1.99	1.27				1230		2455													
N	1.79	1.85	1.18				1250		2430													
N	1.83	1.89	1.23				1215		2405													
N	1.96	1.98	1.29				1240		2460													
O	1.94	2.13	1.33	103	71.5	2942	1250	1241	2466	2174	9.40	6.94	0.52	10.1	0.37	16.8	0.19	1.11	49.8	0.19	3.57	3.01
O	1.93	2.09	1.31	104	71.8	3033	1286	1271	2507	2217	9.42	6.96	0.51	10.2	0.37	16.8	0.20	1.11	49.9	0.20	3.59	3.01
O	1.90	2.06	1.33	103	68.7	3015	1253	1267	2442	2222	9.42	6.99	0.52	10.2	0.37	16.9	0.19	1.11	50.1	0.21	3.59	3.02
O	1.93	2.09	1.39	106	73.3	2990	1273	1250	2489	2196	9.41	6.93	0.52	10.1	0.38	16.8	0.19	1.11	49.8	0.20	3.61	3.00
O	1.88	2.00	1.31	102	72.0	2944	1249	1296	2456	2277	9.38	6.92	0.51	10.1	0.37	16.8	0.19	1.11	49.8	0.21	3.57	3.02
O	1.90	2.01	1.28	107	72.8	2898	1265	1282	2482	2252	9.39	6.91	0.51	10.0	0.37	16.8	0.19	1.10	49.8	0.25	3.59	3.01
O	1.93	2.03	1.32	101	71.3	2845	1213	1273	2407	2261	9.42	6.88	0.50	9.9	0.37	16.7	0.19	1.11	49.6	0.26	3.61	3.01
O	1.88	2.04	1.28	101	71.4	2948	1260	1270	2478	2217	9.41	6.90	0.50	10.0	0.37	16.8	0.19	1.11	49.6	0.23	3.58	3.02
P	1.98	1.93	1.42	101			1340		2480		9.52	6.98	0.49	10.3	0.38	16.6	0.20	1.09	50.4	0.19	2.80	
P	1.95	1.95	1.41	103			1330		2470		9.54	6.98	0.51	10.3	0.38	16.6	0.20	1.12	50.3	0.19	2.90	
P	1.94	1.95	1.43	101			1330		2460		9.55	6.99	0.50	10.3	0.38	16.6	0.20	1.12	50.3	0.20	2.90	
P	1.98	1.92	1.43	101			1340		2500		9.52	7.00	0.50	10.4	0.38	16.6	0.20	1.12	50.3	0.19	2.90	
P	1.97	1.97	1.38	101			1320		2450		9.52	6.97	0.50	10.3	0.38	16.6	0.20	1.10	50.2	0.19	3.00	
P	1.98	1.94	1.41	103			1330		2450		9.52	6.97	0.51	10.3	0.38	16.6	0.20	1.10	50.2	0.19	3.00	
P	1.97	1.97	1.42	101			1310		2420		9.54	7.00	0.50	10.3	0.38	16.6	0.20	1.11	50.4	0.20	3.10	
P	1.94	1.95	1.41	102			1330		2450		9.53	7.00	0.51	10.3	0.38	16.6	0.20	1.12	50.4	0.20	3.00	
Q	1.78	2.23	1.27	109			1211		2250		8.12	6.89	0.40	9.8	0.32	13.7	0.18	1.12	53.2	0.18	3.70	2.97
Q	1.73	2.19	1.18	109			1196		2227		8.47	6.84	0.41	9.8	0.32	13.9	0.18	1.12	53.1	0.18	3.72	2.97
Q	1.77	2.17	1.20	111			1223		2252		8.07	6.88	0.41	9.8	0.32	13.7	0.18	1.10	53.2	0.18	3.43	2.98
Q	1.69	2.12	1.13	107			1199		2233		8.13	6.91	0.41	9.8	0.33	13.7	0.18	1.07	53.3	0.18	3.74	2.97
Q	1.86	2.02	1.11	109			1224		2245		7.85	6.82	0.55	10.1	0.31	13.7	0.18	1.09	53.2	0.18	3.61	2.97
Q	1.87	2.31	1.18	111			1200		2332		8.32	6.89	0.40	9.8	0.32	13.8	0.18	1.11	53.3	0.18	3.45	2.97
Q	1.71	2.06	1.01	107			1188		2270		8.35	6.89	0.41	9.8	0.32	13.8	0.18	1.11	53.3	0.18		2.97
Q	1.98	2.23	1.32	106			1176		2251		7.97	6.84	0.44	10.1	0.33	12.5	0.18	1.08	52.2	0.19	3.46	2.96
R	1.82	1.84	1.29								9.44	7.03		10.3	0.37	16.8	0.19		50.3	0.18	2.67	3.08
R	1.79	1.85	1.30								9.41	7.04		10.2	0.38	16.8	0.20		50.3	0.22	2.67	3.11
R	1.90	2.07	1.46								9.46	7.01		10.3	0.38	16.7	0.20		50.4	0.18	2.78	3.09
R	1.90	1.97	1.45								9.45	7.03		10.3	0.38	16.7	0.20		50.3	0.19	2.65	3.11
R</																						

**12. Measurement of Uncertainty** : (ref Dr Hugh Bartlett, Hugh Bartlett Consulting CC.)

The samples used in this certification process have been selected in such a way as to represent the entire batch of material and were taken from the final packaged units; therefore all possible sources of uncertainty (sample uncertainty and measurement uncertainty) are included in the final combined standard uncertainty determination.

The uncertainty measurement takes into consideration the between lab and the within lab variances and is calculated from the square roots of the variances of these components using the formula:

$$\text{Combined standard uncertainty} = \sqrt{(\text{between lab. var/no of labs}) + (\text{mean square within lab. var /no of assays})}$$

These uncertainty measurements may be used, by laboratories, as a component for calculating the total uncertainty for method validation according to the relevant ISO guidelines.

Analyte	Method	unit	S <sup>1</sup>	$\sigma_L$ <sup>2</sup>	Sw <sup>3</sup>	CSU <sup>4</sup>
Pt	PbColl	g/t	0.101	0.054	0.063	0.014
Pd	PbColl	g/t	0.070	0.031	0.051	0.009
Au	PbColl	g/t	0.074	0.043	0.041	0.011
Co	M/ICP	ppm	3.58	2.83	2.05	0.98
Co	P	ppm	2.56	2.03	1.50	0.70
Cr	M/ICP	ppm	598	627	89.5	222
Cu	M/ICP	ppm	56.9	41.7	27.3	12.4
Cu	P	ppm	45.1	36.7	27.1	13.4
Ni	M/ICP	ppm	135.1	96.7	48.3	26.3
Ni	P	ppm	65.4	58.7	40.0	22.8
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.070	0.055	0.032	0.018
CaO	XRF	%	0.046	0.041	0.019	0.014
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.008	0.005	0.006	0.002
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.102	0.084	0.041	0.027
K <sub>2</sub> O	XRF	%	0.0059	0.004	0.004	0.001
MgO	XRF	%	0.096	0.066	0.064	0.022
MnO	XRF	%	0.004	0.003	0.003	0.001
Na <sub>2</sub> O	XRF	%	0.040	0.036	0.017	0.012
SiO <sub>2</sub>	XRF	%	0.251	0.210	0.126	0.072
TiO <sub>2</sub>	XRF	%	0.006	0.004	0.005	0.001
LOI		%	0.329	0.265	0.073	0.077
SG	pyc		0.055	0.051	0.022	0.018

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 fulfill 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:** AMIS0448 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.

13 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	0.85	1.3	77.7	29
Al	M/ICP	ppm	5.1	0.26	2.5	71
As	M/ICP	ppm	7.9	4.8	30.0	53
Au	NiS	g/t	1.2	0.12	5.0	16
Ba	M/ICP	ppm	100	11.7	5.9	82
Be	M/ICP	ppm	1.5	6.0	194	34
Bi	M/ICP	ppm	0.79	0.16	9.9	32
Ca	M/ICP	ppm	4.9	0.32	3.3	76
Cd	M/ICP	ppm	0.20	0.14	35.5	29
Ce	M/ICP	ppm	829	2365	143	24
Co	XRF	ppm	111	17.6	7.9	31
Cr	P	ppm	344	44.3	6.5	23
Cs	M/ICP	ppm	471	1357	144	24
Cu	XRF	ppm	1299	112	4.3	44
Dy	M/ICP	ppm	1.2	0.60	24.8	16
Er	M/ICP	ppm	1.0	0.0	0.0	7
Eu	M/ICP	ppm	7.1	13.9	98.3	16
Fe	M/ICP	ppm	7.0	0.58	4.1	72
Ga	M/ICP	ppm	27.2	74.1	136	37
Gd	M/ICP	ppm	1.3	0.19	7.4	8
Ge	M/ICP	ppm	0.68	0.14	10.5	8
Hf	M/ICP	ppm	0.87	0.31	17.7	31
Ho	M/ICP	ppm	0.30	0.02	3.6	8
In	M/ICP	ppm	0.03	0.01	26.2	16
K	M/ICP	ppm	0.33	0.04	5.8	77
La	M/ICP	ppm	5.4	0.79	7.4	60
Li	M/ICP	ppm	27.8	3.6	6.6	73
Lu	M/ICP	ppm	0.15	0.03	10.7	16
Mg	M/ICP	ppm	9.9	0.63	3.2	69
Mn	M/ICP	ppm	1456	123	4.2	61
Mo	M/ICP	ppm	1.3	0.81	31.6	30
Na	M/ICP	ppm	0.84	0.09	5.3	79
Nb	M/ICP	ppm	2.1	0.44	10.6	31
Nd	M/ICP	ppm	4.8	0.17	1.8	8
Ni	XRF	ppm	2472	225	4.6	40
P	M/ICP	ppm	104	107	51.5	62
Pb	M/ICP	ppm	20.7	6.3	15.1	68
Pd	NiS	g/t	2.0	0.18	4.5	37
Pr	M/ICP	ppm	1.2	0.05	2.1	8
Pt	NiS	g/t	1.9	0.08	2.2	36
Rb	M/ICP	ppm	18.5	1.9	5.1	31
Rh		g/t	0.15	0.02	6.1	44
Re	M/ICP	ppm	0.01	0.0	21.8	7
Ru	NiS	g/t	0.19	0.03	7.5	39
S	M/ICP	ppm	0.63	0.09	7.2	74
Sb	M/ICP	ppm	1.5	6.1	200	36
Sc	M/ICP	ppm	20.9	2.7	6.4	63
Se	M/ICP	ppm	3.2	1.1	17.5	15
Si	M/ICP	ppm	23.6	0.48	1.0	8
Sm	M/ICP	ppm	1.2	0.0	2.1	7
Sn	M/ICP	ppm	19.9	71.0	178	37
Sr	M/ICP	ppm	115	7.4	3.2	67
Ta	M/ICP	ppm	0.28	0.09	15.7	31
Tb	M/ICP	ppm	0.25	0.05	9.6	16
Te	M/ICP	ppm	0.91	0.67	36.9	29
Th	M/ICP	ppm	3.9	0.32	4.0	31
Ti	M/ICP	ppm	0.11	0.01	5.2	78
Tl	M/ICP	ppm	0.21	0.02	5.6	23
Tm	M/ICP	ppm	0.13	0.02	8.2	8
U	M/ICP	ppm	25.5	2.8	5.5	32
V	M/ICP	ppm	106	9.1	4.3	76
W	M/ICP	ppm	0.51	0.37	36.6	22
Y	M/ICP	ppm	7.7	1.1	7.1	67
Yb	M/ICP	ppm	1.0	0.16	8.2	16
Zn	M/ICP	ppm	80.9	20.2	12.5	87
Zr	M/ICP	ppm	27.0	7.7	14.2	75