



AMIS0143

Certified Reference Material

Platinum (PGM) Platreef Ore Bushveld Complex, South Africa

Certificate of Analysis

Recommended Concentrations and two “Between Laboratory” Standard Deviations

Certified Concentrations

Pt Pb Collection	1.14	±	0.08	g/t
Pd Pb Collection	1.31	±	0.08	g/t
Au Pb Collection	0.142	±	0.014	g/t
Pt NIS	1.11	±	0.12	g/t
Pd NIS	1.31	±	0.08	g/t
Rh NiS	0.095	±	0.012	g/t
Cu M/ICP	737	±	53	ppm
Cu P	742	±	53	ppm
Ni M/ICP	1329	±	91	ppm
Ni P	1265	±	106	ppm
Ni XRF	1362	±	105	ppm
Specific Gravity	3.10	±	0.10	

Provisional Concentrations

Au NIS	0.14	±	0.04	g/t
Ir NiS	0.024	±	0.006	g/t
Ru NiS	0.092	±	0.018	g/t
Co M/ICP	55.6	±	6.9	ppm
Co P	48.8	±	6.4	ppm
Cu XRF	745	±	96	ppm

4E (Pt, Pd, Au & Rh) = 2.687 g/t

Major Element Recommended Concentrations and two “Between Laboratory” Standard Deviations

Certified Concentrations

Al ₂ O ₃	5.64	±	0.08	%
CaO	15.14	±	0.36	%
Cr ₂ O ₃	0.19	±	0.01	%
Fe ₂ O ₃	9.08	±	0.20	%
K ₂ O	0.19	±	0.01	%
MgO	19.77	±	0.30	%
MnO	0.34	±	0.01	%
Na ₂ O	0.28	±	0.03	%
SiO ₂	43.56	±	0.84	%
TiO ₂	0.28	±	0.014	%

Provisional Concentration

LOI	4.99	±	0.86	%
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1. **Intended Use:** AMIS0143 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of tails or low grade PGE, 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. The material can be used for routine quality control by inserting within a batch of samples, method development and for the calibration of equipment.

The recommended mean and "Between Lab" standard deviations for this material property values based on a measurement campaign (round robin) and reflect the average results from the laboratories that participated in the round robin, after examination of the data set and removal of technically and statistically invalid results (see Clause 9 - this certificate). Slight variations in analytical procedures between laboratories will reflect as slight biases to the recommended concentrations and this is acceptable. Good laboratories however will report results within the two standard deviation levels with a failure of <10 %.

2. **Origin of Material:** This standard was made using Platreef material from the northern limb of the Bushveld Complex supplied by Anglo Platinum Limited. Platreef is a Pt/Pd/Ni/Cu ore. This specific material was obtained from the open pit, PPRust Mine.

3. **Mineral and Chemical Composition:** 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.

Major element chemistry data from 12 of the labs has been compiled and certified. Uncertified summary statistics for trace element data are set out in the appendix.

4. **Appearance:** The material is a very fine powder. It is colored a Blueish Grey (Corstor 5B 7/1).

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 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. ICP-OES or ICP-MS, Pb collection with Ag as a co-collector.
2. Au, Pt, Pd, Rh, Ru and Ir. ICP-MS, nickel sulphide collection.
3. Cu and Ni. Multi-acid total digestion, including HF, with ICP-OES finish.
4. Cu and Ni. Aqua regia digestion with ICP-OES finish.
5. Cr, Co, Cu and Ni. Pressed pellet XRF.
6. Cr, Co, Cu and Ni. Fusion, ICP-OES or ICP-MS
7. Specific Gravity. Gas pycnometer.
8. XRF (major elements).
9. Multi acid digest ICP scan – trace elements.

Additionally, XRF analyses were requested for the major elements and a multi-element multi acid digest and ICP scan was requested for the trace elements.

8. Information requested:

1. Aliquots used for all determinations.
2. Results for individual PGM's reported in ppb.
3. Results for base metals reported in ppm.
4. QC data, to include replicates, blanks and certified reference materials used.
5. Analytical techniques used.

9. Method of Certification: Twenty five laboratories were each given eight randomly selected packages of sample. Twenty two of the laboratories submitted results.

The final limits were calculated after a three step examination of the data, first removing incompatible data outside a spread normally expected for similar analytical methods done by reputable laboratories. Then, data from any one laboratory was removed from further calculations, if the mean of all analyses from that laboratory failed a t-test of the global means of the other laboratories. Next, data that fell outside of the 2 standard deviations were removed. The mean and standard deviations were then re-calculated.

Analytes with an RSD of near or less than 5 % are reported as "Certified Concentrations" with limits at two "Between Laboratory" standard deviations. Those with RSD's of between near 5 % and 15 % are reported as "Provisional Concentrations" with limits at two "Between Laboratory" standard deviations. Those with RSD's over 15 % are reported as "Informational Values".

This method is different from that used by Government agencies in that the actual "between-laboratory" standard deviation is used in the calculations. This produces upper and lower limits that reflect actual individual analyses rather than a grouped set of analyses. The limits can therefore be used to monitor accuracy from individual analyses, unlike the Confidence Limits published on other standards.

10. Participating Laboratories: The 25 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ALS Chemex Laboratory Group Brisbane Australia
2. ALS Chemex Laboratory Group Johannesburg SA
3. ALS Chemex Laboratory Group Lima Peru
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. Anglo Platinum - Eastern Bushveld Regional Laboratory SA

Assay data (cont)

Lab Code	Pt	Pd	Au	Pt	Pd	Au	Ir	Rh	Ru	Co	Cu	Cu	Cu	Ni	Ni	Al2O3	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	SiO2	TiO2	LOI	SG		
	PbCol	PbCol	PbCol	NIS	NIS	NIS	NIS	NIS	NIS	M/ICP	M/ICP	M/ICP	M/ICP	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF		
	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t	g/t	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%		
K	1.11	1.32	0.14											750													1316		
K	1.10	1.30	0.14											748													1309		
K	1.12	1.32	0.14											750													1323		
K	1.11	1.31	0.14											741													1297		
K	1.10	1.31	0.14											749													1307		
K	1.13	1.31	0.14											746													1295		
K	1.11	1.31	0.14											750													1315		
K	1.11	1.30	0.14											747													1311		
L	1.06	1.26	0.14							67.0	62.0	719	711		1315	1316											1318		
L	1.05	1.23	0.13							65.0	62.0	722	708		1313	1314											1323		
L	1.05	1.22	0.14							61.0	67.0	718	717		1309	1306											1297		
L	1.07	1.27	0.15							59.0	68.0	723	721		1326	1310											1309		
L	1.10	1.27	0.12							67.0	76.0	713	714		1322	1322											1322		
L	1.09	1.28	0.14							66.0	74.0	717	722		1310	1309											1309		
L	1.07	1.25	0.13							62.0	68.0	711	711		1322	1326											1326		
L	1.08	1.27	0.13							59.0	79.0	714	712		1316	1318											1318		
M				1.21	1.38	0.14								730													1250		
M				1.16	1.31	0.14								700													1250		
M				1.19	1.27	0.14								690													1220		
M				1.21	1.29	0.14								690													1220		
M				1.18	1.28	0.13								690													1240		
M				1.17	1.29	0.13								720													1240		
M				1.19	1.28	0.15								710													1300		
M				1.27	1.38	0.16								700													1260		
N				0.93	1.08	0.10	0.02	0.08	0.07	60.0				900													1100		
N				1.01	1.16	0.11	0.02	0.09	0.08	60.0				800													1100		
N				1.04	1.19	0.11	0.02	0.09	0.08	50.0				800													1100		
N				1.04	1.19	0.11	0.02	0.09	0.08	70.0				700													1100		
N				1.08	1.19	0.11	0.02	0.09	0.09	60.0				700													1300		
N				1.02	1.16	0.11	0.02	0.09	0.08	60.0				900													1200		
N				1.04	1.17	0.11	0.02	0.09	0.09	60.0				800													1200		
N				0.98	1.13	0.11	0.03	0.08	0.08	60.0				800													1000		
O	1.18	1.32	0.15							62.0	46.3	853	831		1335	1285											3.12		
O	1.21	1.36	0.16							54.6	47.5	754	842		1215	1300											3.11		
O	1.16	1.30	0.14							56.4	48.3	759	836		1190	1310											3.12		
O	1.19	1.32	0.14							53.6	47.9	752	844		1200	1290											3.12		
O	1.15	1.30	0.14							53.8	48.6	756	851		1205	1310											3.11		
O	1.10	1.24	0.14							54.9	49.1	740	860		1190	1300											3.11		
O	1.16	1.31	0.15							52.2	48.0	753	846		1200	1285											3.10		
O	1.18	1.32	0.15							53.7	48.8	755	869		1200	1325											3.11		
P				60.0	50.0	788	783	800	1340	220	1470	5.64	15.30	0.20	9.11	0.20	19.75	0.34	0.28	43.40	0.28	4.93				3.11			
P				59.2	48.3	758	797	810	1300	280	1460	5.68	15.40	0.19	9.16	0.20	19.85	0.34	0.28	43.70	0.28	4.92				3.11			
P				59.3	50.4	757	806	800	1310	1285	1420	5.66	15.35	0.19	9.12	0.20	19.80	0.34	0.28	43.50	0.28	4.94				3.11			
P				59.3	49.9	771	804	810	1330	1250	1480	5.68	15.40	0.19	9.17	0.20	19.85	0.34	0.28	43.60	0.28	4.92				3.11			
P				56.7	49.4	735	791	810	1240	1260	1440	5.69	15.40	0.19	9.18	0.20	19.90	0.34	0.28	43.50	0.27	4.92				3.11			
P				57.7	48.9	763	785	780	1290	1230	1400	5.70	15.35	0.19	9.12	0.20	19.85	0.34	0.28	43.40	0.28	4.93				3.11			
P				58.2	47.9	754	770	790	1270	1225	1420	5.69	15.30	0.19	9.12	0.20	19.85	0.34	0.28	43.60	0.28	4.93				3.11			
P				57.9	47.9	742	765	810	1260	1185	1420	5.70	15.35	0.19	9.15	0.20	19.85	0.34	0.28	43.80	0.28	4.93				3.11			
Q	1.02	1.28	0.14							54.4	44.5	846		1350													3.03		
Q	0.97	1.18	0.13							53.4	43.5	840		1340													3.03		
Q	1.04	1.29	0.14							55.8	45.1	848		1340													3.06		
Q	1.04	1.30	0.14							54.2	45.5	811		1310													3.03		
Q	1.07	1.33	0.14							50.6	46.4	784		1300													3.01		
Q	1.04	1.30	0.14							54.9	45.3	857		1390													3.05		
Q	1.02	1.27	0.14							56.7	49.7	873		1400													3.00		
Q	0.90	1.14	0.12							52.6	47.5	819		1330													3.04		
R	1.16	1.32	0.15							56.8	51.1	843	772	840	1350	1155	1320	5.62	15.00	0.19	8.94	0.18	19.40	0.35	0.31	43.10	0.28	4.25	3.03
R	1.14	1.29	0.14							55.8	49.9	835	822	830	1340	1195	1340	5.69	14.81	0.18	8.77	0.20	19.87	0.33	0.27	43.48	0.28	5.58	3.13
R	1.14	1.29	0.14							59.3	52.0	838	790	830	1335	1200	1320	5.67	14.69	0.18	8.71	0.19	19.84	0.32	0.27	43.41	0.29	5.54	3.01
R	1.16	1.31	0.14							59.6	51.6	855	799	840	1350	1220	1330	5.68	14.71	0.18	8.75	0.20	19.84	0.33	0.27	43.37	0.29	5.54	3.03
R	1.13	1.28	0.14							61.4	54.5	859	810	840	1355	1240	1330	5.75	14.79	0.18	8.79	0.20	19.92	0.33	0.28	43.60	0.29	5.54	3.16
R	1.18	1.33	0.15							57.2	53.4	810	816	850	1300	1210	1320	5.74	14.75	0.18	8.74	0.20	19.91	0.33	0.27	43.20	0.29	5.53	3.18
R	1.13	1.27	0.14							58.8	52.9	845	800	840	1330	1205	1330	5.74	14.79	0.18	8.77	0.20	19.88	0.33	0.28	43.68	0.29	5.55	3.11
R	1.14	1.29	0.15							60.5	51.6	883	808	830	1380	1175	1340	5.69	14.81	0.18	8.77	0.20	19.87	0.33	0.27	43.48	0.28	5.58	3.13
S	1.13	1.30	0.13							55.8	49.9	835	807	810	1290	1170	1190	5.65	15.30	0.19	9.13	0.18	19.75	0.34	0.29	43.40	0.28	4.80	3.13
S	1.15	1.29	0.14							57.0	50.0	733	719		1230	1190											3.13		
S	1.12	1.28	0.13							56.9	50.1	716	713		1190	1160													

12. Measurement of Uncertainty:

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 ISO guidelines.

Measurement of Uncertainty

Analyte	Method	unit	S ¹	σ_L ²	SW ³	CSU ⁴
Pt	PbCol	g/t	0.038	0.020	0.025	0.005
Pd	PbCol	g/t	0.039	0.018	0.029	0.005
Au	PbCol	g/t	0.007	0.003	0.005	0.005
Pt	NIS	g/t	0.058	0.044	0.035	0.015
Pd	NIS	g/t	0.044	0.025	0.037	0.010
Au	NIS	g/t	0.017	0.014	0.010	0.005
Ir	NiS	g/t	0.003	0.002	0.002	0.001
Rh	NiS	g/t	0.006	0.004	0.004	0.002
Ru	NiS	g/t	0.009	0.008	0.006	0.003
Co	M/ICP	ppm	3.536	2.205	1.998	0.621
Co	P	ppm	3.201	2.573	1.214	0.787
Cu	M/ICP	ppm	26.39	14.73	18.09	4.31
Cu	P	ppm	26.38	21.68	11.48	6.98
Cu	XRF	ppm	49.04	43.77	20.15	14.79
Ni	M/ICP	ppm	45.69	27.80	26.38	7.87
Ni	P	ppm	53.15	43.52	19.33	13.29
Ni	XRF	ppm	51.35	50.34	18.65	17.95
Al ₂ O ₃	XRF	%	0.039	0.027	0.026	0.010
CaO	XRF	%	0.180	0.149	0.081	0.048
Cr ₂ O ₃	XRF	%	0.006	0.004	0.005	0.001
Fe ₂ O ₃	XRF	%	0.098	0.085	0.044	0.029
K ₂ O	XRF	%	0.007	0.006	0.003	0.002
MgO	XRF	%	0.150	0.118	0.074	0.038
MnO	XRF	%	0.005	0.004	0.003	0.001
Na ₂ O	XRF	%	0.015	0.015	0.007	0.006
SiO ₂	XRF	%	0.416	0.357	0.154	0.114
TiO ₂	XRF	%	0.007	0.005	0.004	0.002
LOI		%	0.432	0.397	0.081	0.126
SG	pyc		0.050	0.031	0.036	0.010

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. Uncertified 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: AMIS0143 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.

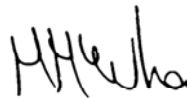
17. Minimum sample size: The majority of laboratories reporting used a 0.5g sample size for the ICP and a 30g sample size for the fire assay. These are the recommended minimum sample sizes for the use of this material.

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. 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.

11 November 2010

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

AMIS0143	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.36	0.10	14.53	56
Al	M/ICP	%	3.03	0.45	7.43	99
As	M/ICP	ppm	3.99	5.72	71.60	48
Ba	M/ICP	ppm	45.44	8.22	9.05	87
Be	M/ICP	ppm	0.17	0.07	20.38	60
Bi	M/ICP	ppm	0.49	0.06	6.27	59
Ca	M/ICP	%	10.47	0.87	4.18	98
Cd	M/ICP	ppm	0.16	0.02	6.86	47
Ce	M/ICP	ppm	8.98	1.45	8.10	64
Cr	M/ICP	ppm	991	557	28.09	108
Cs	M/ICP	ppm	1.22	0.15	6.25	61
Dy	M/ICP	ppm	1.42	0.07	2.39	15
Er	M/ICP	ppm	0.83	0.10	5.94	16
Eu	M/ICP	ppm	0.35	0.07	10.44	16
Fe	M/ICP	%	6.13	0.50	4.09	99
Ga	M/ICP	ppm	7.20	0.77	5.33	69
Ge	M/ICP	ppm	0.16	0.14	43.81	44
Hf	M/ICP	ppm	1.59	0.42	13.19	59
Ho	M/ICP	ppm	0.29	0.02	4.10	15
In	M/ICP	ppm	0.04	0.01	6.50	56
K	M/ICP	%	0.17	0.02	6.67	96
La	M/ICP	ppm	4.06	0.83	10.22	73
Li	M/ICP	ppm	12.98	3.19	12.29	84
Lu	M/ICP	ppm	0.12	0.02	9.96	23
Mg	M/ICP	%	11.75	0.91	3.89	99
Mn	M/ICP	ppm	2464	284	5.75	100
Mo	M/ICP	ppm	0.64	0.15	12.16	63
Na	M/ICP	%	0.20	0.03	8.19	90
Nb	M/ICP	ppm	1.07	0.19	8.84	60
Nd	M/ICP	ppm	5.00	0.28	2.80	16
P	M/ICP	ppm	116.32	26.14	11.24	94
Pb	M/ICP	ppm	16.74	2.92	8.71	87
Pr	M/ICP	ppm	1.15	0.08	3.68	16
Rb	M/ICP	ppm	12.47	2.77	11.09	62
Re	M/ICP	ppm	0.00	0.00	20.92	37
S	M/ICP	%	0.54	0.08	7.01	85
Sb	M/ICP	ppm	1.46	0.30	10.34	64
Sc	M/ICP	ppm	20.61	3.05	7.41	85
Se	M/ICP	ppm	2.38	0.98	20.64	40
Si	M/ICP	%	18.50	3.35	9.05	21
Sm	M/ICP	ppm	1.23	0.09	3.76	15
Sn	M/ICP	ppm	0.87	0.25	14.35	54
Sr	M/ICP	ppm	32.37	5.25	8.11	87
Ta	M/ICP	ppm	0.09	0.09	47.09	44
Tb	M/ICP	ppm	0.30	0.29	48.66	32
Te	M/ICP	ppm	0.54	0.11	9.98	56
Th	M/ICP	ppm	0.94	0.16	8.61	54
Ti	M/ICP	%	0.16	0.02	4.72	100
Tl	M/ICP	ppm	0.25	0.05	10.52	64
Tm	M/ICP	ppm	0.12	0.03	11.38	16
U	M/ICP	ppm	0.62	0.12	9.78	62
V	M/ICP	ppm	97.79	20.43	10.44	100
W	M/ICP	ppm	0.68	0.29	21.03	61
Y	YM/ICP	ppm	7.78	1.27	8.17	87
Yb	M/ICP	ppm	0.89	0.58	32.89	32
Zn	M/ICP	ppm	63.16	10.93	8.65	93
Zr	M/ICP	ppm	39.55	11.20	14.16	88