



## AMIS0165

### *Certified Reference Material*

### Platinum (PGM) Platreef Concentrate 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	16.90	±	1.26	g/t
Pd Pb Collection	19.10	±	1.36	g/t
Au Pb Collection	1.66	±	0.14	g/t
Pt NIS	17.33	±	1.94	g/t
Pd NIS	19.09	±	1.88	g/t
Au NIS	1.66	±	0.16	g/t
Ir NiS	0.52	±	0.08	g/t
Rh NiS	1.72	±	0.12	g/t
Ru NiS	2.02	±	0.22	g/t
Co M/ICP	928	±	51	ppm
Co P	932	±	61	ppm
Cu M/ICP	1.771	±	0.103	%
Cu P	1.766	±	0.088	%
Ni M/ICP	2.816	±	0.178	%
Ni P	2.886	±	0.270	%
Ni XRF	2.994	±	0.222	%
Specific Gravity	3.16	±	0.06	

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.

$$4E = \text{Platinum} + \text{Palladium} + \text{Rhodium} + \text{Gold} = 39.69 \text{ g/t}$$

# Major Element Recommended Concentrations and Limits (at two Standard Deviations)

## **Certified Concentrations**

Al <sub>2</sub> O <sub>3</sub>	4.45	±	0.12	%
CaO	4.89	±	0.20	%
Cr <sub>2</sub> O <sub>3</sub>	0.32	±	0.03	%
Fe <sub>2</sub> O <sub>3</sub>	18.38	±	0.78	%
MgO	17.53	±	0.40	%
MnO	0.177	±	0.012	%
SiO <sub>2</sub>	37.99	±	0.13	%

## **Provisional Concentrations**

TiO <sub>2</sub>	0.17	±	0.02	%
LOI	8.00	±	1.30	%

1. **Intended Use:** AMIS0165 can be used to check analysis of samples of PGE, Cu and Ni concentrate materials, derived from the Platreef or 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 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:** AMIS0165 is a commissioned CRM made from Mogalakwena North concentrate (PRNCP) concentrate material. The material was supplied by Anglo Platinum Limited.

3. **Mineral and Chemical Composition:** The Platreef is a Pt/Pd Ni/Cu ore from the northern limb of the Bushveld Complex in South Africa. Mineralization in the 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. Ore is finely ground and concentrated in a flotation process. Concentrate grades vary from 35 g/t to 110 g/t, and from this a PGM-rich nickel/copper matte is produced.

Major element chemistry data from 7 of the labs has been certified and is compiled in the table above. 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 Dark Blueish Grey (Corstor 5PB 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 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. Co, Cu and Ni. Multi-acid total digestion, including HF, with ICP-OES finish.
4. Co, Cu and Ni. Aqua regia digestion with ICP-OES finish.
5. Cr, Co, Cu and Ni. Pressed pellet XRF.
6. S by LECO
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 four laboratories were each given eight randomly 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 recalculated 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 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





Analyte	Method	Unit	S <sup>1</sup>	$\sigma_L$ <sup>2</sup>	SW <sup>3</sup>	CSU <sup>4</sup>
Pt	Pb Coll	g/t	0.630	0.482	0.348	0.158
Pd	Pb Coll	g/t	0.676	0.526	0.359	0.171
Au	Pb Coll	g/t	0.068	0.044	0.042	0.013
Pt	NIS	g/t	0.970	0.818	0.571	0.298
Pd	NIS	g/t	0.936	0.721	0.563	0.250
Au	NIS	g/t	0.079	0.048	0.064	0.019
Ir	NiS	g/t	0.039	0.030	0.028	0.012
Rh	NiS	g/t	0.063	0.048	0.045	0.019
Ru	NiS	g/t	0.112	0.104	0.060	0.040
Co	M/ICP	ppm	26.63	23.24	11.71	7.87
Co	P	ppm	30.69	26.03	12.24	8.35
Cu	M/ICP	ppm	514.9	408.5	292.9	140.7
Cu	P	ppm	439.3	388.5	175.4	131.3
Ni	M/ICP	ppm	887.6	711.9	546.4	261.6
Ni	P	ppm	1351.0	1290.1	370.4	432.3
Ni	XRF	%	1111.8	1346.3	281.4	551.1
SG	pyc		0.035	0.031	0.021	0.012
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.058	0.053	0.032	0.020
CaO	XRF	%	0.101	0.108	0.032	0.041
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.014	0.012	0.008	0.005
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.387	0.363	0.143	0.130
MgO	XRF	%	0.197	0.174	0.113	0.068
MnO	XRF	%	0.006	0.004	0.004	0.002
SiO <sub>2</sub>	XRF	%	0.671	0.630	0.244	0.225
TiO <sub>2</sub>	XRF	%	0.010	0.009	0.005	0.004
LOI		%	0.652	0.722	0.139	0.274

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

**13. Certified values:** The Certified, Provisional and Indicated values listed on p1 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Dr Barry Smee.

**14. Metrological Traceability:** The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the standards used by the individual laboratories the majority of which are accredited and who have maintained measurement traceability during the analytical process.

**15. Certification:** AMIS0165 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, 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.

20 July 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

See below the multi element trace element data submitted by five of the round robin laboratories, for informational use only.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	7.0	2.6	18.9	24
Al	M/ICP	%	2.3	0.2	3.4	24
As	M/ICP	ppm	14.1	10.2	36.0	24
Ba	M/ICP	ppm	40.2	25.6	31.9	24
Bi	M/ICP	ppm	8.0	2.8	17.4	16
Ca	M/ICP	%	3.4	0.2	2.6	28
Cd	M/ICP	ppm	2.1	0.5	13.1	16
Ce	M/ICP	ppm	6.2	0.8	6.7	16
Co	XRF	ppm	966	80	4.1	48
Cr	M/ICP	ppm	1748	488	13.9	16
Cs	M/ICP	ppm	1.3	0.8	30.2	16
Cu	XRF	ppm	17515	1445	4.1	44
Fe	M/ICP	%	12.7	0.9	3.6	32
Ga	M/ICP	ppm	5.0	0.6	6.4	16
Ge	M/ICP	ppm	0.9	0.2	10.2	16
In	M/ICP	ppm	0.1	0.01	6.8	16
K	M/ICP	%	0.2	0.02	5.0	31
K2O	XRF	%	0.2	0.01	3.4	40
La	M/ICP	ppm	3.0	0.3	5.6	16
Li	M/ICP	ppm	21.3	15.9	37.4	24
Lu	M/ICP	ppm	0.1	0.01	5.1	15
Mg	M/ICP	ppm	10.1	0.7	3.7	35
Mn	M/ICP	ppm	1351	169	6.2	36
Mo	M/ICP	ppm	4.5	1.7	18.6	24
Na	M/ICP	%	0.3	0.04	5.6	24
Na2O	XRF	%	0.4	0.1	13.1	47
Nb	M/ICP	ppm	1.7	0.8	23.3	16
P	M/ICP	ppm	109	21	9.5	16
Pb	M/ICP	ppm	144	55	19.1	16
Rb	M/ICP	ppm	11.0	1.4	6.3	16
S	M/ICP	ppm	7.4	0.7	4.9	16
S	LECO	%	7.0	0.7	5.2	24
Sb	M/ICP	ppm	9.1	6.3	34.7	23
Sc	M/ICP	ppm	16.5	5.2	15.9	16
Sn	M/ICP	ppm	1.1	0.2	8.2	15
Sr	M/ICP	ppm	38.9	7.7	9.9	24
Tb	M/ICP	ppm	0.1	0.02	5.6	16
Te	M/ICP	ppm	8.5	6.3	36.9	16
Ti	M/ICP	%	0.1	0.01	3.1	28
Tl	M/ICP	ppm	1.8	0.9	24.2	16
V	M/ICP	ppm	73.4	5.3	3.6	24
W	M/ICP	ppm	0.9	0.4	24.7	16
Y	M/ICP	ppm	4.9	0.5	5.4	16
Yb	M/ICP	ppm	0.6	0.1	7.0	16
Zn	M/ICP	ppm	528	104	9.9	24
Zr	M/ICP	ppm	19.2	4.6	12.0	16