



AMIS0171

Certified Reference Material

**Platinum (PGM) Merensky Concentrate
Bushveld Complex, South Africa**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Pt Pb Collection	58.28	±	3.62	g/t
Pd Pb Collection	36.86	±	2.70	g/t
Au Pb Collection	4.70	±	0.28	g/t
Pt NIS	58.28	±	1.42	g/t
Pd NIS	36.91	±	1.76	g/t
Au NIS	4.51	±	0.50	g/t
Rh NiS	7.48	±	0.42	g/t
Ru NiS	11.01	±	0.60	g/t
Co M/ICP	820	±	60	ppm
Co P	793	±	54	ppm
Cu M/ICP	1.622	±	0.103	%
Cu P	1.604	±	0.079	%
Ni M/ICP	2.468	±	0.153	%
Ni P	2.431		0.143	%
Specific Gravity	3.16		0.12	

Provisional Concentrations

Ir NiS	2.35	±	0.30	g/t
Co XRF	845	±	167	ppm
Ni XRF	2.458	±	0.260	%

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.

$$4E = \text{Platinum} + \text{Palladium} + \text{Rhodium} + \text{Gold} = 107.4 \text{ g/t}$$

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

Certified Concentrations

Al ₂ O ₃	2.09	±	0.08	%
CaO	1.82	±	0.08	%
Cr ₂ O ₃	0.51	±	0.02	%
Fe ₂ O ₃	19.30	±	0.50	%
MgO	20.42	±	0.86	%
MnO	0.13	±	0.01	%
SiO ₂	42.53	±	1.52	%

Informational Mean

K₂O 0.07 %

1. Intended Use: AMIS0171 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 concentrate materials; 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 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 Merensky Reef Pt/Pd concentrate material supplied by Anglo Platinum Limited from their Rustenburg Concentrators.

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.

Major element chemistry data from 10 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 Medium Dark Grey (Corstor).

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 <54um. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54um. 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 two 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 19 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 - Mogalakwena Analytical Laboratory (MPL)
7. Anglo Research (Crown Campus)
8. Barplats Laboratory SA
9. Genalysis Laboratory Services (South Africa) Pty
10. Genalysis Laboratory Services WA
11. Impala Mineral Processes Laboratory
12. Performance Laboratories SA
13. Rappa Research Laboratory
14. Set Point Laboratories (Isando) SA
15. Set Point Laboratories (Mokopane) SA
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booyens JHB
19. Zimplats Head Office Assay Laboratory

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 are set out below. A proficiency report has been sent to the managers of the participating laboratories. Additional digital data from this round robin is available on request.

Lab Code	Pt Pb Coll g/t	Pd Pb Coll g/t	Au NIS g/t	Pt NIS g/t	Pd NIS g/t	Au NIS g/t	Ir NIS g/t	Rh NIS g/t	Ru NIS g/t	Co MIPC ppm	Co P ppm	Cr XRF %	Cu MIPC %	Cu P %	Ni MIPC %	Ni P %	Ni XRF %	SG pyc	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	SiO2 XRF %	
A	57.00	37.00	4.48	59.00	39.00	4.03	3.41	7.00	11.10	836	834	788	16700	16200	27900	25700	26900	3.17	2.05	1.81	0.51	19.32	0.05	20.33	0.14	41.81	
A	50.00	37.00	4.52	57.00	39.00	4.31	3.27	6.89	10.70	837	790	814	17200	16200	27300	25600	26200	3.18	2.01	1.82	0.51	19.36	0.04	20.38	0.14	41.95	
A	59.00	37.00	4.55	57.00	38.00	4.30	3.54	7.03	10.80	833	796	795	16900	16400	27600	25800	26700	3.17	1.97	1.78	0.50	19.22	0.04	20.10	0.14	41.35	
A	59.00	36.00	4.47	58.00	37.00	4.16	3.40	6.93	10.90	837	805	822	17000	16200	28200	25600	26800	3.17	2.04	1.82	0.51	19.30	0.04	20.48	0.14	42.29	
A	57.00	37.00	4.58	57.00	37.00	4.22	3.40	6.89	10.70	837	787	782	17000	15700	27400	25500	26400	3.18	2.07	1.84	0.50	19.34	0.04	20.47	0.14	41.99	
A	58.00	37.00	4.59	58.00	37.00	4.10	3.43	7.03	10.80	837	787	800	16900	15800	27300	25100	26700	3.16	1.98	1.77	0.50	19.16	0.04	20.11	0.14	41.23	
A	60.00	37.00	4.73	58.00	39.00	4.20	3.65	7.03	11.00	836	795	771	16500	15800	27200	25100	26600	3.16	2.02	1.81	0.50	19.25	0.05	20.23	0.14	41.73	
A	57.00	37.00	4.54	58.00	38.00	4.17	3.71	6.93	11.00	834	801	795	16600	16200	27900	25700	26700	3.19	2.06	1.89	0.52	19.29	0.04	20.29	0.14	41.87	
B	57.00	37.00	4.70																								
B	57.00	38.00	4.76																								
B	57.00	37.00	4.69																								
B	58.00	37.00	4.69																								
B	56.00	37.00	4.67																								
B	57.00	37.00	4.88																								
B	58.00	37.00	4.72																								
B	58.00	38.00	4.70																								
C				58.89	36.54	4.58	2.48	7.68	11.21		363																
C				58.11	35.91	4.49	2.53	7.43	10.88		368																
C				59.43	36.56	4.37	2.56	7.65	11.17		359																
C				58.17	35.67	4.53	2.47	7.41	10.90		353																
C				59.99	36.97	4.56	2.57	7.75	11.36		351																
C				58.31	35.93	4.43	2.47	7.49	11.00		368																
C				57.42	35.33	4.51	2.38	7.31	10.71		359																
C				60.36	37.12	4.53	2.49	7.76	11.51		351																
D				58.15	36.21	4.33	2.60	7.46	11.34	860			16340		25310				3.21	2.14	2.05	0.59	19.49		20.96	42.20	
D				58.23	36.05	4.31	2.59	7.44	11.12	880			16290		25210				3.22	2.17	2.11	0.58	19.37		20.91	42.35	
D				57.86	36.07	4.30	2.63	7.44	11.11	860			16290		24720				3.21	2.16	2.10	0.59	19.54		20.95	42.50	
D				58.13	36.20	4.30	2.60	7.47	11.16	870			16440		25900				3.21	2.16	2.14	0.57	19.66		20.72	42.55	
D				58.13	36.05	4.30	2.64	7.48	11.18	850			16190		24690				3.21	2.14	2.01	0.58	19.49		20.67	42.62	
D				58.22	36.07	4.33	2.63	7.45	11.24	880			16460		24750				3.21	2.13	2.07	0.57	19.55		20.95	42.43	
D				58.46	36.04	4.35	2.61	7.47	11.13	850			16170		24920				3.25	2.22	2.10	0.58	19.54		20.72	42.56	
D				58.01	36.13	4.30	2.63	7.48	11.07	870			16210		24870				3.21	2.17	2.14	0.58	19.43		20.86	42.21	
E										790	770	880	16100	16550	24300	24600	24900	3.08	2.16	1.87	0.52	19.50	0.07	21.10	0.13	43.70	
E										800	780	870	16450	16550	24300	24700	24800	3.09	2.14	1.86	0.51	19.35	0.07	20.90	0.13	43.40	
E										800	760	860	16400	16350	24500	24400	24900	3.08	2.09	1.86	0.51	19.30	0.07	20.90	0.13	43.60	
E										770	770	880	15700	16500	23500	24400	25000	3.09	2.12	1.88	0.52	19.50	0.07	21.10	0.13	43.70	
E										800	770	860	16400	16350	24600	24600	24800	3.08	2.10	1.88	0.51	19.30	0.07	20.90	0.13	43.20	
E										790	770	870	16200	16550	24000	24600	24800	3.09	2.12	1.87	0.51	19.40	0.07	21.00	0.13	43.40	
E										800	770	870	16400	16500	25000	24200	24800	3.07	2.14	1.87	0.52	19.35	0.07	21.00	0.13	43.40	
F	58.90	35.10	4.57							790	780	880	16300	16490	24700	24300	24900	3.08	2.12	1.88	0.52	19.45	0.07	21.10	0.13	43.60	
F										850	800		16850	16350	25900	25400			2.06	1.77	1.40	0.49	19.25		20.50	41.50	
F										850	820		17050	16850	25500	26200			2.08	1.80	1.41	0.49	19.70		20.70	41.70	
F	59.70	38.20	4.77							840	800		16800	16100	25200	24200			2.06	1.76	1.40	0.49	19.65		20.70	41.70	
F	55.40	35.20	4.53							820	800		16450	16200	25100	24300			2.06	1.76	1.40	0.49	19.60		20.70	41.80	
F	55.60	34.70	4.48							840	800		16650	16500	25300	24600			2.09	1.83	1.40	0.49	19.65		20.70	41.80	
F	55.50	34.70	4.48							840	800		16650	16250	25200	25300			2.04	1.77	1.40	0.49	19.40		20.70	41.10	
G	57.10	35.40	4.75							790	760		16100	15350	23900	23600			3.18	2.11	1.83	0.50	18.99	0.08	20.78	0.13	42.86
G	56.50	35.00	4.77							850	790		16460	15900	24400	24600			3.25	2.09	1.81	0.50	18.93	0.08	20.55	0.13	42.70
G	57.90	35.80	4.76							790	770		16100	15650	23600	23900			3.17	2.10	1.83	0.51	19.07	0.08	20.85	0.13	42.93
G	56.90	35.10	4.65							790	780		16300	15550	24700	23600			3.29	2.10	1.83	0.51	19.01	0.08	20.83	0.13	42.77
G	56.70	34.70	4.40							770	780		15950	15500	23800	23200			3.14	2.14	1.84	0.51	19.10	0.08	20.89	0.13	43.00
G	59.30	36.70	4.93							790	770		16050	15300	24000	22500			3.23	2.09	1.81	0.50	19.84	0.08	20.83	0.13	42.61
G	59.20	36.50	4.92							800	790		16450	15000	25100	22700			3.05	2.10	1.82	0.50	19.01	0.09	20.87	0.13	42.75
G	59.40	36.50	4.91							790	770		16100	15450	23800	23700			3.07	2.11	1.81	0.51	19.04	0.08	20.89	0.13	42.83
H	60.70	38.50	5.18							840	760		16950	15500	24900	23500			3.12								
H	59.10	37.70	4.78							840	740		17150	15400	25300	23400			3.13								
H	61.20	38.40	5.05							830	780		17000	16100	24800	24600			3.14								
H	61.70	38.70	5.14							830	770		16950	15650	24900	24900			3.13								
H	59.70	37.70	4.98							790	790		16100	16150	23500	24400			3.14								
H	58.50	36.70	4.86							770	780		15550	16200	23000	24700			3.12								
H	58.10	36.80	4.94							810	770																

Analyte	Method	Unit	S ¹	σ _L ²	Sw ³	CSU ⁴
Pt	Pb Coll	g/t	1.814	0.972	1.363	0.316
Pd	Pb Coll	g/t	1.354	0.893	0.780	0.271
Au	Pb Coll	g/t	0.154	0.088	0.115	0.029
Pt	NIS	g/t	0.707	0.402	0.589	0.161
Pd	NIS	g/t	0.875	0.661	0.551	0.230
Au	NIS	g/t	0.252	0.239	0.106	0.086
Ir	NiS	g/t	0.150	0.155	0.060	0.059
Rh	NiS	g/t	0.209	0.171	0.146	0.068
Ru	NiS	g/t	0.301	0.228	0.208	0.085
Co	M/ICP	ppm	30.22	20.38	16.29	5.88
Co	P	ppm	26.80	27.72	11.48	10.59
Co	XRF	ppm	83.52	89.10	26.19	33.86
Cu	M/ICP	%	513.9	371.4	265.3	110.6
Cu	P	%	392.4	335.4	225.2	122.0
Ni	M/ICP	%	766.4	564.4	393.3	175.6
Ni	P	%	713.0	632.0	368.1	228.4
Ni	XRF	%	1301.2	1588.9	286.0	650.0
SG	pyc		0.057	0.050	0.032	0.018
Al ₂ O ₃	XRF	%	0.042	0.032	0.026	0.011
CaO	XRF	%	0.036	0.024	0.028	0.009
Cr ₂ O ₃	XRF	%	0.011	0.009	0.007	0.003
Fe ₂ O ₃	XRF	%	0.252	0.206	0.138	0.071
K ₂ O	XRF	%	0.014	0.017	0.004	0.007
MgO	XRF	%	0.427	0.363	0.164	0.116
MnO	XRF	%	0.005	0.005	0.002	0.002
SiO ₂	XRF	%	0.756	0.632	0.325	0.203

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. 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 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: AMIS0171 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. 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.

07 January 2011

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	4.21	0.72	8.54	24
Al	M/ICP	%	1.23	0.20	8.10	24
As	M/ICP	ppm	19.39	3.99	10.29	16
Ba	M/ICP	ppm	17.52	1.94	5.54	16
Bi	M/ICP	ppm	4.57	0.27	2.98	8
Ca	M/ICP	%	1.34	0.16	5.78	23
Cd	M/ICP	ppm	1.19	0.89	37.40	14
Ce	M/ICP	ppm	4.63	0.07	0.74	7
Cr	M/ICP	ppm	2320	719	15.50	24
Cs	M/ICP	ppm	0.34	0.02	3.02	8
Dy	M/ICP	ppm	0.78	0.02	1.53	8
Er	M/ICP	ppm	0.49	0.05	5.52	8
Eu	M/ICP	ppm	0.11	0.01	3.48	7
Fe	M/ICP	%	13.69	0.62	2.25	38
Ga	M/ICP	ppm	19.62	35.47	90.41	16
Hf	M/ICP	ppm	0.32	0.04	5.63	8
Ho	M/ICP	ppm	0.16	0.01	4.35	8
In	M/ICP	ppm	0.08	0.01	5.61	8
K	M/ICP	%	0.06	0.01	7.01	22
La	M/ICP	ppm	1.82	0.75	20.64	16
Li	M/ICP	ppm	3.93	1.20	15.29	15
Lu	M/ICP	ppm	0.09	0.004	2.11	8
Mg	M/ICP	%	11.83	0.31	1.32	23
Mn	M/ICP	ppm	959	62.64	3.27	32
Mo	M/ICP	ppm	1.38	1.04	37.64	8
Na	M/ICP	%	0.27	0.36	64.89	16
Nb	M/ICP	ppm	0.83	0.04	2.12	8
Nd	M/ICP	ppm	2.18	0.16	3.68	8
P	M/ICP	ppm	462	144	15.60	24
Pb	M/ICP	ppm	282	50.2	8.91	24
Pr	M/ICP	ppm	0.55	0.02	2.10	8
Rb	M/ICP	ppm	2.50	0.08	1.60	8
Re	M/ICP	ppm	0.07	0.01	10.09	8
S	M/ICP	%	5.52	1.12	10.14	24
Sb	M/ICP	ppm	10.92	4.16	19.06	16
Sc	M/ICP	ppm	14.93	1.66	5.57	15
Se	M/ICP	ppm	25.25	3.82	7.56	8
Si	M/ICP	%	20.10	0.66	1.64	8
Sm	M/ICP	ppm	0.59	0.05	4.37	8
Sn	M/ICP	ppm	0.95	0.19	9.75	8
Sr	M/ICP	ppm	18.78	2.48	6.61	24
Ta	M/ICP	ppm	5.12	10.35	101	16
Tb	M/ICP	ppm	0.12	0.01	2.83	8
Te	M/ICP	ppm	9.75	0.81	4.14	8
Th	M/ICP	ppm	3.64	0.18	2.44	8
Ti	M/ICP	%	0.10	0.01	5.82	32
Tl	M/ICP	ppm	3.04	5.81	95.44	16
Tm	M/ICP	ppm	0.08	0.02	10.08	8
U	M/ICP	ppm	29.85	0.91	1.52	8
V	M/ICP	ppm	95.85	21.55	11.24	24
W	M/ICP	ppm	0.34	0.10	15.33	8
Y	M/ICP	ppm	3.91	0.83	10.60	16
Yb	M/ICP	ppm	0.52	0.04	3.41	8
Zn	M/ICP	ppm	299	57.66	9.65	24
Zr	M/ICP	ppm	9.51	3.18	16.75	16