

AMIS0281

Certified Reference Material

**Multi element-PGM ore
 Sudbury Basin, Canada**

Certificate of Analysis

Recommended Concentrations and two “Between Laboratory” Standard Deviations¹

Certified Concentrations²

Ni M ICP	1.74	±	0.11	%
Ni P	1.67	±	0.09	%
Cu M ICP	5.55	±	0.22	%
Cu P	5.50	±	0.47	%
Pt Pb Collection	0.54	±	0.06	g/t
Pd Pb Collection	1.50	±	0.08	g/t
Co M ICP	173	±	15	ppm
Specific gravity	3.24	±	0.04	
Ag 4A_MICP	8	±	1	ppm

Provisional Concentrations

Au Pb Collection	0.220	±	0.028	g/t
Co P	167	±	21	ppm

$$3E \text{ PGM (Pt + Pd + Au)} = 2.26 \text{ g/t}$$

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.

AMIS

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 (Reg. No. 1989/000201/07)

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

Certified Concentrations

Al ₂ O ₃	9.58	±	0.34	%
CaO	3.82	±	0.26	%
Fe ₂ O ₃	26.58	±	1.44	%
K ₂ O	0.81	±	0.06	%
MgO	2.56	±	0.26	%
Na ₂ O	2.43	±	0.28	%
SiO ₂	37.85	±	1.24	%
TiO ₂	0.42	±	0.04	%
S Comb/LECO	11.84	±	0.50	%

Provisional Concentrations

MnO	0.10	±	0.02	%
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Indicated Mean

Cr ₂ O ₃	0.07	%
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1. Intended Use: AMIS0281 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis Nickel-Copper-PGM ores, hosted by 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 material provided by Quandra FNX Mining Ltd and SGS Minerals Services. The material is from project areas within the confines or peripheral to the Sudbury Structure and the associated 1.85 billion year old Sudbury Igneous Complex; located approximately 400 km north of Toronto, in close proximity to the City of Greater Sudbury, northeastern Ontario, Canada.

3. Mineral and Chemical Composition: The vast bulk of sulphides in the Sudbury ores consist essentially of varying proportions of pyrrhotite, chalcopyrite and pentlandite with varying amounts of other Cu-, Ni-, Co-, PGM-bearing minerals and gold.

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.

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4. **Appearance:** The material is a Dark Bluish 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. 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. Nineteen 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.

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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 19 out of 25 laboratories that provided results timeously were (not in same order as in the table of assays):

- 1 Activation Laboratories Pty Ltd (ActLabs) CA
- 2 Alex Stewart International Corporation Zambia
- 3 ALS Chemex Laboratory Group Brisbane Australia
- 4 ALS Chemex Laboratory Group Johannesburg SA
- 5 Genalysis Laboratory Services (South Africa) Pty
- 6 Genalysis Laboratory Services W Australia
- 7 Inspectorate Metals & Minerals
- 8 Intertek Utama Services (Indonesia)
- 9 Set Point Laboratories (Isando) SA
- 10 SGS Australia Pty Ltd (Newburn) WA
- 11 SGS Chelopech (Bulgaria)
- 12 SGS Durango (Mexico)
- 13 SGS Geosol Laboratories Ltda (Brazil)
- 14 SGS Mineral Services Callao (Peru)
- 15 SGS Mineral Services Lakefield (Canada)
- 16 SGS South Africa (Pty) Ltd - Booyens JHB
- 17 SGS Toronto (Canada)
- 18 SGS Townsville (Australia)
- 19 Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements are set out below – Economic elements.

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Lab Code	Pt Pb Coll g/t	Pd Pb coll g/t	Au Pb coll g/t	Co M ICP ppm	Co P M ICP ppm	Cu M ICP ppm	Cu P M ICP ppm	Cu XRF ppm	Ni M ICP ppm	Ni P M ICP ppm	Ni XRF ppm	4A_MICP Ag ppm
A	0.54	1.56	0.23	169.00	170.00	55500	53800			16000		
A	0.56	1.54	0.21	171.00	170.00	52100	53400			16000		
A	0.53	1.51	0.22	174.00	180.00	54800	53400			16500		
A	0.55	1.52	0.22	171.00	170.00	51900	53500			16600		
A	0.53	1.53	0.22	170.00	170.00	52400	54100			16400		
A	0.55	1.54	0.23	170.00	170.00	55900	53900			16100		
A	0.53	1.52	0.23	170.00	170.00	56400	53500			16500		
A	0.55	1.56	0.21	174.00	170.00	56200	53300			16200		
B			0.21									
B			0.20									
B			0.22									
B			0.21									
B			0.14									
B			0.16									
B			0.14									
B			0.20									
C	0.59	1.49	0.27	160.00	159.00	56100			17500			7.55
C	0.60	1.54	0.25	164.00	160.00	53000			16500			7.56
C	0.59	1.47	0.23	170.00	155.00	54800			17600			7.62
C	0.59	1.51	0.23	168.00	157.00	54400			17100			7.41
C	0.57	1.47	0.23	158.00	163.00	54900			17100			6.58
C	0.59	1.47	0.23	165.00	161.00	53200			17000			7.30
C	0.57	1.43	0.22	182.00	157.00	55700			17600			8.29
C	0.59	1.46	0.23	173.00	155.00	54800			17300			7.46
D				170.00		54100	54200	55100	17250	16700	17150	7.00
D				180.00		54200	54400	55300	17300	17050	17300	7.00
D				170.00		53000	54100	55400	17100	16900	17200	8.00
D				170.00		54500	54400	55400	17550	16800	17200	7.00
D				180.00		54200	54600	55600	16850	17150	17350	8.00
D				170.00		53800	54300	55400	16950	17100	17300	8.00
D				180.00		55900	54500	55400	17700	16900	17200	8.00
D				180.00		54900	53700	55500	17150	16200	17150	8.00
E	0.50	1.44	0.21	177.00	155.00	55300	51600		16900	16400		
E	0.51	1.44	0.19	173.00	149.00	55600	50700		16800	16600		
E	0.49	1.43	0.20	178.00	163.00	54700	53400		16600	16800		
E	0.50	1.47	0.20	177.00	163.00	55700	54000		16800	16700		
E	0.50	1.42	0.20	170.00	161.00	53100	52300		16100	16900		
E	0.50	1.44	0.19	169.00	159.00	53800	50700		16300	16400		
E	0.50	1.42	0.20	178.00	159.00	56400	51200		16600	16400		
E	0.51	1.46	0.20	178.00	161.00	54700	50900		16600	16300		
F			0.24			177.00	57100		14600			
F			0.23			181.00	58000		14900			
F			0.24			178.00	57000		14900			
F			0.23			179.00	57000		14800			
F			0.24			178.00	57700		14800			
F			0.23			178.00	54900		14000			
F			0.22			175.00	55300		15100			
F			0.22			178.00	55000		14800			
G	0.39	1.03	0.19	151.38	156.80			57500			17300	9.45
G	0.40	1.02	0.17	140.06	156.70			57800			17100	8.74
G	0.40	1.04	0.17	147.29	152.50			57300			16900	8.90
G	0.39	0.98	0.16	148.03	156.10			57200			16900	9.95
G	0.40	1.00	0.17	149.33	155.00			56400			16800	9.07
G	0.45	1.24	0.18	145.02	154.50			57300			17100	8.66
G	0.40	0.96	0.17	143.81	150.00			57200			17000	9.01
G	0.40	0.94	0.14	142.78	153.10			57400			17000	8.46
J			0.25			200.00		51600		16100		
J			0.25			160.00		51000		16200		
J			0.12			199.00		50800		16200		
J			0.25			199.00		50600		16200		
J			0.25			240.00		50600		16100		
J			0.12			160.00		51000		16100		
J			0.37			160.00		50800		16100		
J			0.25			180.00		51600		16600		
L	0.60	1.60	0.22	201.00	188.00	53500			18100			8.00
L	0.59	1.52	0.22	184.00	187.00	53300			18200			8.00
L	0.62	1.64	0.21	182.00	185.00	54500			17600			7.50
L	0.63	1.58	0.21	182.00	182.00	52800			17900			8.10
L	0.63	1.57	0.20	182.00	187.00	53500			18100			8.10
L	0.61	1.58	0.20	186.00	183.00	53800			18300			8.10
L	0.61	1.55	0.24	185.00	182.00	52700			18000			7.80
L	0.61	1.54	0.23	186.00	181.00	54700			18100			8.00

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Assay data (continued) – Economic elements

Lab Code	Pt Pb Coll g/t	Pd Pb coll g/t	Au Pb coll g/t	Co M ICP ppm	Co P M ICP ppm	Cu M ICP ppm	Cu P M ICP ppm	Cu XRF ppm	Ni M ICP ppm	Ni P M ICP ppm	Ni XRF ppm	4A_MICP Ag ppm
M				136.00	166.00			57800			17600	
M				134.00	173.00			57300			17400	
M				131.00	169.00			57000			17400	
M				131.00	174.00			56900			17300	
M				133.00	164.00			57400			17500	
M				130.00	165.00			57000			17300	
M				135.00	173.00			57800			17600	
M				136.00	169.00			57200			17400	
O	0.51	1.46	0.20	168.00	164.50	55500	57400		18050			8.28
O	0.50	1.46	0.21	165.50	157.50	55700	57200		17600			8.30
O	0.52	1.47	0.21	168.50	162.00	55300	57300		17350			8.23
O	0.52	1.47	0.21	165.50	160.50	56900	57600		17800			7.74
O	0.53	1.53	0.21	165.00	162.50	57300	57600		18050			8.60
O	0.51	1.47	0.20	160.00	160.50	55600	57100		17700			7.86
O	0.53	1.48	0.21	162.50	160.00	56100	58000		17550			8.07
O	0.51	1.46	0.21	160.00	161.00	56100	57600		17650			7.54
P	0.51	1.51	0.22									
P	0.53	1.52	0.22									
P	0.50	1.40	0.21									
P	0.55	1.50	0.22									
P	0.51	1.46	0.23									
P	0.54	1.44	0.22									
P	0.54	1.52	0.22									
P	0.52	1.52	0.22									
Q	0.40	1.55	0.21	175.00	133.00	56000	54200		17700	17400		7.30
Q	0.57	1.53	0.25	171.00	135.00	55800	53700		17500	17400		7.20
Q	0.56	1.43	0.23	164.00	139.00	54300	54600		17400	17400		7.10
Q	0.57	1.51	0.23	170.00	136.00	54700	55500		17400	17400		7.30
Q	0.52	1.53	0.24	170.00	133.00	55600	54500		17300	17500		7.20
Q	0.58	1.52	0.22	162.00	137.00	54400	55300		17300	17200		7.10
Q	0.59	1.51	0.23	168.00	134.00	54800	55100		17300	17100		7.30
Q	0.52	1.53	0.25	167.00	132.00	54200	54800		17200	17400		7.20
R	0.54	1.47	0.22	173.00	165.00	55700	58100		16700	16800		9.00
R	0.54	1.48	0.21	167.00	162.00	56400	57800		17000	16800		9.00
R	0.55	1.50	0.21	178.00	158.00	55300	58300		17300	17400		9.00
R	0.54	1.47	0.22	171.00	159.00	55500	57900		17000	17300		9.00
R	0.53	1.45	0.21	171.00	158.00	57000	57600		17400	16600		8.00
R	0.53	1.50	0.21	166.00	166.00	57500	57700		17700	17300		9.00
R	0.53	1.47	0.20	170.00	160.00	55900	56900		16800	16800		9.00
R	0.53	1.47	0.21	166.00	167.00	56100	58100		17500	17500		9.00
S	0.58	1.57	0.24	177.00	159.00	55600	57800		16800	16800		8.00
S	0.59	1.51	0.21	180.00	156.00	56200	54400		17600	16700		8.00
S	0.59	1.53	0.23	176.00	159.00	56800	53400		17200	16300		8.00
S	0.53	1.51	0.22	177.00	157.00	56000	56500		17600	17100		11.20
S	0.60	1.54	0.23	176.00	154.00	56200	54400		17700	17000		11.80
S	0.53	1.58	0.22	174.00	154.00	56200	54800		17300	17000		11.30
S	0.54	1.50	0.25	180.00	150.00	56200	54500		17400	16700		11.30
S	0.55	1.53	0.23	177.00	154.00	54200	54900		16900	16200		11.20
T	0.55	1.46	0.24	170.00	182.00	55600	53700		17400	16200		11.20
T	0.59	1.65	0.23	185.00	184.00	56100	55900		17600	17100		11.70
T	0.59	1.79	0.25	180.00	181.00	55800	55200		17600	17300		11.40
T	0.55	1.46	0.27	180.00	171.00	56300	55100		17700	17000		7.50
T	0.50	1.38	0.21	170.00	176.00	55300	55000		17400	16800		7.50
T	0.54	1.48	0.23	170.00	175.00	56000	57100		18000	17400		7.50
T	0.53	1.45	0.22	175.00	178.00	55900	57100		17500	17400		8.00
T	0.53	1.50	0.22	185.00	173.00	55600	55900		17500	17000		8.00
U	0.53	1.44	0.22	191.30	175.00	56723	58718		18475	17417		7.60
U	0.54	1.45	0.22	190.20	175.00	55894	58351		18320	18152		8.00
U	0.53	1.47	0.22	188.80	185.00	56377	59179		18163	18746		7.70
U	0.53	1.47	0.22	183.50	189.00	56206	59128		18266	18548		7.60
U	0.54	1.49	0.23	186.20	175.00	56026	56118		18363	17263		7.70
U	0.53	1.44	0.21	185.10	191.00	56448	59099		18254	18674		8.00
U	0.53	1.48	0.22	184.90	181.00	56253	56940		18444	18129		7.60
U	0.53	1.49	0.22	182.60	180.00	55709	59462		18227	18844		7.90
V				172.00	164.00	56900	55400		17300	16100		8.00
V				164.00	167.00	56000	55700		16900	16300		7.70
V				168.00	166.00	56700	56000		16700	16400		7.30
V				162.00	164.00	57000	55900		16300	16600		7.70
V				162.00	170.00	57300	55500		16600	16800		7.60
V				171.00	164.00	56700	55900		16500	16300		7.40
V				161.00	168.00	56200	56000		16400	16400		7.50
V				164.00	160.00	55900	55300		16400	16500		7.30

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Assay data (continued) – Major Oxides

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb/LECO %	SG pycnometer
A	9.79	3.92	0.09	26.40	0.84	2.55	0.10	2.41	38.30	0.43	5.83	11.70	3.23
A	9.81	3.96	0.13	26.70	0.83	2.58	0.11	2.35	38.60	0.45	5.49	11.50	3.24
A	9.90	3.93	0.08	26.40	0.85	2.59	0.11	2.54	38.40	0.43	5.44	11.80	3.26
A	9.81	3.93	0.09	26.40	0.85	2.56	0.11	2.59	38.80	0.44	5.56	11.70	3.25
A	9.95	3.98	0.10	26.10	0.88	2.59	0.11	2.37	38.80	0.45	5.48	11.80	3.26
A	9.95	3.95	0.09	26.00	0.87	2.60	0.11	2.37	38.80	0.44	5.44	11.70	3.26
A	9.91	3.95	0.09	25.80	0.84	2.61	0.11	2.32	38.90	0.44	5.57	11.70	3.25
A	9.88	3.98	0.09	26.10	0.87	2.59	0.11	2.34	39.00	0.44	5.48	11.60	3.26
B												12.20	
B												12.25	
B												12.17	
B												12.16	
B												12.00	
B												12.08	
B												12.17	
B												12.18	
C	8.37	4.46	0.04	22.02	0.78	2.57	0.09	2.44					
C	7.39	4.49	0.04	21.87	0.81	1.94	0.08	1.87					
C	7.86	4.77	0.05	22.59	0.82	2.32	0.09	2.18					
C	7.90	4.56	0.04	23.45	0.87	2.09	0.09	1.69					
C	8.90	3.99	0.04	22.59	0.81	2.32	0.09	1.89					
C	9.67	4.23	0.04	23.88	0.78	2.70	0.10	2.40					
C	9.18	5.19	0.05	24.73	0.87	2.69	0.10	2.51					
C	8.18	4.91	0.04	24.02	0.92	2.17	0.09	1.90					
D	9.54	3.84	0.07	25.73	0.80	2.59	0.12		37.50	0.43	5.30	12.40	
D	9.62	3.88	0.07	25.88	0.81	2.61	0.12		37.90	0.41	5.14	12.20	
D	9.50	3.85	0.07	25.81	0.80	2.59	0.12		37.60	0.43	5.24	12.50	
D	9.54	3.87	0.07	25.81	0.81	2.61	0.12		37.70	0.42	5.40	12.60	
D	9.59	3.88	0.07	25.88	0.81	2.60	0.12		37.90	0.42	5.21	12.40	
D	9.62	3.86	0.09	25.88	0.81	2.62	0.12		37.90	0.42	5.30	12.10	
D	9.59	3.87	0.07	25.88	0.81	2.62	0.12		37.90	0.42	5.30	12.80	
D	9.52	3.85	0.07	25.73	0.80	2.60	0.12		37.50	0.42	5.25	12.60	
E	9.62	3.96	0.09	26.41	0.82	2.69	0.12	2.97	36.63	0.44	4.40		3.25
E	9.44	3.98	0.09	26.76	0.83	2.75	0.12	2.99	36.65	0.44	4.41		3.27
E	9.22	3.87	0.09	26.51	0.81	2.61	0.12	2.90	35.86	0.43	4.22		3.25
E	9.02	3.97	0.09	26.18	0.85	2.66	0.13	2.98	34.93	0.43	4.50		3.26
E	9.47	3.98	0.10	26.54	0.82	2.65	0.13	2.94	36.68	0.44	4.42		3.25
E	9.17	3.90	0.10	26.23	0.81	2.61	0.12	2.93	35.34	0.43	4.15		3.25
E	9.37	3.95	0.10	26.50	0.82	2.60	0.12	2.95	36.41	0.44	4.24		3.27
E	9.41	3.97	0.09	26.36	0.84	2.65	0.12	2.98	36.74	0.44	4.51		3.25
J												11.72	
J												11.60	
J												11.69	
J												11.73	
J												11.68	
J												11.54	
J												11.63	
J												11.54	
K	7.79	3.62		22.67	0.69	2.12	0.10	2.27	34.61	0.45	3.76		
K	7.71	3.61		22.90	0.67	2.10	0.10	2.31	34.58	0.46	3.96		
K	8.20	3.61		23.08	0.67	2.19	0.10	2.31	34.89	0.39	3.83		
K	8.07	3.57		22.80	0.65	2.15	0.10	2.31	34.36	0.38	4.16		
K	8.14	3.56		22.75	0.67	2.20	0.13	2.29	34.32	0.39	4.04		
K	8.21	3.56		22.64	0.67	2.23	0.12	2.25	34.26	0.39	4.03		
K	8.10	3.53		22.68	0.66	2.16	0.10	2.30	34.15	0.38	4.43		
K	8.17	3.57		22.88	0.68	2.19	0.11	2.26	34.50	0.40	3.73		
L	9.41	3.90	0.08	25.80	0.80	2.61	0.10	2.44	37.40	0.43	4.55	12.00	
L	9.42	3.79	0.08	25.80	0.80	2.61	0.10	2.46	37.40	0.43	4.56	12.60	
L	9.41	3.90	0.08	25.80	0.80	2.60	0.10	2.43	37.40	0.43	4.59	12.20	
L	9.38	3.90	0.08	25.90	0.80	2.61	0.10	2.41	37.30	0.43	4.44	11.90	
L	9.41	3.90	0.08	25.90	0.80	2.60	0.10	2.45	37.40	0.42	4.42	11.90	
L	9.41	3.81	0.08	25.90	0.80	2.61	0.10	2.43	37.40	0.42	4.47	11.80	
L	9.41	3.80	0.08	25.80	0.80	2.62	0.10	2.43	37.40	0.42	4.48	12.00	
L	9.39	3.81	0.08	25.90	0.80	2.61	0.10	2.43	37.30	0.44	4.48	11.70	
M												12.40	
M												12.00	
M												12.00	
M												12.00	
M												12.20	
M												11.80	
M												11.80	

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Assay data (continued) – Major Oxides

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb/LECO %	SG pycnometer
O	9.77	3.72	0.06	28.17	0.76	2.34	0.10	2.21		0.41		11.90	3.21
O	9.71	3.71	0.06	27.38	0.75	2.34	0.10	2.21		0.40		11.70	3.23
O	9.92	3.79	0.06	27.16	0.77	2.39	0.10	2.24		0.41		11.80	3.32
O	9.75	3.74	0.06	27.81	0.76	2.35	0.10	2.21		0.40		11.80	3.22
O	9.60	3.65	0.06	28.17	0.75	2.29	0.10	2.18		0.40		11.90	3.23
O	9.54	3.64	0.06	27.52	0.73	2.29	0.10	2.17		0.39		11.80	3.20
O	9.62	3.65	0.06	27.95	0.75	2.30	0.10	2.18		0.40		11.80	3.20
O	9.58	3.65	0.06	27.59	0.75	2.30	0.10	2.17		0.40		11.90	3.22
P													3.19
P													3.26
P													3.25
P													3.25
P													3.26
P													3.22
P													3.27
P													3.25
Q	9.60	3.94	0.07	26.88	0.81	2.56	0.10	2.60	38.07	0.43		11.50	
Q	9.57	3.95	0.07	26.71	0.80	2.54	0.10	2.57	37.94	0.43		11.20	
Q	9.60	3.96	0.09	27.06	0.81	2.59	0.10	2.56	38.07	0.44		11.50	
Q	9.60	3.94	0.08	26.71	0.81	2.55	0.10	2.57	38.01	0.43		11.40	
Q	9.60	3.94	0.08	26.93	0.81	2.58	0.10	2.56	38.00	0.44		11.60	
Q	9.64	3.96	0.09	27.16	0.81	2.53	0.11	2.59	38.24	0.43		11.50	
Q	9.56	3.96	0.07	27.25	0.80	2.56	0.10	2.59	37.96	0.42		11.50	
Q	9.61	3.95	0.08	26.99	0.81	2.60	0.10	2.55	38.10	0.43		11.40	
R													11.50
R													11.80
R													11.60
R													11.50
R													11.50
R													11.60
R													11.40
R													11.70
S													3.20
S													3.24
S													3.22
S													3.22
S													3.24
S													3.26
S													3.24
S													3.28
T	9.60	3.89	0.09	26.35	0.82	2.69	0.10		38.15	0.43	5.72	11.80	3.37
T	9.63	3.89	0.09	26.39	0.83	2.70	0.10		38.19	0.44	5.71	11.80	3.35
T	9.60	3.89	0.09	26.29	0.82	2.68	0.10		38.11	0.43	5.72	11.90	3.34
T	9.63	3.90	0.09	26.38	0.83	2.70	0.10		38.17	0.44	5.74	11.90	3.33
T	9.59	3.89	0.09	26.29	0.83	2.68	0.10		38.07	0.43	5.72	11.80	3.32
T	9.60	3.88	0.09	26.26	0.82	2.69	0.10		38.13	0.43	5.69	11.90	3.35
T	9.64	3.90	0.09	26.38	0.83	2.68	0.10		38.16	0.44	5.72	11.90	3.34
T	9.63	3.89	0.09	26.37	0.83	2.69	0.10		38.13	0.44	5.68	11.70	3.32
U	9.36	3.80	0.07	28.09	0.91	2.63	0.10	2.58		0.42			3.31
U	9.39	3.80	0.06	28.09	0.91	2.61	0.10	2.60		0.43			3.45
U	9.34	3.80	0.05	27.95	0.91	2.61	0.10	2.57		0.42			3.42
U	9.39	3.78	0.06	27.82	0.90	2.61	0.10	2.55		0.43			3.46
U	9.37	3.81	0.06	28.08	0.91	2.70	0.11	2.58		0.43			3.34
U	9.32	3.79	0.06	27.86	0.90	2.66	0.11	2.58		0.42			3.32
U	9.34	3.81	0.05	27.92	0.90	2.63	0.11	2.57		0.42			3.30
U	9.38	3.85	0.07	28.08	0.91	2.64	0.11	2.59		0.43			3.22
V	9.88	3.62	0.04	26.15	0.81	2.40	0.10	2.60		0.42		12.33	3.21
V	10.17	3.64	0.04	26.29	0.82	2.42	0.10	2.59		0.42		12.25	3.21
V	9.71	3.57	0.04	26.32	0.80	2.29	0.10	2.51		0.38		12.18	3.23
V	9.35	3.50	0.04	26.18	0.76	2.34	0.10	2.45		0.40		12.16	3.22
V	9.62	3.47	0.04	26.09	0.78	2.29	0.10	2.57		0.37		12.28	3.19
V	9.73	3.60	0.04	26.08	0.76	2.21	0.10	2.48		0.37		12.25	3.20
V	9.75	3.62	0.04	26.25	0.81	2.34	0.10	2.44		0.40		12.22	3.19
V	9.64	3.67	0.04	26.41	0.78	2.27	0.10	2.43		0.38		12.24	3.21

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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.

Analyte	Method	Unit	S ¹	σ_L ²	SW ³	CSU ⁴
Pt	Pb Coll	g/t	0.029	0.021	0.017	0.007
Pd	Pb Coll	g/t	0.043	0.030	0.026	0.009
Au	Pb Coll	g/t	0.014	0.008	0.009	0.002
Co	M/ICP	ppm	7.465	5.055	4.365	1.528
Co	P	ppm	10.423	7.379	4.003	2.009
Cu	M/ICP	ppm	1094	605	779	185
Cu	P	ppm	2370	1979	816	603
Ni	M/ICP	ppm	549	424	267	131
Ni	P	ppm	448	353	274	122
Al ₂ O ₃	XRF	%	0.190	0.161	0.097	0.055
CaO	XRF	%	0.133	0.120	0.028	0.038
Cr ₂ O ₃	XRF	%	0.019	0.017	0.005	0.006
Fe ₂ O ₃	XRF	%	0.723	0.688	0.169	0.230
K ₂ O	XRF	%	0.029	0.024	0.016	0.008
MnO	XRF	%	0.008	0.006	0.003	0.002
Na ₂ O	XRF	%	0.142	0.152	0.049	0.058
SiO ₂	XRF	%	0.858	0.999	0.314	0.411
TiO ₂	XRF	%	0.017	0.013	0.010	0.004
S Comb/LECO		%	0.252	0.013	0.010	0.004
SG	pyc		0.027	0.018	0.023	0.008
Ag	4A_MICP	ppm	1.339	0.576	0.670	0.670

1. S - Std Dev for use on control charts.
2. σ_L - Between 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.

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

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: AMIS0281 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: Most of the 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.

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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, Daishnee Padayachee, Melesha Mungaroo and Allan Fraser; accept no liability for any decisions or actions taken following the use of the reference

Date of Version v0.02: 22 June 2020

Version: v0.02

Reason for Version v0.02: Correction of Cu and Ni unit of measurements

Version v0.02 replaces the original report of AMIS0281 Certification

Date of Version v0.01: 22 February 2019

Version: v0.01

Reason for Version v0.01: Certification of Ag by Allan Fraser.

Date of Version 000: 19 April 2012

Version: 000

Approving Officer:

African Mineral Standards: _____

Melesha Gopi Mungaroo (Technical Manager)

Certifying Officer:



Geochemist: _____

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Certifying Officers:



African Mineral Standards: _____

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Geochemist: _____

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Appendix – uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	4.99	0.44	4.38	105
As	M/ICP	ppm	4.01	3.74	46.6	57
Ba	M/ICP	ppm	247	299	60.6	88
Be	M/ICP	ppm	0.59	0.23	19.3	62
Bi	M/ICP	ppm	1.33	0.31	11.5	56
Ca	M/ICP	%	2.73	0.38	6.88	107
Cd	M/ICP	ppm	5.37	3.64	33.9	93
Ce	M/ICP	ppm	39.92	4.79	6.00	53
Cr	M/ICP	ppm	368	204	27.8	104
Cs	M/ICP	ppm	0.30	0.03	5.42	42
Dy	M/ICP	ppm	1.57	0.13	4.17	30
Er	M/ICP	ppm	0.88	0.34	19.4	31
Eu	M/ICP	ppm	0.93	0.27	14.7	32
Fe	M/ICP	%	18.4	1.48	4.01	83
Ga	M/ICP	ppm	11.8	2.59	11.0	56
Gd	M/ICP	ppm	2.44	0.49	10.1	32
Ge	M/ICP	ppm	0.78	0.76	48.6	32
Hf	M/ICP	ppm	0.86	0.18	10.6	55
Ho	M/ICP	ppm	0.27	0.06	11.5	32
In	M/ICP	ppm	1.41	0.16	5.78	51
K	M/ICP	%	0.67	0.10	7.21	104
La	M/ICP	ppm	19.5	4.25	10.9	87
Li	M/ICP	ppm	7.79	1.83	11.7	88
Lu	M/ICP	ppm	0.10	0.04	19.8	29
Mg	M/ICP	%	1.53	0.22	7.15	107
Mn	M/ICP	ppm	782	99.1	6.34	105
Mo	M/ICP	ppm	2.43	1.14	23.5	55
Na	M/ICP	%	1.81	0.20	5.53	106
Nb	M/ICP	ppm	2.51	0.40	7.93	55
Nd	M/ICP	ppm	18.2	2.32	6.38	30
P	M/ICP	ppm	573	155	13.5	85
Pb	M/ICP	ppm	79.9	25.7	16.1	96
Pr	M/ICP	ppm	4.93	0.41	4.14	30
Rb	M/ICP	ppm	15.0	3.08	10.3	56
Re	M/ICP	ppm	0.00	0.00	36.2	18
S	M/ICP	%	11.4	0.80	3.49	45
Sb	M/ICP	ppm	1.03	0.25	12.1	55
Sc	M/ICP	ppm	10.1	1.68	8.33	89
Se	M/ICP	ppm	44.7	25.3	28.4	56
Si	M/ICP	%	17.3	0.43	1.24	8
Sm	M/ICP	ppm	3.13	0.55	8.76	31
Sn	M/ICP	ppm	3.26	0.53	8.11	52
Sr	M/ICP	ppm	347	49.3	7.10	99
Ta	M/ICP	ppm	0.21	0.21	48.1	50
Tb	M/ICP	ppm	0.31	0.08	12.4	39
Te	M/ICP	ppm	2.97	0.63	10.6	52
Th	M/ICP	ppm	1.62	0.29	8.84	51
Ti	M/ICP	%	0.25	0.03	5.63	80
Tl	M/ICP	ppm	0.26	0.07	13.0	56
Tm	M/ICP	ppm	0.09	0.05	27.9	32
U	M/ICP	ppm	0.40	0.12	14.5	51
V	M/ICP	ppm	84.3	25.9	15.4	96
W	M/ICP	ppm	0.85	1.84	109	44
Y	M/ICP	ppm	7.40	1.48	10.0	91
Yb	M/ICP	ppm	0.69	0.16	11.8	39
Zn	M/ICP	ppm	719	58.7	4.08	95
Zr	M/ICP	ppm	26.9	21.0	39.2	86

AMIS

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