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AMIS0104

Certified Reference Material

Manganese Ore
Otjosondu manganese field, Namibia

Certificate of Analysis

Recommended Concentration and two “Between Laboratory” Standard Deviations

Certified Concentrations

Mn XRF	35.31	±	1.06	%
Mn M/ICP	35.49	±	2.08	%
Zn M/ICP	142	±	16	ppm
Ba M/ICP	2.86	±	0.23	%
Co M/ICP	240	±	21	ppm
SG	4.32	±	0.24	

Provisional Concentrations

As M/ICP	116	±	14	ppm
Cu M/ICP	192	±	26	ppm
P M/ICP	192	±	46	ppm
Sr M/ICP	309	±	38	ppm
V M/ICP	108			ppm

Major Element Certified Concentrations

Al ₂ O ₃	2.20	±	0.06	%
CaO	1.34	±	0.06	%
Fe ₂ O ₃	20.78	±	0.38	%
K ₂ O	0.26	±	0.02	%
SiO ₂	18.30	±	0.30	%
TiO ₂	0.27	±	0.02	%

Major Element Provisional Concentrations

MgO	0.35	±	0.06	%
LOI	3.28	±	0.70	%

Major Element Informational Values

Cr ₂ O ₃	0.03	%
Na ₂ O	0.10	%
S ICP	0.32	%

1. Intended use: AMIS0104 is a certified reference material (ISO Guide 30 2.1) which may be used to demonstrate the validity of measurement results of manganese ore, with a similar grade and matrix, when measured in parallel to the unknown to be characterized (ISO Guide 35 9.2).

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: Otjosundu manganese field is situated just north of the Okahandja Lineament some 150km north east of Windhoek. The Otjosundu manganese ore is associated with banded iron formation consisting of hematite-quartzite and iron-rich gneisses. The entire Otjosundu area has undergone Damaran metamorphism of at least upper amphibolite grade. The original paragenesis has been altered to a silica-rich metamorphic manganese mineral assemblage. This ore was supplied by Otjosundu Mining.

3. Mineral and chemical composition: In pure manganese ores the critical assemblage braunite + haematite + jacobsonite + rhodonite is frequently developed, whereas interlayered impure silicate ores bear various proportions of spessartine, Mn³⁺-bearing andradite-calderite and andradite garnets, rhodonite, manganoan aegirine-augite, aegirine, Ba-K-Na-feldspars, barite and rare kinoshitalite. Petrological constraints derived from country rock lithologies indicate peak metamorphic conditions of 660–700°C at estimated pressures of 3.5–4.5 kbar. Numerous Ba-rich pegmatitic veins restricted to the ore horizons testify to the production of partial melts from siliciclastic strata within the manganese formations*.

*Ref Bühn, B., Okrusch, M., Woermann, E., Lehnert, K., and Hoernes, S.; 1995; *Metamorphic Evolution of Neoproterozoic Manganese Formations and their Country Rocks at Otjosundu, Namibia*; *Journal of Petrology*, Volume 36, Number 2, Pages 463-496.

4. Appearance: The material is a very fine powder coloured Dusky Yellowish Brown (Corstor 10YR 2/2).

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 100% <54µm. Wet sieve particle size analysis of random samples confirmed the material was 100% <54µm. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Samples were selected for homogeneity testing and third party analysis. Statistical analysis for the consensus test results were carried out by an independent statistician. Explorer Packs are subdivided from the Laboratory packs as required.

7. Methods of analysis requested:

1. Multi element scan to include Zn, Pb, Cu, Co, Ni, As, Ag. Multi-acid total digestion, including HF, ICP-OES or ICP-MS.
2. Mn - fusion ICP.
3. Majors (Mn, Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, Na₂O, SiO₂, TiO₂. LOI.) XRF fusion.
4. SG, gas pycnometer.

8. Method of certification: Eighteen laboratories were each given eight randomly selected packages of sample. Sixteen 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.

9. Participating laboratories: (Not in same order as in the table of assays)

1. ACME Analytical Laboratories Ltd CA
2. Activation Laboratories Pty Ltd (ActLabs) CA
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. Anglo Research (Crown Campus)
7. Assayers Canada
8. Genalysis Laboratory Services WA
9. Intertek Utama Services (Indonesia)
10. Labtium Inc Finland
11. OMAC Laboratories Limited (Ireland)
12. Set Point Laboratories (Isando) SA
13. SGS Australia Pty Ltd (Newburn) WA
14. SGS Lakefield Research Africa (Pty) Ltd (Booyens SA)
15. SGS Mineral Services Lakefield (Canada)
16. Ultra Trace (Pty) Ltd WA

10. Assay Data: Data as received from the laboratories is set out below. A proficiency report has been sent to the managers of the participating laboratories.

Lab Code	Mn M/ICP %	Mn XRF %	As M/ICP ppm	Ba M/ICP ppm	Co M/ICP ppm	Cu M/ICP ppm	P M/ICP ppm	Sr M/ICP ppm	V M/ICP ppm	Zn M/ICP ppm	Ag M/ICP ppm	SG	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S M/ICP %	LOI %
A	35.50	35.50	123	30100	245.00	180.00	250.00	321	145.00	145.00		4.49	2.19	1.35	0.04	20.80	0.28	0.40	0.10	18.30	0.27	0.35	2.76
A	35.50	35.50	125	30200	250.00	185.00	250.00	327	140.00	150.00		4.51	2.20	1.34	0.04	20.70	0.28	0.40	0.09	18.30	0.27	0.35	2.82
A	35.50	35.60	118	28900	245.00	180.00	250.00	311	135.00	135.00		4.50	2.21	1.35	0.04	20.80	0.28	0.39	0.10	18.30	0.27	0.34	2.80
A	35.60	35.70	121	29400	250.00	180.00	250.00	315	140.00	135.00		4.47	2.19	1.36	0.04	20.80	0.28	0.40	0.10	18.30	0.27	0.34	2.76
A	35.50	35.90	119	29500	240.00	175.00	200.00	315	135.00	135.00		4.49	2.20	1.34	0.04	20.80	0.28	0.39	0.09	18.30	0.27	0.33	2.83
A	35.50	35.20	122	30000	245.00	175.00	200.00	317	140.00	145.00		4.52	2.19	1.35	0.04	20.70	0.28	0.39	0.10	18.30	0.27	0.33	2.82
A	35.60	36.30	124	30700	245.00	180.00	200.00	330	140.00	145.00		4.50	2.20	1.35	0.04	20.80	0.28	0.40	0.10	18.30	0.27	0.34	2.75
A	35.60	35.50	121	30200	240.00	180.00	200.00	324	135.00	145.00		4.50	2.19	1.35	0.04	20.80	0.28	0.39	0.10	18.30	0.27	0.35	2.81
B	34.40	35.32		26768	220.00	190.00				120.00		4.26	2.21	1.38		20.70	0.26	0.36	0.19	18.30	0.24		3.73
B	36.70	35.17		26410	210.00	180.00				110.00		4.25	2.20	1.36		20.50	0.26	0.36	0.19	18.20	0.24		3.55
B	34.50	35.24		26679	220.00	190.00				110.00		4.26	2.23	1.36		20.80	0.26	0.37	0.19	18.30	0.24		3.48
B	36.30	35.32		26589	220.00	180.00				110.00		4.27	2.20	1.35		20.60	0.26	0.35	0.18	18.30	0.24		3.50
B	36.20	35.48		26768	210.00	180.00				110.00		4.27	2.22	1.36		20.60	0.26	0.36	0.17	18.30	0.24		3.55
B	35.40	35.55		26768	210.00	180.00				120.00		4.26	2.22	1.37		20.80	0.26	0.36	0.17	18.40	0.25		3.50
B	35.10	35.24		26321	210.00	180.00				120.00		4.27	2.19	1.39		20.50	0.26	0.35	0.17	18.20	0.24		3.46
B	36.50	35.40		26858	210.00	190.00				120.00		4.25	2.23	1.37		20.70	0.26	0.37	0.16	18.30	0.24		3.55
C		34.47	110	22000	250.00	210.00		320		130.00		4.24	2.14	1.38	0.02	20.10	0.27	0.33	0.17	18.20	0.28		4.37
C		34.39	110	22000	240.00	200.00		310		120.00		4.23	2.16	1.39	0.02	20.00	0.28	0.33	0.17	18.30	0.28		4.39
C		34.39	120	21000	240.00	200.00		310		120.00		4.25	2.17	1.36	0.03	20.00	0.27	0.34	0.16	18.20	0.28		4.31
C		34.70	120	20000	250.00	200.00		320		130.00		4.25	2.20	1.39	0.02	20.20	0.28	0.33	0.18	18.50	0.29		4.33
C		34.39	120	21000	240.00	200.00		310		130.00		4.23	2.18	1.38	0.02	20.10	0.27	0.35	0.17	18.30	0.28		4.28
C		34.62	120	22000	240.00	200.00		310		130.00		4.25	2.19	1.38	0.03	20.10	0.27	0.33	0.15	18.40	0.28		4.22
C		34.62	130	22000	240.00	200.00		310		130.00		4.22	2.15	1.39	0.02	20.20	0.27	0.33	0.17	18.40	0.28		4.33
C		34.24	120	21000	240.00	200.00		300		140.00		4.24	2.16	1.37	0.03	20.00	0.28	0.34	0.17	18.20	0.28		4.32

Assay Data (cont):

Lab Code	Mn M/ICP %	Mn XRF %	As M/ICP ppm	Ba M/ICP ppm	Co M/ICP ppm	Cu M/ICP ppm	P M/ICP ppm	Sr M/ICP ppm	V M/ICP ppm	Zn M/ICP ppm	Ag M/ICP ppm	SG	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S M/ICP %	LOI %
D		35.10			215.00	166.00		344	25.00	144.00	0.20		2.21	1.32	0.03	20.50	0.27	0.35	0.10	18.20	0.27		4.73
D		35.10			251.00	187.00		359	23.00	141.00	0.20		2.22	1.31	0.03	20.50	0.27	0.34	0.10	18.20	0.27		4.79
D		35.10			236.00	167.00		334	37.00	144.00	0.10		2.19	1.30	0.03	20.50	0.27	0.35	0.11	18.20	0.27		4.71
D		35.10			237.00	179.00		341	26.00	145.00	0.10		2.22	1.30	0.03	20.50	0.27	0.35	0.10	18.20	0.27		4.71
D		35.10			242.00	201.00		356	35.00	150.00	0.10		2.23	1.30	0.03	20.50	0.27	0.36	0.09	18.20	0.27		4.70
D		35.20			239.00	226.00		345	35.00	155.00	0.10		2.22	1.32	0.03	20.50	0.27	0.35	0.09	18.20	0.27		4.66
D		35.10			242.00	189.00		354	33.00	151.00	0.10		2.22	1.31	0.03	20.50	0.27	0.35	0.09	18.20	0.27		4.65
D		35.20			223.00	169.00		340	31.00	151.00	0.20		2.21	1.30	0.03	20.50	0.27	0.36	0.10	18.10	0.27		4.66
E	36.48			30507	146.70	130.50	58.65	307	47.99	139.16			2.36	1.40	0.03	20.93	0.28	0.35	0.96	18.60	0.27	0.28	3.27
E	36.36			30544	153.50	144.56	72.85	290	81.63	142.58			2.32	1.40	0.03	21.33	0.24	0.35	0.96	18.78	0.27	0.28	3.30
E	35.70			29247	144.51	166.86	96.83	293	69.77	136.38			2.25	1.36	0.03	21.34	0.22	0.33	0.91	18.77	0.26	0.26	3.50
E	35.58			29358	166.28	185.87	160.11	306	80.46	141.93			2.24	1.35	0.03	20.70	0.22	0.32	0.91	18.24	0.26	0.31	3.64
E	36.00			28970	165.33	183.50	187.70	305	91.16	141.09			2.24	1.33	0.03	20.99	0.21	0.32	0.90	18.37	0.26	0.30	3.71
E	36.36			28003	165.40	183.99	163.01	298	64.54	139.48			2.14	1.29	0.03	20.62	0.21	0.31	0.87	18.58	0.25	0.32	3.50
E	36.11			28325	161.40	177.05	181.77	297	57.53	142.58			2.18	1.33	0.03	20.33	0.23	0.31	0.89	18.21	0.25	0.31	3.44
E	35.73			29531	163.50	174.36	176.16	297	60.25	138.97			2.27	1.37	0.03	20.96	0.24	0.33	0.92	18.48	0.26	0.29	3.48
F	34.63	35.79	140		187.00	206.55				150.09		4.22	2.37	1.39	0.04	21.03	0.27	0.30		18.15	0.31	0.33	3.60
F	35.30	35.30	147		186.00	219.00				151.29		4.23	2.34	1.35	0.04	20.95	0.26	0.25		18.40	0.32	0.30	3.56
F	34.69	35.87	140		188.00	194.11				141.69		4.24	2.20	1.38	0.04	20.80	0.27	0.30		18.26	0.31	0.31	3.58
F	35.06	35.30	146		186.00	222.73				148.89		4.21	2.22	1.32	0.04	20.93	0.26	0.32		18.40	0.32	0.30	3.61
F	34.60	35.78	146		181.00	205.31				148.89		4.23	2.23	1.39	0.04	20.77	0.27	0.27		18.19	0.31	0.31	3.60
F	34.57	35.40	142		181.00	205.31				148.89		4.22	2.28	1.35	0.04	21.03	0.25	0.27		18.40	0.32	0.28	3.57
F	34.60	35.77	146		188.00	219.00				159.70		4.21	2.22	1.39	0.04	20.72	0.26	0.31		18.22	0.31	0.28	3.60
F	34.60	35.30	145		188.00	231.44				162.10		4.23	2.34	1.33	0.04	20.88	0.25	0.31		18.30	0.32	0.34	3.63
G	37.33		114	20721	238.00	179.40		333	77.00	135.00													
G	36.15		109	20127	228.00	174.00		330	65.00	128.00													
G	36.39		115	20880	238.00	189.20		330	70.00	152.00													
G	35.73		111	20914	242.00	177.60		326	62.00	132.00													
G	36.32		109	19899	244.00	177.20		331	76.00	145.00													
G	36.54		108	20052	242.00	182.00		334	67.00	142.00													
G	36.07		111	20590	239.00	183.80		335	54.00	151.00													
G	35.96		112	21212	243.00	179.90		335	62.00	137.00													
H	36.85	35.24		29176	233.00	205.00		295	124.00	108.00	11.10	4.15	2.50	1.36	0.04	20.60	0.28	0.35	0.09	18.30	0.31	0.05	3.16
H	36.42	35.29		29194	232.00	206.00		293	124.00	106.00	11.80	4.12	2.39	1.37	0.04	20.62	0.29	0.36	0.13	18.74	0.27	0.04	3.44
H	35.99	35.38		29400	237.00	214.00		303	128.00	109.00	12.10	4.14	2.34	1.36	0.03	20.64	0.32	0.30	0.11	18.38	0.28	0.05	3.44
H	37.65	35.42		29481	229.00	196.00		262	119.00	101.00	10.20	4.13	2.39	1.38	0.03	20.75	0.31	0.27	0.10	18.45	0.30	0.06	3.43
H	36.48	35.49		29194	225.00	198.00		276	121.00	104.00	11.40	4.23	2.36	1.37	0.03	20.72	0.31	0.30	0.08	18.39	0.29	0.02	3.39
H	36.86	35.30		29678	230.00	196.00		277	119.00	103.00	10.70	4.09	2.52	1.35	0.03	20.64	0.36	0.35	0.23	18.07	0.30	0.04	3.37
H	36.83	35.41		29579	237.00	197.00		284	123.00	104.00	11.10	4.11	2.44	1.39	0.03	20.70	0.27	0.39	0.12	18.02	0.30	0.03	3.24
H	36.79	35.40		29311	233.00	204.00		289	123.00	105.00	8.30	4.13	2.38	1.37	0.03	20.82	0.26	0.34	0.09	18.45	0.30	0.04	3.15
I	35.40	34.13	107		28000	237.00	174.00	175.00	291	134.00	131.00		4.38	2.17	1.30	0.03	21.12	0.25	0.29	0.24	18.30	0.27	0.31
I	35.20	34.66	112	27800	250.00	184.00	195.00	308	141.00	131.00			4.38	2.21	1.31	0.03	21.40	0.26	0.30	0.25	18.50	0.27	0.31
I	34.90	34.18	112	27400	245.00	179.00	197.00	307	139.00	132.00			4.39	2.20	1.30	0.03	21.12	0.25	0.30	0.26	18.40	0.27	0.31
I	35.00	34.21	112	27400	245.00	180.00	188.00	305	139.00	135.00			4.39	2.21	1.30	0.03	21.16	0.25	0.29	0.27	18.40	0.27	0.31
I	34.70	34.01	108	27100	237.00	175.00	165.00	291	136.00	132.00			4.39	2.20	1.30	0.03	21.06	0.25	0.31	0.27	18.40	0.27	0.31
I	35.20	34.30	111	27600	244.00	181.00	177.00	306	139.00	133.00			4.39	2.18	1.30	0.03	21.25	0.25	0.29	0.26	18.30	0.27	0.31
I	35.10	34.49	106	27500	235.00	178.00	206.00	291	135.00	134.00			4.39	2.18	1.30	0.03	21.35	0.26	0.29	0.26	18.40	0.27	0.31
I	34.90	34.43	114	27400	249.00	181.00	180.00	306	138.00	136.00			4.38	2.23	1.31	0.03	21.29	0.25	0.30	0.29	18.40	0.27	0.31
K		35.40	124	29006	253.00	251.00				157.00			2.21	1.35	0.02	20.76	0.27	0.37	0.03	18.28	0.29	0.31	3.10
K		35.49	126	28827	258.00	247.00				157.00			2.22	1.36	0.02	20.82	0.27	0.37	0.03	18.38	0.29	0.31	3.20
K		35.61	123	29185	267.00	251.00				165.00			2.22	1.35	0.02	20.82	0.28	0.37	0.02	18.29	0.29	0.32	3.10
K		35.48	123	28917	250.00	243.00				154.00			2.21	1.36	0.03	20.76	0.27	0.37	0.04	18.32	0.29	0.31	3.10
K		35.41	126	28648	253.00	251.00				162.00			2.18	1.35	0.02	20.71	0.27	0.37	0.04	18.23	0.29	0.31	3.20
K		35.21	126	28648	263.00	255.00				161.00			2.17	1.35	0.02	20.62	0.27	0.37	0.04	18.11	0.28	0.31	3.10
K		35.21	125	28827	265.00	246.00				158.00			2.19	1.34	0.02	20.62	0.27	0.37	0.02	18.09	0.29	0.31	3.10
K		35.03	125	28469	262.00	248.00				163.00			2.18	1.33	0.02	20.49	0.27	0.38	0.02	18.14	0.29	0.31	3.30
L	33.73	34.14	108	29252	246.00	192.00	201.00	325	83.00	147.00		4.29	1.93	1.29		19.78	0.26	0.35	0.05	18.20	0.26	0.32	3.26
L	33.65	33.84	104	28054	240.00	193.00	209.00	325	84.00	145.00		4.31	1.91	1.28		18.96	0.26	0.35	0.05	18.10	0.26	0.32	3.17
L	33.65	33.94	108	28286	240.00	193.00	188.00	321	83.00	143.00		4.21	1.90	1.29		18.68	0.26	0.35	0.04	18.18	0.26	0.32	3.16
L	34.15	34.20	110	29240	247.00	195.00	272.00	329	85.00	148.00		4.22	1.91	1.30		19.08	0.26	0.35	0.05	18.19	0.26	0.32	3.22
L	33.94	34.16	113	29046	242.00																		

Assay Data (cont):

Lab Code	Mn M/ICP %	Mn XRF %	As M/ICP ppm	Ba M/ICP ppm	Co M/ICP ppm	Cu M/ICP ppm	P M/ICP ppm	Sr M/ICP ppm	V M/ICP ppm	Zn M/ICP ppm	Ag M/ICP ppm	SG	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S M/ICP %	LOI %
P	34.31	36.24	108		223.00	200.00				136.00	3.40	3.75	2.19	1.36	0.04	20.78	0.26	0.39	0.11	18.60	0.26		3.94
P	34.31	36.28	110		227.00	199.00				136.00	3.30	3.89	2.22	1.38	0.04	20.78	0.25	0.38	0.12	18.68	0.26		3.88
P	34.93	36.23	108		219.00	193.00				132.00	3.50	4.05	2.22	1.36	0.04	20.89	0.25	0.38	0.11	18.58	0.26		4.06
P	33.62	36.21	112		223.00	194.00				135.00	2.70	3.69	2.20	1.36	0.03	20.85	0.25	0.39	0.11	18.60	0.26		4.13
P	34.62	36.24	109		230.00	202.00				137.00	3.00	4.07	2.22	1.38	0.04	20.80	0.25	0.39	0.11	18.65	0.25		3.99
P	34.62	36.28	110		225.00	196.00				135.00	2.80	3.90	2.22	1.37	0.03	20.78	0.25	0.38	0.12	18.61	0.25		3.98
P	34.70	36.21	111		226.00	199.00				136.00	3.40	4.27	2.23	1.37	0.03	20.80	0.25	0.38	0.12	18.60	0.26		3.99
P	33.69	36.26	110		222.00	198.00				135.00	4.30	3.75	2.23	1.37	0.03	20.85	0.25	0.38	0.12	18.65	0.26		3.98
Q	36.90		88	19100	191.20	136.30	100.00	290	92.00	110.00	0.80												
Q	37.40		90	17700	190.00	134.70	90.00	298	93.00	105.00	0.80												
Q	36.60		85	19700	185.30	135.60	90.00	298	90.00	102.00	0.70												
Q	36.70		93	17800	199.00	142.70	100.00	301	98.00	112.00	0.80												
Q	37.40		88	18400	193.40	133.60	90.00	295	95.00	107.00	0.70												
Q	37.00		91	18200	199.10	139.40	100.00	298	98.00	112.00	0.70												
Q	36.90		90	19600	195.10	138.10	100.00	296	97.00	111.00	0.80												
Q	36.60		89	19200	196.80	141.20	100.00	289	98.00	112.00	0.80												

11. 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	CSU*	unit	Analyte	CSU*	unit
Al ₂ O ₃	0.019	%	Mn M/ICP	0.284	%
As M/ICP	6.140	ppm	Mn XRF	0.462	%
Ba M/ICP	1202	ppm	Na ₂ O	0.045	%
CaO	0.024	%	P M/ICP	20.532	ppm
Co M/ICP	8.000	ppm	S ICP	0.016	%
Cr ₂ O ₃	0.005	%	SG	0.112	
Cu M/ICP	8.866	ppm	SiO ₂	0.096	%
Fe ₂ O ₃	0.154	%	Sr M/ICP	16.171	ppm
K ₂ O	0.008	%	TiO ₂	0.008	%
LOI	0.306	%	V M/ICP	26.336	ppm
MgO	0.021	%	Zn M/ICP	5.433	ppm

*CSU = Combined standard uncertainty

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

13. 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.

14. Certification: AMIS0104 is a new material.

15. 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.

16. Minimum sample size: The majority of laboratories reporting used a 0.2g sample size for the ICP. This is the recommended minimum sample size for the use of this material.

17. Availability: This product is available in Laboratory Packs containing 1kg of material or in Explorer Packs containing client specified weights of material from 50g up to 250g. Laboratory Packs are sealed bottles delivered in sealed foil pouches. Explorer Packs contain material in standard geochem envelopes placed into foil pouches that are nitrogen flushed and vacuum sealed.

19. Legal notice: This certificate and the certified 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 this certified reference material.

Certified 30 March 2009

Certifying officers:



African Mineral Standards: _____
Mike McWha
BSc (Hons), FGSSA, MSAIMM, Pr.Sci.Nat



Geochemist: _____
Barry W. Smee
BSc, PhD, P.Geo, (B.C.)

Appendix – uncertified trace element statistics

	Method	Mean	2SD	RSD%	n
Be	M/ICP	2.1	0.3	8.1	61
Bi	M/ICP	0.61	0.13	10.5	46
Cd	M/ICP	0.78	1.14	72.9	39
Ce	M/ICP	299.4	23.3	3.9	46
Cr	M/ICP	180.2	35.4	9.8	54
Cs	M/ICP	0.19	0.03	6.8	16
Dy	M/ICP	10.6	1.6	7.6	31
Er	M/ICP	5.7	0.9	8.3	31
Eu	M/ICP	4.3	3.4	39.5	32
Ga	M/ICP	35.8	24.6	34.4	32
Gd	M/ICP	12.1	1.9	7.7	31
Ge	M/ICP	1.7	1.7	50.4	8
Hf	M/ICP	3.0	0.5	7.9	39
Ho	M/ICP	2.0	0.3	7.6	31
In	M/ICP	0.05	0.03	30.5	30
La	M/ICP	44.4	6.4	7.2	64
Li	M/ICP	18.3	3.0	8.3	37
Lu	M/ICP	0.66	0.19	14.4	32
Mo	M/ICP	4.7	2.2	23.7	63
Nb	M/ICP	5.5	1.2	11.2	32
Nd	M/ICP	55.7	5.2	4.7	30
Ni	M/ICP	42.1	11.6	13.8	93
Pb	M/ICP	50.7	10.7	10.5	39
Pr	M/ICP	12.6	2.0	7.7	30
Rb	M/ICP	5.3	0.5	5.0	31
Sb	M/ICP	9.7	2.3	11.9	55
Sc	M/ICP	4.6	1.8	19.6	64
Sm	M/ICP	12.8	1.3	5.0	31
Sn	M/ICP	2.0	0.7	17.2	47
Ta	M/ICP	0.21	0.04	8.4	15
Tb	M/ICP	1.8	0.3	9.0	30
Th	M/ICP	9.5	1.2	6.5	47
Tl	M/ICP	0.42	0.13	16.2	30
Tm	M/ICP	0.78	0.14	8.7	30
U	M/ICP	8.1	1.9	11.5	62
W	M/ICP	3.5	0.6	8.0	30
Y	M/ICP	41.2	5.0	6.1	61
Yb	M/ICP	4.9	1.1	11.3	31
Zr	M/ICP	134.1	19.9	7.4	47