African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0158

Certified Reference Material

Zinc lead sulphide ore
Rosh Pinah Mine, Namibia

Certificate of Analysis

Recommended Concentrations and Limits[1.]
(at two Standard Deviations)

Certified Concentrations[2.]

Zn M/ICP	1.62	±	0.06	%
Zn P	1.62	±	0.05	%
Zn F	1.59	±	0.08	%
Zn XRF	1.65	±	0.08	%
Cu M/ICP	370	±	16	ppm
Cu P	356	±	20.6	ppm
Fe M/ICP	1.92	±	0.08	%
Fe P	1.85	±	0.18	%
Mn M/ICP	2429	±	177	ppm
Mn P	2422	±	134	ppm
Pb M/ICP	2162	±	192	ppm
Pb P	2182	±	134	ppm
Specific Gravity	2.81	±	0.12	

Provisional Concentrations

Ag M/ICP	5.6	±	0.9	ppm
Ag P	5.7	±	0.8	ppm
As P	19.4	±	4.3	ppm

Informational Mean

As M/ICP	23.3	ppm

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.*

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

Certified Concentrations

Al_2O_3	5.25	±	0.18	%
CaO	7.57	±	0.10	%
Fe_2O_3	2.71	±	0.10	%
K_2O	2.89	±	0.06	%
MgO	5.07	±	0.20	%
MnO	0.31	±	0.02	%
SiO_2	61.88	±	1.46	%
S Combustion / LECO	1.74	±	0.10	%
S M/ICP	1.75	±	0.18	%
S P	1.76	±	0.10	%

Provisional Concentrations

Cr_2O_3	0.04	±	0.01	%
TiO_2	0.23	±	0.04	%
LOI	11.88	±	1.48	%

1. Intended Use: AMIS0158 can be used to check analysis of samples of SEDEX Zinc-lead ores 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: AMIS0158 was supplied by Exxaro from their Rosh Pinah mine situated 800km south of Windhoek in Namibia. The Rosh Pinah Zinc-lead deposit is hosted by the Rosh Pinah Formation of the Late Proterozoic Gariep Belt, which is an arcuate north trending tectonic unit some 400km long by 80km wide. This belt consists of sediments deposited in association with late pre-Cambrian continental rifting, which resulted in the formation of sedimentary basins. These basins are commonly sites for sedimentary exhalative (“SEDEX”) base metal mineralisation, which involves hot, metal-rich brines from depth rising along the extensional faults before emerging from the sea floor and interacting with the cold seawater. This results in the deposition of metal sulphides into topographic lows along with other sediments. Compressive tectonic processes resulted in the obliteration of the extensional features, folding of the strata and the development of thrust faulting.

The current geological interpretation of the Rosh Pinah deposit is that it represents a single layer of SEDEX sulphide mineralisation subsequently deformed by tectonic processes. The original strata have undergone varying degrees of deformation ranging from broad folding in the northern extremity of the deposit to isoclinal folding with associated faulting to the south. Ductile deformation

has resulted in the attenuation of the mineralised zone along the limbs of the folds with general thickening in the fold hinges. Shearing along fault planes sub-parallel to fold axes has enhanced thinning of some of the mineralised zones. The result of this has been the development of a series of discrete, sub-linear orebodies resident primarily on the crests and troughs of folds, but which typically extend into one or both of the fold limbs. These individual orebodies range in size from several tens of meters to as much as 200m in length along the axes, with thicknesses of the order of less than 1m to as much as 60m. The degree of geometric variability in section is substantial over distances of only 10m to 15m, with changes to the ore thickness of 50% or more commonly encountered within these distances.

3. Mineral and Chemical Composition: The mineralisation consists of sphalerite and galena with pyrite and minor chalcopyrite along with a suite of other minor accessory minerals. Sphalerite and galena are the economically important minerals with gold, silver and copper providing minor contributions to value. The upper contacts of the orebodies as defined by mineralisation are very sharp with little or no mineralisation beyond the hangingwall. The lower horizons show varying degrees of mineralisation, largely in the form of fracture-filling sulphides between breccia clasts and in fractures developed in late-stage brittle deformation. The grades developed in this "footwall" are generally less than 2% zinc equivalent and so are not currently of economic interest.

4. Appearance: The material is a very fine Med Light Grey powder (Corstor colour chart – 10Y 6/2).

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 <54um. Wet sieve parti**c**le 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 consensus test results were carried out by an independent statistician.

7. Methods of Analysis requested:

1. Multi element scan to include Zn, Ag, As, Cu, Fe, Mn, Pb, Tl. Multi-acid total digestion, including HF, ICP-OES or ICP-MS – (M ICP).
2. Multi element scan to include Zn, Ag, As, Cu, Fe, Mn, Pb, Tl. Aqua-regia digestion, ICP-OES or ICP-MS – (P).
3. Zn. Fusion, ICP – (F).
4. Zn. Fusion, XRF.
5. Majors (Al2O3, CaO, Cr2O3, Fe2O3, K2O, MgO, MnO, Na2O, SiO2, TiO2. LOI.) XRF fusion.
6. S – Total Combustion (Leco).
7. SG (gas pycnometer).

8. Information requested:

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported (not averages)
4. All results for Zn and major elements to be reported in %.
5. All results for multi-element scans to be reported in ppm.
6. Report all QC data, to include replicates, blanks and certified reference materials used.

9. Method of Certification: Twenty two laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Eighteen laboratories reported results in time for certification of the economic elements. Eight of these laboratories reported results for the major elements.

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 them 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 re-calculated 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: (Not in same order as in the table of assays):

1. Alex Stewart International Corporation Zambia
2. ALS Chemex Laboratory Group Brisbane Australia
3. ALS Chemex Laboratory Group Guangzhou (China)
4. ALS Chemex Laboratory Group Johannesburg SA
5. ALS Chemex Laboratory Group La Serena (Chile)
6. ALS Chemex Laboratory Group Lima (Peru)
7. ALS Chemex Laboratory Group Perth WA
8. ALS Chemex Laboratory Group Vancouver CA
9. Eltra Africa (South Africa)
10. Genalysis Laboratory Services (South Africa) Pty
11. Set Point Laboratories (Isando) SA
12. SGS Geosol Laboratories Ltda (Brazil)
13. SGS Mineral Services Callao (Peru)
14. SGS Mineral Services Lakefield (Canada)
15. SGS South Africa (Pty) Ltd - Booysens
16. SGS Toronto (Canada)
17. Ultra Trace (Pty) Ltd WA
18. Zincor Laboratory (South Africa)

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 is 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	Zn M/ICP per	Zn P per	Zn F per	Zn XRF per	Ag M/ICP	Ag P	As M/ICP	As P	Cu M/ICP	Cu P	Fe M/ICP	Fe P	Mn M/ICP ppm	Mn P	Pb M/ICP	Pb P	SG
A	1.60	1.33	1.60	1.72	4.90	4.90	27.0	20.0	326		1.93	1.69	2540	2215	2148	1711	2.78
A	1.60	1.32	1.61	1.70	4.80	4.80	30.0	22.0	322		1.89	1.68	2520	2223	2115	1710	2.80
A	1.60	1.34	1.60	1.70	4.90	4.90	30.0	21.0	329		1.91	1.69	2556	2210	2149	1732	2.79
A	1.60	1.33	1.61	1.72	4.90	4.90	28.0	21.0	324		1.90	1.70	2500	2211	2115	1737	2.79
A	1.60	1.33	1.60	1.69	4.90	4.90	28.0	22.0	324		1.92	1.69	2550	2203	2110	1707	2.79
A	1.60	1.33	1.63	1.72	4.90	4.90	27.0	21.0	320		1.91	1.70	2544	2236	2159	1740	2.79
A	1.60	1.32	1.60	1.71	4.90	4.90	28.0	22.0	325		1.88	1.70	2525	2218	2132	1703	2.78
A	1.60	1.34	1.60	1.71	5.00	5.00	27.0	22.0	327		1.91	1.71	2500	2229	2141	1738	2.79
B	1.62	1.62	1.62		6.10	6.10	23.0	22.6	375	360	1.93	1.90	2400	2520	2140	2300	2.79
B	1.62	1.63	1.63		5.90	5.90	24.0	21.8	365	362	1.93	1.91	2410	2530	2210	2350	2.79
B	1.63	1.61	1.61		5.80	5.80	22.0	21.8	370	363	1.91	1.92	2410	2540	2120	2230	2.81
B	1.62	1.63	1.65		5.90	5.90	22.0	22.6	370	361	1.94	1.91	2420	2530	2120	2250	2.79
B	1.62	1.61	1.61		5.70	5.70	23.0	21.8	365	353	1.92	1.90	2390	2500	2170	2180	2.78
B	1.61	1.62	1.62		5.90	5.90	22.0	22.6	370	363	1.90	1.92	2400	2540	2130	2250	2.80
B	1.63	1.64	1.63		5.90	5.90	22.0	21.6	365	366	1.93	1.92	2430	2580	2110	2250	2.79
B	1.64	1.59	1.63		6.00	6.00	22.0	22.2	365	368	1.91	1.92	2440	2540	2130	2190	2.80
C				1.67													
C				1.60													
C				1.62													
C				1.65													
C				1.60													
C				1.61													
C				1.63													
C				1.58													
E			1.69	1.64				17.0	325		1.89		2090		1974	2003	2.73
E			1.60	1.62				16.0	341		1.97		2203		2032	2017	2.69
E			1.54	1.61				18.0	327		1.86		2110		1985	2052	2.68
E			1.64	1.56				17.0	322		1.85		2112		1971	1982	2.64
E			1.55	1.68				19.0	336		1.90		2116		2027	2053	2.80
E			1.60	1.68			11.0	17.0	323		1.85		2075		1981	2073	2.71
E			1.60	1.62			16.0	16.0	312		1.76		2054		1870	2048	2.73
E			1.63	1.62				16.0	333		1.89		2189		2011	1976	2.72

Assay data (cont)

Lab	Zn	Zn	Zn	Zn	Ag	Ag	As	As	Cu	Cu	Fe	Fe	Mn	Mn	Pb	Pb	SG
Code	M/ICP	P	F	XRF	M/ICP	P	M/ICP	P	M/ICP	P	M/ICP	P	M/ICP	P	M/ICP	P	
	per	per	per	per									ppm				
F	1.64	1.60	1.55		5.38	5.38	17.0	17.0	360	356	1.95	1.86	2320	2490	1980	2110	2.99
F	1.65	1.50	1.52		5.32	5.32	18.0	17.0	356	355	1.94	1.82	2320	2440	2020	2060	2.93
F	1.63	1.57	1.52		5.36	5.36	18.0	17.0	375	349	1.93	1.85	2330	2470	2040	2150	2.99
F	1.64	1.55	1.52		5.38	5.38	18.0	16.0	372	357	1.94	1.85	2350	2470	2090	2090	2.92
F	1.68	1.57	1.52		5.22	5.22	18.0	17.0	365	356	1.94	1.81	2340	2420	2120	2110	2.91
G	1.59		1.56	1.65				16.0	371	359	1.89	2.04	2580	2440	2000	2330	
G	1.62		1.55	1.61				17.0	367	340	1.98	2.05	2590	2280	2010	2170	
G	1.65		1.55	1.67				18.0	358	361	1.90	1.99	2470	2430	2020	2320	
G	1.59		1.57	1.64				17.0	393	346	1.97	1.95	2550	2340	2040	2270	
G	1.58		1.58	1.67				16.0	386	359	1.95	2.00	2540	2460	1990	2320	
G	1.64		1.58	1.68				17.0	366	359	1.92	2.04	2390	2440	2010	2210	
G	1.65		1.56	1.66				16.0	388	336	1.90	2.00	2560	2340	2000	2320	
G	1.60		1.55	1.65				16.0	386	336	1.85	2.04	2520	2350	2030	2230	
H	1.59		1.62				26.0	21.0	368	344		1.76	2484	2375	2258	2216	
H	1.60		1.62				27.0	22.0	358	354		1.72	2462	2346	2295	2209	
H	1.59		1.63				25.0	23.0	362	351		1.76	2486	2422	2256	2225	
H	1.59		1.60				24.0	20.0	361	345		1.78	2476	2404	2262	2207	
H	1.59		1.61				25.0	25.0	363	348		1.71	2416	2404	2273	2224	
H	1.58		1.62				26.0	21.0	363	351		1.72	2410	2395	2270	2216	
H	1.60		1.63				26.0	22.0	364	356		1.76	2397	2381	2289	2219	
H	1.59		1.62				25.0	25.0	363	355		1.74	2431	2391	2259	2215	
I	1.59		1.63	1.63			20.0	32.0	374	362	1.83	1.87	2520	2540	2140	1830	2.78
I	1.57		1.64	1.66			20.0	32.0	366	363	1.88	1.83	2530	2380	2030	1830	2.77
I	1.58		1.61	1.68			20.0	33.0	363	354	1.87	1.91	2530	2450	2060	1830	2.78
I	1.60		1.67	1.65			20.0	30.0	366	364	1.85	1.91	2540	2500	2070	1870	2.79
I	1.63		1.66	1.69			20.0	31.0	370	364	1.86	1.92	2530	2530	2080	1880	2.78
I	1.62		1.67	1.66			20.0	32.0	369	369	1.83	1.83	2520	2480	2080	1830	2.76
I	1.62		1.66	1.70			20.0	33.0	393	366	1.88	1.89	2540	2530	2100	1820	2.77
I	1.57		1.69	1.65			20.0	32.0	374	372	1.88	1.86	2530	2480	2100	1830	2.77
J	1.58		1.70	1.62	6.10	6.10	24.0	19.0	360	350	1.85	1.80	2400	2400	2220	2240	
J	1.60		1.75	1.60	5.90	5.90	20.0	20.0	370	350	1.88	1.79	2500	2400	2250	2240	
J	1.58		1.82	1.60	6.20	6.20	24.0	19.0	360	360	1.87	1.85	2400	2400	2220	2320	
J	1.55		1.75	1.62	6.10	6.10	25.0	18.0	350	360	1.82	1.84	2400	2400	2180	2270	
J	1.59		1.73	1.62	6.20	6.20	23.0	19.0	360	350	1.87	1.81	2400	2400	2240	2240	
J	1.66		1.73	1.60	5.90	5.90	23.0	19.0	380	360	1.90	1.81	2500	2400	2310	2260	
J	1.58		1.79	1.63	6.00	6.00	22.0	20.0	360	350	1.89	1.79	2500	2400	2250	2220	
J	1.61		1.74	1.60	6.30	6.30	24.0	17.0	370	360	1.90	1.81	2500	2400	2330	2290	
K	1.68	1.61			5.20	5.20	20.0	24.0	380	390	1.93	1.88	2500	2400	2290	2200	4.21
K	1.65	1.60			6.00	6.00	20.0	20.0	370	380	1.90	1.85	2400	2400	2230	2170	4.17
K	1.65	1.61			5.60	5.60	10.0	19.0	370	380	1.89	1.88	2400	2400	2250	2190	4.40
K	1.68	1.65			5.30	5.30	20.0	21.0	380	390	1.92	1.91	2400	2500	2290	2220	4.32
K	1.69	1.68			5.30	5.30	30.0	22.0	380	440	1.94	1.91	2500	2400	2310	2270	4.31
K	1.65	1.61			5.70	5.70	30.0	22.0	370	390	1.90	1.88	2400	2400	2260	2210	4.26
K	1.68	1.63			5.40	5.40	20.0	19.0	370	390	1.93	1.89	2400	2500	2280	2240	4.28
K	1.69	1.65			5.20	5.20	30.0	19.0	380	370	1.94	1.92	2500	2400	2290	2240	4.28
L	1.62	1.70			6.00	6.00	28.0	20.0	370	370	1.96	1.93	2400	2500	2190	2220	
L	1.61	1.66			5.00	5.00	28.0	18.0	370	360	1.98	1.93	2400	2500	2220	2210	
L	1.64	1.65			6.00	6.00	29.0	18.0	380	370	2.02	1.91	2500	2500	2270	2180	
L	1.63	1.63			5.00	5.00	26.0	18.0	380	360	2.02	1.91	2500	2400	2270	2150	
L	1.63	1.68			6.00	6.00	26.0	19.0	370	370	1.96	1.94	2400	2500	2190	2190	
L	1.65	1.67			5.00	5.00	27.0	17.0	390	370	2.00	1.94	2500	2500	2280	2200	
L	1.70	1.64			5.00	5.00	26.0	17.0	380	360	2.02	1.91	2500	2400	2260	2150	
L	1.68	1.61			6.00	6.00	28.0	17.0	380	350	1.99	1.83	2500	2400	2250	2060	
M	1.75		1.73		6.10	6.10	20.0	22.0	360	340	1.90	1.81	2300	2300	2200	2120	
M	1.74		1.77		6.10	6.10	20.0	22.0	360	350	1.90	1.84	2300	2300	2200	2150	
M	1.75		1.77		6.20	6.20	20.0	21.0	360	350	1.91	1.83	2400	2300	2190	2130	
M	1.66		1.74		5.90	5.90	20.0	19.0	350	340	1.87	1.82	2300	2300	2150	2140	
M	1.69		1.74		6.00	6.00	30.0	20.0	360	350	1.89	1.84	2300	2300	2180	2150	
M	1.67		1.73		6.00	6.00	30.0	22.0	360	350	1.89	1.81	2300	2300	2180	2120	
M	1.74		1.71		6.00	6.00	30.0	22.0	360	350	1.90	1.83	2300	2300	2190	2130	
M	1.70		1.70		6.00	6.00	40.0	20.0	360	350	1.86	1.82	2300	2300	2160	2150	
N		1.62			5.20	5.20	18.0	22.0	356	346	1.83	1.67	2340	2370		2100	
N		1.61			5.60	5.60	20.0	17.0	388	365	1.95	1.71	2280	2420		2140	
N		1.62			5.20	5.20	28.0	22.0	382	359	2.01	1.67	2360	2380		2110	
N		1.59			5.10	5.10	26.0	22.0	391	355	1.99	1.67	2340	2380		2110	
N		1.62			5.20	5.20	19.0	21.0	366	374	1.98	1.73	2320	2460		2170	
N		1.61			5.00	5.00	29.0	19.0	379	370	2.07	1.72	2420	2450		2160	
N		1.62			5.00	5.00	24.0	18.0	371	364	1.92	1.68	2260	2380		2110	
N		1.61			5.00	5.00	30.0	20.0	372	380	1.91	1.73	2240	2460		2170	
O	1.64			1.63	5.10	5.10	22.0	17.0	370	335	1.95	1.60	2400	2050	2230	1850	
O	1.65			1.68	5.30	5.30	21.0	21.0	380	346	1.94	1.64	2400	2100	2240	1890	
O	1.65			1.69	5.10	5.10	20.0	20.0	380	340	2.01	1.64	2500	2120	2290	1900	
O	1.63			1.68	5.30	5.30	26.0	18.0	380	335	1.99	1.59	2400	2040	2250	1835	
O	1.65			1.68	5.10	5.10	22.0	17.0	370	333	1.93	1.53	2600	1965	2190	1765	
O	1.62			1.62	5.20	5.20	23.0	21.0	370	340	1.96	1.63	2400	2090	2230	1890	
O	1.62			1.66	5.40	5.40	27.0	17.0	380	349	1.92	1.62	2300	2070	2200	1860	
O	1.64			1.66	5.10	5.10	26.0	21.0	370	354	1.93	1.64	2600	2090	2200	1880	
P	1.57	1.60	1.55		5.90	5.90	21.0	19.0	380	350	1.98	1.90	2300	2300	2290	2120	2.91
P	1.61	1.64	1.57		6.20	6.20	20.0	21.0	380	360	1.97	1.95	2400	2400	2200	2170	2.85
P	1.59	1.62	1.54		6.10	6.10	20.0	21.0	380	360	1.94	1.93	2300	2400	2170	2170	2.79
P	1.60	1.62	1.54		6.10	6.10	20.0	20.0	370	360	1.95	1.93	2400	2400	2190	2170	2.85
P	1.59	1.61	1.58		6.20	6.20	18.0	21.0	370	350	1.96	1.93	2400	2400	2190	2150	2.90
P	1.54	1.62	1.56		6.10	6.10	21.0	18.0	360	360	1.89	1.92	2300	2400	2110	2150	2.84
P	1.57	1.64	1.55		5.80	5.80	18.0	19.0	370	360	1.91	1.95	2300	2400	2160	2190	2.84
P	1.54	1.63	1.56		6.20	6.20	19.0	19.0	370	360	1.91	1.94	2300	2400	2130	2190	2.77
Q				1.53													
Q				1.42													
Q				1.55													
Q				1.53													
Q				1.53													
Q				1.53													
Q				1.49													
Q				1.50													
V																	2.83
V																	2.82
V																	2.82
V																	2.80
V																	2.83
V																	2.82
V																	2.80
V																	2.81

12. Measurement of Uncertainty: The samples used in the certification process were 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:

Combined standard uncertainty=sqrt((between lab.var/no of labs) + (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 the relevant ISO guidelines.

Analyte	Method	Unit	S [1]	σ_L [2]	Sw [3]	CSU [4]
Zn	M/ICP	%	0.031	0.021	0.019	0.007
Zn	P	%	0.024	0.017	0.020	0.007
Zn	F	%	0.041	0.039	0.018	0.014
Zn	XRF	%	0.037	0.034	0.023	0.013
Ag	M/ICP	ppm	0.446	0.262	0.317	0.083
Ag	P	ppm	0.423	0.350	0.234	0.120
As	M/ICP	ppm	3.923	2.192	2.724	0.669
As	P	ppm	2.138	1.403	1.237	0.408
Cu	M/ICP	ppm	8.10	3.82	6.63	1.30
Cu	P	ppm	10.32	6.45	6.74	1.99
Fe	M/ICP	%	0.043	0.024	0.031	0.007
Fe	P	%	0.095	0.077	0.026	0.022
Mn	M/ICP	ppm	88.3	58.7	50.3	17.0
Mn	P	ppm	67.0	49.5	36.3	15.4
Pb	M/ICP	ppm	96.0	71.9	36.3	20.2
Pb	P	ppm	66.9	49.5	34.0	15.4
SG	pycnometer		0.060	0.061	0.025	0.023

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 Informational 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, who have maintained measurement traceability during the analytical process.

15. Certification: AMIS0158 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 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, 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.

2 December 2009

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 1. – Uncertified trace element statistics

Although requested, very few of the laboratories reported multi-element scan data. The data below is for informational use only.

AMIS0158 Trace

Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	2.88	0.22	3.9	63
Ba	M/ICP	ppm	298	274	45.9	54
Be	M/ICP	ppm	0.96	0.13	7.1	60
Bi	M/ICP	ppm	2.17	2.36	54.4	27
Ca	M/ICP	%	5.22	0.5	4.4	62
Cd	M/ICP	ppm	36.5	3.4	4.6	62
Ce	M/ICP	ppm	40.9	2.1	2.6	8
Co	M/ICP	ppm	5.10	1.4	13.6	58
Cr	M/ICP	ppm	230	75.2	16.4	63
Cs	M/ICP	ppm	2.00	0.00	0.0	7
Dy	M/ICP	ppm	3.00			7
Er	M/ICP	ppm	1.63	0.46	14.2	8
Eu	M/ICP	ppm	0.68	0.21	15.3	8
Ga	M/ICP	ppm	10.0			56
Gd	M/ICP	ppm	4.00			7
Hf	M/ICP	ppm	0.91	0.21	11.7	7
Ho	M/ICP	ppm	0.60			7
In	M/ICP	ppm	0.53	0.03	2.7	8
K	M/ICP	%	2.36	0.22	4.6	62
La	M/ICP	ppm	15.9	9.9	31.1	64
Li	M/ICP	ppm	8.88	0.5	2.6	8
Lu	M/ICP	ppm	0.20			8
Mg	M/ICP	%	2.99	0.25	4.2	62
Mo	M/ICP	ppm	2.62	0.98	18.6	61
Na	M/ICP	ppm	0.24	0.03	5.3	63
Nb	M/ICP	ppm	2.50			7
Nd	M/ICP	ppm	18.1	1.2	3.2	8
Ni	M/ICP	ppm	16.5	3.8	11.6	63
P	M/ICP	ppm	401	50.9	6.4	55
Pr	M/ICP	ppm	4.95	0.4	4.2	8
Rb	M/ICP	ppm	118	9.2	3.9	8
Sb	M/ICP	ppm	8.44	2.9	17.2	58
Sc	M/ICP	ppm	3.00			55
Si	M/ICP	%	27.9	0.4	0.6	8
Sm	M/ICP	ppm	3.50			7
Sr	M/ICP	ppm	166	11.5	3.5	63
Ta	M/ICP	ppm	0.20			7
Tb	M/ICP	ppm	0.50	0.21	21.4	8
Th	M/ICP	ppm	6.00	0.5	4.5	8
Ti	M/ICP	%	0.12	0.02	8.2	63
Tm	M/ICP	ppm	0.20			8
U	M/ICP	ppm	6.89	7.5	54.3	19
V	M/ICP	ppm	24.7	2.2	4.5	58
W	M/ICP	ppm	19.1	19.9	52.1	34
Y	M/ICP	ppm	8.61	0.2	1.4	8
Yb	M/ICP	ppm	1.50			7
Zr	M/ICP	ppm	148	14.1	4.8	8