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AMIS0153

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	8.84	±	0.34	%
Zn P	8.59	±	0.40	%
Zn F	8.66	±	0.30	%
Zn XRF	8.90	±	0.42	%
Ag M/ICP	19.9	±	1.3	g/t
Ag P	19.8	±	1.7	g/t
As P	102	±	11	ppm
Cu M/ICP	1993	±	114	ppm
Cu P	2022	±	108	ppm
Fe M/ICP	2.23	±	0.08	%
Fe P	2.21	±	0.14	%
Mg M/ICP	1.29	±	0.10	%
Mn M/ICP	2832	±	156	ppm
Mn P	2804	±	199	ppm
Pb M/ICP	1.02	±	0.05	%
Pb P	1.01	±	0.07	%
Specific Gravity	2.92	±	0.10	

Provisional Concentration

As M/ICP	108	±	20	ppm

Informational Concentrations

Tl M/ICP	7.8	ppm
Tl P	5.5	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	1.56	±	0.08	%
CaO	3.54	±	0.20	%
Fe_2O_3	3.06	±	0.32	%
K_2O	0.67	±	0.04	%
MgO	2.23	±	0.10	%
MnO	0.36	±	0.02	%
SiO_2	67.26	±	1.88	%
S Comb/LECO	6.07	±	0.34	%

Provisional Concentrations

Cr_2O_3	0.051	±	0.006	%
TiO_2	0.069	±	0.020	%
LOI	7.91	±	1.00	%

1. Intended Use: AMIS0153 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: AMIS0153 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 metres 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 hanging wall. 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 Light Grey powder (Corstor colour chart – 5Y 7/1).

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 <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 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.
2. Multi element scan to include Zn, Ag, As, Cu, Fe, Mn, Pb, Tl. Aqua-regia digestion, ICP-OES or ICP-MS.
3. Zn. Fusion, ICP.
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 laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Fifteen 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. ALS Chemex Laboratory Group Brisbane Australia
2. ALS Chemex Laboratory Group Guangzhou (China)
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group La Serena (Chile)
5. ALS Chemex Laboratory Group Lima (Peru)
6. ALS Chemex Laboratory Group Perth WA
7. ALS Chemex Laboratory Group Vancouver CA
8. Eltra Africa (South Africa)
9. Set Point Laboratories (Isando) SA
10. SGS Geosol Laboratories Ltda (Brazil)
11. SGS Lakefield Research Africa (Pty) Ltd (Booysens SA)
12. SGS Mineral Services Callao (Peru)
13. SGS Mineral Services Lakefield (Canada)
14. SGS Toronto (Canada)
15. Ultra Trace (Pty) Ltd WA

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.

Assay dada – Economic Elements

Lab Code	Zn M/ICP %	Zn P %	Zn F %	Zn XRF %	Ag M/ICP ppm	Ag P ppm	As M/ICP ppm	As P ppm	Cu M/ICP ppm	Cu P ppm	Fe M/ICP %	Fe P %	Mn M/ICP ppm	Mn P ppm	Pb M/ICP ppm	Pb P ppm	Tl M/ICP ppm	Tl P ppm
F	8.04		8.08	9.73	19.54				1975		2.22	2.30	2858	3068	10667	11933		
F	8.00		8.38	9.71	19.88				1982		2.19	2.12	2844	2918	10537	10692		
F	8.05		8.41	9.77	20.59				2072		2.23	2.23	2968	2976	10799	11492		
F	7.88		8.33	9.75	19.47				2030		2.20	2.21	2878	3058	10353	11593		
F	7.91		8.13	9.80	21.28				2081		2.29	2.18	2998	3059	11132	11362		
F	8.15		8.48	9.72	19.94				1985		2.24	2.21	2848	3016	10670	11295		
F	8.00		8.01	9.73	20.53				2100		2.19	2.17	2944	3033	10639	10965		
F	8.10		8.10	9.80	20.08				2019		2.23	2.16	2913	2907	11061	11156		
G	8.61	8.76	8.53		19.60	19.40	106.0	99.0	1920	2040	2.15	2.30	2800	2940	10200	10500	5.24	4.29
G	8.70	8.63	8.75		19.60	18.70	106.0	96.0	1910	2020	2.19	2.27	2830	2880	10200	10400	5.31	4.54
G	8.50	8.58	8.56		19.10	19.20	107.0	98.0	1920	2080	2.16	2.35	2800	3010	10200	10200	5.37	4.12
G	8.58	8.81	8.69		19.40	20.10	104.0	94.0	1900	2010	2.10	2.23	2750	2820	10100	10700	5.25	4.07
G	8.63	8.57	8.45		19.30	18.90	108.0	99.0	1970	1980	2.17	2.21	2830	2810	10100	10400	5.29	4.21
G	8.56	8.35	8.66		19.70	18.30	105.0	94.0	1880	1990	2.16	2.23	2830	2820	10300	10100	5.17	4.17
G	8.92	8.58	8.52		19.30	18.90	106.0	94.0	1880	1960	2.16	2.21	2790	2800	10200	10300	5.08	4.19
G	8.39	8.43	8.74		19.10	19.00	105.0	93.0	1850	2000	2.12	2.27	2730	2870	10100	10400	5.18	4.16
H	8.69		8.61	8.98	20.00		104.0	114.0	1870	2100	2.28	2.22	2750	2850	10000	10700		
H	8.80		8.66	9.06	20.00		102.0	109.0	1990	2100	2.24	2.26	2790	2890	10300	10600		
H	8.79		8.73	8.97	19.00		101.0	108.0	1940	2080	2.27	2.27	2740	2870	10400	11000		
H	8.71		8.96	9.04	19.00		102.0	114.0	2010	2060	2.21	2.29	2800	2900	10100	11000		
H	8.88		8.58	9.04	20.00		99.0	109.0	1960	2110	2.14	2.31	2730	2950	10100	10600		
H	8.70		8.70	9.01	20.00		109.0	109.0	1890	2080	2.19	2.40	2720	2900	10500	10400		
H	8.55		8.74	8.99	19.00		103.0	116.0	1980	2120	2.19	2.31	2730	2920	10300	10800		
H	8.58		8.75	8.94	20.00		103.0	118.0	2020	2120	2.24	2.31	2790	2920	10600	10800		

Assay data (cont)

Lab Code	Zn M/ICP %	Zn P %	Zn F %	Zn XRF %	Ag M/ICP ppm	Ag P ppm	As M/ICP ppm	As P ppm	Cu M/ICP ppm	Cu P ppm	Fe M/ICP %	Fe P %	Mn M/ICP ppm	Mn P ppm	Pb M/ICP ppm	Pb P ppm	Tl M/ICP ppm	Tl P ppm
I			8.53		19.10		109.0	98.0	1960	1960		2.12	2720	2650	10600	10300		
I			8.57		19.30		107.0	103.0	1955	1976		2.13	2757	2669	10400	10100		
I			8.69		20.20		97.0	101.0	1969	1974		2.11	2751	2662	10400	10100		
I			8.70		19.20		109.0	100.0	1991	1973		2.13	2671	2688	10000	10100		
I			8.86		19.60		110.0	100.0	1975	1959		2.09	2718	2648	10200	10200		
I			8.69		19.70		104.0	105.0	1981	1957		2.10	2720	2658	10400	10500		
I			8.56		20.20		101.0	101.0	1942	1984		2.10	2686	2663	10400	10300		
I			8.49		19.70		103.0	108.0	1943	1941		2.08	2697	2633	10300	10100		
J				8.94														
J				8.94														
J				9.01														
J				8.91														
J				8.95														
J				8.93														
J				8.97														
J				8.98														
K	8.66	8.24	8.61	9.08	23.00	18.00	120.5		1940	1978	2.21	1.74	2818	2465	10589	9410	4.90	3.70
K	8.92	8.26	9.01	8.99	23.00	18.00	120.5		1890	1992	2.25	1.75	2813	2481	10838	9696	4.70	3.40
K	8.87	8.21	8.41	9.08	23.00	20.00	131.6		1857	2149	2.23	1.75	2734	2637	10812	9782	4.50	3.40
K	8.99	8.41	8.69	9.05	23.00	20.00	129.7		1995	2170	2.22	1.79	2896	2671	11008	9973	4.50	3.80
K	8.73	8.42	8.59	9.05	22.00	19.00	127.0		1980	2053	2.20	1.73	2899	2572	10715	9630	4.50	3.50
K	8.79	8.21	8.95	9.03	23.00	19.00	127.0		2098	2081	2.21	1.74	3060	2593	10743	9835	4.60	3.60
K	8.86	8.33	8.77	8.97	22.00	21.00	130.6		2149	2171	2.19	1.80	2986	2692	10721	9856	4.50	3.70
K	9.28	8.23	9.12	9.07	22.00	20.00	127.9		2036	2139	2.21	1.77	2979	2645	11150	9675	4.40	3.80
L	9.27	8.67	8.72	8.52	21.00	20.00	120.0	100.0	2080	2050	2.28	2.19	2900	2900	10750	10350	10.00	
L	8.97	8.61	8.94	8.60	21.00	21.00	100.0	100.0	2010	2020	2.26	2.19	2900	2900	10650	10400		
L	9.03	8.58	8.75	8.52	19.00	19.00	100.0	100.0	2040	2010	2.22	2.17	2900	2900	10450	10350	10.00	
L	9.21	8.60	8.42	8.52	20.00	20.00	110.0	100.0	2070	1980	2.26	2.16	2900	2900	10650	10300		
L	9.15	8.70	8.74	8.52	20.00	19.00	100.0	100.0	2060	2030	2.26	2.15	2900	2900	10600	10300		
L	9.16	8.50	8.40	8.52	20.00	20.00	100.0	100.0	2050	1970	2.27	2.13	2900	2900	10600	10150		
L	9.01	8.64	8.57	8.48	20.00	20.00	110.0	100.0	2040	2010	2.23	2.16	2900	2900	10500	10350		
L	8.96	8.55	8.78	8.56	20.00	20.00	90.0	100.0	1990	1980	2.23	2.12	2900	2800	10450	10100		
M	8.80			9.22	19.00	19.70	100.0	107.0	1980	2060	2.20	2.06	2800	2790	10050	9550	10.00	
M	8.81			9.14	20.00	19.90	90.0	104.0	1980	1980	2.20	2.14	2800	2700	10150	9600	10.00	
M	8.80			9.27	20.00	20.50	90.0	108.0	1980	2030	2.20	2.20	2800	2790	10050	9980	10.00	
M	9.20			8.97	20.00	19.40	110.0	104.0	2040	1910	2.25	2.12	2900	2730	10400	9620	10.00	
M	8.90			9.23	20.00	20.00	100.0	113.0	1990	2050	2.20	2.18	2800	2940	10050	9860	10.00	10.00
M	8.90			9.09	20.00	20.50	100.0	110.0	1990	2040	2.19	2.19	2800	2790	10050	9890	10.00	
M	8.92			9.01	20.00	19.40	100.0	105.0	2010	1960	2.23	2.09	2900	2850	10250	9420	10.00	10.00
M	9.00			9.25	19.00	19.20	100.0	104.0	2010	1940	2.23	2.09	2900	2710	10250	9450	10.00	
N	8.80	8.57	8.54		20.00	20.00	100.0	100.0	1990	2040	2.21	2.20	2800	2800	10100	9810	10.00	10.00
N	8.71	8.23	8.69		21.00	20.20	90.0	100.0	1970	1960	2.20	2.13	2800	2700	10050	9500	10.00	
N	8.84	8.84	8.55		21.00	20.10	110.0	100.0	1980	2090	2.21	2.27	2800	2800	10100	10150		
N	8.65	8.45	8.53		20.00	20.20	110.0	100.0	1960	2010	2.19	2.19	2800	2700	9920	9760		
N	8.91	8.58	8.56		22.00	20.00	110.0	100.0	2010	2020	2.24	2.19	2800	2700	10150	9800	10.00	
N	8.76	8.61	8.67		21.00	20.60	100.0	100.0	1980	2040	2.20	2.23	2800	2800	10000	10000	10.00	10.00
N	8.94	8.59	8.69		22.00	20.40	100.0	100.0	2020	2040	2.25	2.20	2900	2700	10250	9800	10.00	
N	8.88	8.32	8.65		20.00	21.00	110.0	100.0	1990	2000	2.21	2.18	2800	2700	10050	9720		
O	9.01	9.21			19.00	19.00	110.0	90.0	1860	1945	2.21	2.22	2760	2760	10200	10100		
O	8.78	8.96			19.00	20.00	110.0	110.0	1820	2030	2.14	2.28	2690	2840	9940	10350	10.00	
O	8.89	8.95			20.00	21.00	100.0	100.0	1990	2170	2.11	2.38	2830	2980	10150	10800	10.00	
O	8.43	8.96			20.00	20.00	100.0	110.0	2090	1995	2.15	2.26	2700	2820	9880	10250		
O	8.49	8.59			18.00	18.00	120.0	90.0	1920	1905	2.03	2.12	2720	2640	9800	10200		
O	8.72	8.95			17.00	20.00	100.0	90.0	2040	2030	2.16	2.25	2470	2800	10000	10250		
O	8.68	8.81			20.00	19.00	100.0	100.0	2030	1945	2.02	2.16	2530	2750	10050	9930		
O	9.14	8.99			20.00	18.00	110.0	90.0	1950	1885	2.30	2.12	2840	2640	10500	9650		
P	8.74	8.59			21.00	21.00	100.0	100.0	1950	2000	2.25	2.19	2900	2800	9810	10050	10.00	
P	8.98	8.65			21.00	21.00	100.0	100.0	2010	2020	2.26	2.21	2900	2800	9940	10100	10.00	
P	8.78	8.61			21.00	21.00	100.0	100.0	1970	2020	2.24	2.18	2800	2800	9790	10000	10.00	
P	8.76	8.63			21.00	21.00	100.0	100.0	1970	2000	2.22	2.17	2800	2800	9780	9960		
P	8.81	8.60			22.00	21.00	100.0	100.0	1980	2000	2.24	2.18	2900	2800	9840	10000	10.00	
P	8.91	8.58			21.00	21.00	100.0	100.0	1990	2000	2.26	2.18	2900	2800	9880	9970	10.00	
P	8.77	8.64			21.00	21.00	100.0	100.0	1980	2030	2.25	2.20	2900	2800	9900	10100	10.00	
P	8.95	8.65			22.00	22.00	100.0	100.0	2010	2020	2.28	2.20	2900	2800	9990	10150	10.00	
Q	9.17	8.27	8.67		20.00	20.00	120.0	100.0	2160	1940	2.30	2.25	3000	2900	10500	9940	10.00	10.00
Q	8.92	8.26	8.43		21.00	19.00	120.0	100.0	2100	1940	2.28	2.22	2900	2800	10300	9730		
Q	8.94	8.52	8.67		20.00	21.00	130.0	100.0	2160	2050	2.30	2.29	2900	2900	10400	10050	10.00	
Q	9.10	8.58	8.27		22.00	20.00	130.0	100.0	2120	2060	2.30	2.30	3000	2900	10450	10100		
Q	8.97	8.73	8.46		20.00	20.00	100.0	100.0	2150	2080	2.27	2.34	2900	3000	10250	10300		
Q	9.10	8.48	8.13		20.00	20.00	130.0	100.0	2170	2020	2.30	2.31	2900	3000	10400	10150		10.00
Q	9.00	8.58	8.30		21.00	20.00	140.0	100.0	2170	2090	2.31	2.29	3000	2900	10450	10100		
Q	8.64	8.60	8.49		20.00	20.00	120.0	100.0	2040	2010	2.26	2.29	2900	2900	10200	10050		10.00
R	9.41	8.93			20.00	19.00	120.0	100.0	2070	2140	2.18	2.27	2800	2800	9970	8810	10.00	
R	9.38	8.46			19.00	19.00	110.0	100.0	2050	2010	2.19	2.23	2800	2700	10050	8770		
R	8.97	8.54			19.00	21.00	100.0	100.0	2040	1990	2.20	2.35	2900	2900	10300	8660		
R	9.73	8.74			19.00	20.00	130.0	100.0	2340	2190	2.29	2.25	2900	2700	10350	8620		
R	9.49	8.71			19.00	18.00	130.0	100.0	2120	2000	2.22	2.28	2800	2700	10100	8640	10.00	
R	9.50	8.96			20.00	19.00	110.0	100.0	2110	2060	2.22	2.34	2800	2800	10050	8680	10.00	
R	9.47	8.56			18.00	17.00	110.0	100.0	2080	1940	2.23	2.22	2800	2700	10100	8550		
R	9.34	8.45			18.00	20.00	120.0	100.0	2050	2020	2.18	2.25	2800	2800	10000	8640	10.00	
S	8.75	8.73	8.84	8.74	20.00	19.10	111.0	116.0	2030	2080	2.23	2.21	2810	2880	9890	10200	5.30	4.55
S	8.74	8.76	8.79	8.76	19.50	19.70	110.0	113.0	2000	2100	2.21	2.23	2770	2920	9830	10900	5.30	4.77
S	8.81	8.74	8.78	8.77	19.00	20.60	112.0	108.0	2010	2080	2.22	2.19	2850	2810	9800	10400	5.60	4.64
S	8.73	8.72	8.83	8.73	19.00	19.90	107.0	115.0	1980	2070	2.21	2.23	2790	2860	9740	10300	5.40	4.65
S	8.89	8.68	8.85	8.74	20.00	19.50	126.0	118.0	2040	2050	2.21	2.21	2790	2840	9990	10400	5.50	4.80
S	8.79	8.65	8.84	8.73	18.50	19.90	116.0	113.0	1990	2050	2.22	2.20	2820	2800	9800	10700	5.90	4.81
S	8.77	8.66	8.78	8.77	19.50	19.00	108.0	110.0	2030	2040	2.20	2.20	2830	2790	9740	10500	5.70	4.90
S	8.78	8.71	8.81	8.76	20.00	19.10	112.0	113.0	2010	2070	2.23	2.20	2790	2860	9900	10700	5.40	4.93

Assay dada – Major Oxides

Lab Code	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	LOI %	MgO XRF %	MnO XRF %	SiO_2 XRF %	TiO_2 XRF %	S Comb/LECO %	SG
C											6.11	
C											6.00	
C											6.31	
C											6.01	
C											6.21	
C											6.03	
C											6.06	
C											6.02	
D												
D												
D												
D												
D												
D												
D												
D												
F	1.41	3.59	0.05	3.13	0.68	5.49	2.26	0.36	67.39	0.08	6.46	2.89
F	1.53	3.66	0.05	3.15	0.67	5.53	2.26	0.36	67.56	0.08	6.37	2.68
F	1.48	3.72	0.05	3.21	0.69	5.42	2.31	0.37	69.24	0.08	6.54	2.86
F	1.54	3.63	0.09	3.27	0.68	5.53	2.29	0.37	67.82	0.08	6.62	2.67
F	1.47	3.71	0.05	3.21	0.69	5.50	2.28	0.37	68.82	0.08	6.45	2.84
F	1.63	3.63	0.05	3.17	0.69	5.52	2.30	0.37	68.96	0.08	6.61	3.01
F	1.57	3.65	0.05	3.17	0.68	5.47	2.32	0.37	68.87	0.09	6.52	3.17
F	1.48	3.70	0.05	3.24	0.68	5.48	2.35	0.38	69.60	0.08	6.59	3.12
G											6.01	2.93
G											6.03	2.95
G											6.01	2.94
G											6.09	2.94
G											6.02	2.94
G											6.07	2.93
G											6.05	2.95
G											6.08	2.96
H	1.52	3.42	0.04	2.80	0.65	9.06	2.16	0.33	64.10	0.04	6.00	
H	1.51	3.42	0.04	2.95	0.65	7.32	2.20	0.35	64.40	0.04	5.87	
H	1.48	3.40	0.03	2.92	0.65	6.96	2.18	0.34	64.10	0.04	5.82	
H	1.52	3.40	0.04	2.94	0.65	6.81	2.17	0.34	64.10	0.04	5.84	
H	1.52	3.45	0.03	2.99	0.64	6.81	2.20	0.36	64.80	0.04	5.88	
H	1.84	3.46	0.04	2.99	0.63	7.44	2.18	0.35	64.70	0.05	6.03	
H	1.52	3.46	0.04	3.02	0.63	7.19	2.18	0.35	64.90	0.05	5.80	
H	1.50	3.43	0.04	3.00	0.63	6.59	2.19	0.34	64.70	0.04	5.94	
I											6.21	
I											6.21	
I											6.19	
I											6.19	
I											6.16	
I											6.23	
I											6.20	
I											6.18	
J	1.62	3.73	0.06	3.33	0.68	8.63	2.33	0.38	67.60	0.06	5.37	2.92
J	1.63	3.69	0.05	3.17	0.67	8.65	2.31	0.37	67.40	0.06	5.29	2.89
J	1.55	3.64	0.04	3.33	0.67	8.58	2.28	0.38	66.70	0.06	5.38	2.91
J	1.57	3.65	0.05	3.29	0.65	8.58	2.27	0.38	67.00	0.07	5.36	2.90
J	1.61	3.70	0.05	3.19	0.67	8.61	2.36	0.37	67.50	0.06	5.28	2.90
J	1.61	3.64	0.05	3.29	0.67	8.62	2.30	0.37	67.00	0.06	5.37	2.92
J	1.59	3.66	0.05	3.18	0.68	8.60	2.29	0.36	67.20	0.06	5.28	2.90
J	1.56	3.62	0.05	3.16	0.66	8.54	2.28	0.37	67.10	0.07	5.40	2.89
K											5.76	2.90
K											5.79	2.94
K											5.71	2.91
K											5.71	2.93
K											5.75	2.91
K											5.68	2.93
K											5.79	2.90
K											5.79	2.93
L	1.57	3.55			0.70	4.91	2.23		66.20	0.06	6.22	
L	1.56	3.55			0.70	5.01	2.21		66.40	0.06	6.32	
L	1.57	3.54			0.70	5.64	2.28		66.60	0.06	6.21	
L	1.58	3.56			0.70	5.59	2.26		66.80	0.06	6.11	
L	1.56	3.55			0.70	5.56	2.26		66.50	0.06	6.18	
L	1.59	3.56			0.70	5.62	2.28		66.50	0.06	6.20	
L	1.58	3.55			0.70	5.54	2.27		66.50	0.05	6.19	
L	1.56	3.56			0.71	5.64	2.24		66.50	0.06	6.34	

Assay data (cont)

Lab Code	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	LOI %	MgO XRF %	MnO XRF %	SiO_2 XRF %	TiO_2 XRF %	S Comb/LECO %	SG
M	1.62	3.65	0.05	2.89			2.28	0.33	69.10		6.29	
M	1.60	3.62	0.05	2.87			2.29	0.33	68.50		6.24	
M	1.64	3.67	0.06	2.92			2.32	0.33	69.20		6.00	
M	1.59	3.59	0.05	2.82			2.25	0.32	67.70		6.10	
M	1.61	3.66	0.06	2.89			2.29	0.33	68.90		6.47	
M	1.60	3.61	0.05	2.92			2.25	0.32	68.00		6.21	
M	1.58	3.58	0.05	2.81			2.23	0.32	67.60		6.52	
M	1.63	3.66	0.05	2.89			2.29	0.33	69.00		6.05	
N	1.54	3.41	0.05	3.15	0.66	8.00	2.15	0.36	66.35	0.06	6.15	2.94
N	1.56	3.41	0.05	3.17	0.67	8.11	2.17	0.37	66.51	0.06	6.30	2.95
N	1.55	3.43	0.05	3.17	0.67	8.16	2.17	0.37	66.62	0.06	6.28	3.03
N	1.56	3.41	0.05	3.16	0.66	8.07	2.15	0.37	66.35	0.06	6.17	3.08
N	1.56	3.43	0.05	3.17	0.67	8.16	2.16	0.37	66.49	0.07	6.29	3.01
N	1.55	3.42	0.05	3.17	0.67	8.17	2.16	0.37	66.57	0.06	6.21	2.96
N	1.55	3.42	0.05	3.17	0.67	8.20	2.17	0.37	66.47	0.06	6.23	2.96
N	1.56	3.41	0.05	3.15	0.67	8.06	2.17	0.37	66.60	0.06	6.28	3.03
O											6.29	
O											6.26	
O											6.28	
O											6.24	
O											6.28	
O											6.22	
O											6.25	
O											6.26	
Q	1.51	3.38	0.05	2.76	0.62	7.76	2.14	0.34	63.20	0.07	5.75	2.81
Q	1.54	3.43	0.05	2.81	0.63	7.75	2.18	0.35	64.40	0.07	5.79	2.83
Q	1.58	3.41	0.05	2.82	0.63	7.74	2.18	0.35	64.40	0.07	5.87	2.86
Q	1.53	3.41	0.05	2.80	0.63	7.95	2.17	0.34	64.30	0.07	5.86	2.81
Q	1.54	3.43	0.05	2.83	0.63	7.88	2.18	0.35	64.40	0.07	5.89	2.82
Q	1.55	3.45	0.05	2.86	0.64	7.78	2.20	0.35	64.90	0.07	5.86	2.81
Q	1.56	3.44	0.05	2.83	0.63	7.77	2.19	0.35	64.50	0.07	5.92	2.80
Q	1.55	3.46	0.05	2.84	0.64	7.77	2.20	0.35	64.70	0.07	5.88	2.74
R											5.97	2.95
R											5.85	2.96
R											5.91	2.98
R											5.94	2.98
R											6.00	2.98
R											6.03	2.98
R											5.96	2.98
R											5.94	2.97
S	1.59	3.55	0.06	3.15	0.68	7.58	2.25	0.37	66.61	0.08	6.15	2.88
S	1.60	3.57	0.06	3.16	0.69	7.66	2.25	0.38	66.70	0.08	6.08	2.88
S	1.58	3.57	0.06	3.14	0.68	7.73	2.23	0.38	66.71	0.08	6.10	2.89
S	1.57	3.55	0.05	3.16	0.68	7.58	2.22	0.38	66.61	0.08	6.12	2.88
S	1.60	3.55	0.06	3.16	0.69	7.93	2.24	0.38	66.65	0.08	6.11	2.91
S	1.59	3.55	0.05	3.12	0.69	7.75	2.25	0.37	66.68	0.08	6.13	2.92
S	1.56	3.58	0.05	3.15	0.69	7.83	2.25	0.38	66.71	0.08	6.07	2.91
S	1.56	3.55	0.06	3.12	0.69	7.98	2.25	0.37	66.64	0.08	6.10	2.91

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]	S_W [3]	CSU [4]
Zn	M/ICP	%	0.167	0.098	0.128	0.034
Zn	P	%	0.197	0.142	0.133	0.050
Zn	F	%	0.151	0.074	0.133	0.031
Zn	XRF	%	0.214	0.259	0.056	0.106
Ag	M/ICP	ppm	0.657	0.350	0.493	0.114
Ag	P	ppm	0.837	0.430	0.696	0.157
As	M/ICP	ppm	10.06	6.24	6.73	1.93
As	P	ppm	5.66	3.97	3.33	1.25
Cu	M/ICP	ppm	57.08	31.16	43.01	10.05
Cu	P	ppm	54.00	27.57	42.45	9.12
Fe	M/ICP	%	0.036	0.023	0.024	0.007
Fe	P	%	0.066	0.044	0.040	0.013
Mg	M/ICP	%	0.067	0.045	0.025	0.016
Mn	M/ICP	ppm	77.99	49.34	47.79	14.49
Mn	P	ppm	99.41	66.20	59.96	20.10
Pb	M/ICP	ppm	258.22	182.09	138.22	54.48
Pb	P	ppm	329.80	238.20	183.23	74.55
Tl	M/ICP	ppm	2.47	1.89	0.11	0.60
Tl	P	ppm	2.51	2.50	0.14	1.02
SG			0.053	0.055	0.019	0.021

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 S_W - 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.

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: AMIS0153 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.

23 September 2009
Certified Mg M/ICP and added Major Oxides Data Table– 24 November 2015

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. The especially poor Ba analysis results have been brought to the laboratories attention.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	0.85	0.06	3.5	60
Au	PbColl	ppm	0.23	0.04	7.8	8
Ba	M/ICP	ppm	142	328	116	55
Be	M/ICP	ppm	0.40	0.0	0.0	7
Bi	M/ICP	ppm	4.6	3.2	34.8	56
Ca	M/ICP	%	2.5	0.24	4.9	64
Cd	M/ICP	ppm	200	21.0	5.3	63
Ce	M/ICP	ppm	16.6	1.1	3.3	8
Co	M/ICP	ppm	3.8	1.4	19.0	56
Cr	M/ICP	ppm	298	47.2	7.9	56
Dy	M/ICP	ppm	1.0	0.06	3.1	8
Er	M/ICP	ppm	0.48	0.05	5.6	8
Eu	M/ICP	ppm	0.73	0.07	5.1	8
Ga	M/ICP	ppm	10.0	0.0	0.0	39
Hf	M/ICP	ppm	0.60	0.0	0.0	7
Ho	M/ICP	ppm	0.20	0.0	0.0	7
In	M/ICP	ppm	3.2	0.21	3.3	8
K	M/ICP	%	0.54	0.06	5.1	62
La	M/ICP	ppm	10.0	0.40	2.0	48
Mo	M/ICP	ppm	6.9	2.2	15.8	61
Na	M/ICP	%	0.05	0.02	14.5	63
Nd	M/ICP	ppm	7.8	0.42	2.7	8
Ni	M/ICP	ppm	19.5	3.3	8.4	56
P	M/ICP	%	389	50.1	6.4	53
Pr	M/ICP	ppm	2.0	0.08	2.1	8
Rb	M/ICP	ppm	24.5	0.72	1.5	7
S	ICP	%	6.0	0.44	3.6	48
Sb	M/ICP	ppm	17.1	8.6	25.2	56
Si	M/ICP	%	31.0	0.35	0.57	8
Sm	M/ICP	ppm	1.7	0.10	3.1	8
Sr	M/ICP	ppm	171	23.0	6.7	56
Tb	M/ICP	ppm	0.20	0.0	0.0	7
Th	M/ICP	ppm	2.0	0.24	6.1	8
Ti	M/ICP	%	0.04	0.01	14.3	58
U	M/ICP	ppm	4.3	8.4	97.9	12
V	M/ICP	ppm	15.1	1.2	3.9	56
W	M/ICP	ppm	8.0	7.6	47.9	36
Y	M/ICP	ppm	9.0	0.0	0.0	7
Yb	M/ICP	ppm	0.48	0.05	5.6	8
Zr	M/ICP	ppm	70.0	0.0	0.0	7