



AMIS0149

Certified Reference Material

**Zinc lead sulphide ore
Rosh Pinah Mine, Namibia**

Certificate of Analysis

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

Certified Concentrations²

Zn M/ICP	15.37	±	0.54	%
Zn P	15.07	±	0.58	%
Zn F	15.37	±	0.38	%
Zn XRF	15.60	±	0.58	%
Ag M/ICP	30.1	±	2.3	g/t
Ag P	30.4	±	2.6	g/t
As M/ICP	205	±	23	ppm
Cu M/ICP	3769	±	206	ppm
Cu P	3821	±	176	ppm
Fe M/ICP	2.81	±	0.14	%
Fe P	2.78	±	0.20	%
Mn M/ICP	4905	±	244	ppm
Mn P	4819	±	414	ppm
Pb M/ICP	1.71	±	0.08	%
Pb P	1.70	±	0.13	%
Specific Gravity	3.10	±	0.08	

Provisional Concentrations

As P	200	±	13	ppm
TI M/ICP	9.6	±	1.3	ppm

Informational means

TI P	9	ppm
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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 ₂ O ₃	1.05	±	0.06	%
CaO	4.98	±	0.30	%
Fe ₂ O ₃	3.91	±	0.032	%
MgO	3.01	±	0.20	%
MnO	0.62	±	0.04	%
SiO ₂	49.80	±	1.22	%
LOI	11.87	±	1.32	%
S Combustion	10.26	±	0.64	%

Provisional Concentrations

Cr ₂ O ₃	0.047	±	0.008	%
K ₂ O	0.34	±	0.04	%

Informational Mean

TiO ₂	0.046	%
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1. **Intended Use:** AMIS0149 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:** AMIS0149 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 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 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 <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 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 one laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Sixteen 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 then removed from further calculations when the mean of all analyses from that laboratory failed a "t test" of the global means of the other laboratories. The means and standard deviations were then 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. Anglo Research (Crown Campus)
9. Eltra Africa (South Africa)
10. Set Point Laboratories (Isando) SA
11. SGS Geosol Laboratories Ltda (Brazil)
12. SGS Lakefield Research Africa (Pty) Ltd (Booyens SA)
13. SGS Mineral Services Callao (Peru)
14. SGS Mineral Services Lakefield (Canada)
15. SGS Toronto (Canada)
16. 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.

Lab Code	Zn M/ICP %	Zn P %	Zn F %	Zn XRF %	Ag M/ICP g/t	Ag P g/t	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	Ti M/ICP ppm	Ti P ppm	SG
A	15.87	15.03	15.14	15.60	30.00	31.00	323		4019	3937	2.84	2.71	4945	4614	17814	17075	9.60	6.30	3.10
A	15.87	15.09	15.17	15.72	31.00	30.00	344		4127	3932	2.87	2.67	5022	4532	18125	17741	8.70	6.20	3.13
A	15.57	14.66	16.17	15.81	30.00	30.00	322		4150	3683	2.84	2.59	4948	4373	17109	17417	8.10	6.30	3.09
A	16.03	14.91	16.50	15.58	30.00	30.00	331		4062	3759	2.82	2.64	4931	4506	17593	17385	8.20	6.70	3.11
A	16.10	15.46	16.60	15.71	30.00	32.00	363		4000	3932	2.83	2.75	4945	4679	17311	17338	8.40	7.10	3.10
A	16.30	14.87	16.12	15.87	31.00	30.00	328		4190	3745	2.94	2.65	5162	4501	18064	17182	8.40	6.90	3.11
A	15.72	14.75	16.22	15.86	31.00	29.00	310		4225	3623	2.91	2.60	5088	4450	17016	17016	8.50	6.80	3.08
A	15.80	14.79	16.40	15.65	32.00	30.00	318		4433	3695	3.09	2.61	5243	4461	17500	17338	8.50	6.70	3.11
B	15.25	15.30	15.95	15.15	30.00	30.00	200	200	3820	3900	2.79	2.82	4900	5100	17050	17550	10.00	10.00	
B	15.05	15.05	16.15	15.10	31.00	29.00	200	200	3780	3830	2.77	2.74	4900	5000	16900	17100	10.00		
B	14.95	14.80	15.65	15.10	30.00	30.00	200	200	3750	3750	2.76	2.71	4900	4900	16850	16850	10.00		
B	15.00	15.00	15.90	15.10	30.00	29.00	200	200	3780	3790	2.77	2.72	4900	4900	16900	16900	10.00	10.00	
B	15.20	14.80	15.35	15.25	30.00	30.00	190	200	3790	3740	2.79	2.68	4900	4900	17050	16750	10.00		
B	15.30	15.05	15.10	15.20	30.00	30.00	210	200	3820	3820	2.81	2.77	4900	5000	17200	17300	10.00	10.00	
B	15.15	14.90	15.90	15.15	30.00	29.00	200	200	3770	3790	2.77	2.72	4900	5000	17050	17050	10.00	10.00	
B	15.10	15.05	15.65	15.20	30.00	30.00	180	200	3790	3820	2.80	2.77	4900	5000	17150	17300	10.00		
C	15.30			15.20	30.00	32.90	200	223	3750	3950	2.82	2.80	4900	4850	16700		10.00	10.00	
C	15.30			15.55	30.00	28.00	200	193	3770	3510	2.82	2.40	4900	4210	16700		10.00	10.00	
C	15.50			15.65	30.00	31.40	200	217	3760	3910	2.81	2.74	4900	4670	16700		10.00	10.00	
C	14.80			15.50	28.00	28.20	170	189	3620	3430	2.73	2.44	4700	4230	16200		10.00	10.00	
C	15.45			15.70	30.00	30.40	210	213	3760	3870	2.82	2.58	4900	4510	16800		10.00	10.00	
C	15.45			15.25	30.00	31.20	180	214	3750	3680	2.81	2.66	4900	4650	16800		10.00	10.00	
C	15.10			15.20	30.00	31.60	190	214	3730	3690	2.79	2.69	4900	4780	16550		20.00	10.00	
C	15.15			15.55	29.00	30.80	200	212	3720	3910	2.79	2.69	4800	4600	16600		10.00	10.00	
D	14.80	14.80	15.30		30.00	32.00	210	200	3680	3840	2.74	2.78	4700	4700	16400	16250	10.00	10.00	3.16
D	15.25	14.70	15.25		31.00	31.60	190	200	3790	3820	2.81	2.78	4800	4700	16800	16300	10.00	10.00	3.16
D	15.20	14.75	15.20		32.00	31.20	210	200	3800	3800	2.80	2.77	4800	4700	16650	16300	10.00	10.00	3.28
D	15.05	14.70	15.15		32.00	31.80	200	200	3760	3820	2.78	2.78	4800	4700	16700	16350	10.00	10.00	3.20
D	15.31	14.50	15.15		31.00	32.00	180	200	3790	3740	2.84	2.70	4800	4600	16700	15850	10.00	10.00	3.15
D	15.75	14.70	15.30		31.00	32.80	190	200	3830	3770	2.84	2.74	4900	4700	17000	16100	10.00	10.00	3.29
D	15.55	14.60	15.15		32.00	32.60	180	200	3730	3730	2.82	2.74	4800	4600	17000	16100	10.00	10.00	3.24
D	15.15	14.75	15.35		30.00	32.30	210	200	3670	3780	2.76	2.77	4700	4700	16600	16300	10.00	10.00	3.14
E	15.40	15.25			30.00	28.00	220	170	3670	3410	2.61	2.66	4740	4560	16800	16350			
E	15.40	15.55			31.00	29.00	240	190	3790	3600	2.96	2.73	5050	4680	17600	16650	10.00		
E	15.65	15.45			29.00	30.00	210	200	3580	3750	2.83	2.86	4790	4880	16900	17500		10.00	
E	15.25	15.40			31.00	31.00	200	200	3740	3790	2.83	2.88	4770	4920	16800	17650		10.00	
E	15.65	15.10			29.00	31.00	210	200	3320	3770	2.77	2.89	4680	4940	16600	17650	10.00	10.00	
E	15.35	15.55			32.00	32.00	240	200	3750	3890	2.96	2.96	5020	5060	17500	18000	10.00	10.00	
E	15.10	15.50			29.00	28.00	220	180	3620	3490	2.67	2.59	4850	4430	17050	15800			
E	15.65	15.75			30.00	28.00	220	180	3450	3600	2.82	2.58	4770	4420	16900	15700		10.00	

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	%	0.27	0.13	0.23	0.05
Zn	P	%	0.29	0.22	0.18	0.08
Zn	F	%	0.19	0.08	0.17	0.04
Zn	XRF	%	0.29	0.30	0.11	0.11
Ag	M/ICP	g/t	1.14	0.67	0.80	0.21
Ag	P	g/t	1.32	0.83	0.99	0.28
As	M/ICP	ppm	11.6	7.61	7.39	2.44
As	P	ppm	6.24	3.70	4.67	1.29
Cu	M/ICP	ppm	103	70.8	58.1	21.3
Cu	P	ppm	94.0	50.6	71.9	16.4
Fe	M/ICP	%	0.07	0.04	0.05	0.01
Fe	P	%	0.10	0.06	0.06	0.02
Mn	M/ICP	ppm	122	80.3	81.4	25.7
Mn	P	ppm	207	129	130	38.0
Pb	M/ICP	ppm	383	218	267	66.2
Pb	P	ppm	649	491	378	161
Tl	M/ICP	ppm	0.64	0.55	0.18	0.17
Tl	P	ppm	1.42	1.21	0.13	0.38
SG	pycnometer		0.04	0.04	0.02	0.01

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: AMIS0149 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.

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

AMIS0149 Trace

Element	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	0.58	0.04	3.8	61
Au	PbColl	ppm	0.16	0.01	4.5	8
Ba	M/ICP	ppm	144	379	131.7	53
Be	M/ICP	ppm	0.40	0.00	0.0	7
Bi	M/ICP	ppm	6.8	4.1	30.4	61
Ca	M/ICP	%	3.5	0.4	5.1	63
Cd	M/ICP	ppm	346	44	6.3	61
Ce	M/ICP	ppm	16.8	0.5	1.6	8
Co	M/ICP	ppm	3.8	1.6	20.4	62
Cr	M/ICP	ppm	274	39	7.1	56
Cs	M/ICP	ppm	0.40	0.00	0.0	7
Dy	M/ICP	ppm	1.8	0.5	14.3	8
Er	M/ICP	ppm	1.0	0.0	0.0	7
Eu	M/ICP	ppm	1.3	0.3	11.3	8
Ga	M/ICP	ppm	10.0	0.0	0.0	56
Hf	M/ICP	ppm	0.63	0.40	31.7	8
Ho	M/ICP	ppm	0.40	0.00	0.0	7
In	M/ICP	ppm	6.3	0.3	2.7	8
K	M/ICP	%	0.28	0.03	5.9	56
La	M/ICP	ppm	9.8	0.5	2.4	16
Li	M/ICP	ppm	2.3	0.5	11.9	8
Mg	M/ICP	%	1.7	0.1	3.9	62
Mo	M/ICP	ppm	11.6	2.5	11.0	55
Na	M/ICP	%	0.03	0.01	19.6	56
Nb	M/ICP	ppm	0.88	0.46	26.5	8
Nd	M/ICP	ppm	7.5	0.0	0.0	7
Ni	M/ICP	ppm	22.8	3.3	7.3	61
P	M/ICP	ppm	635	61	4.8	54
Pr	M/ICP	ppm	2.0	0.2	4.7	8
Rb	M/ICP	ppm	13.0	1.7	6.7	8
S	ICP	%	9.7	0.4	2.0	20
Sb	M/ICP	ppm	28.4	10.6	18.7	61
Si	M/ICP	%	23.3	0.3	0.7	8
Sm	M/ICP	ppm	2.3	0.5	11.2	8
Sn	M/ICP	ppm	1.4	1.0	37.6	8
Sr	M/ICP	ppm	219	41	9.3	56
Tb	M/ICP	ppm	0.40	0.00	0.0	8
Th	M/ICP	ppm	0.68	0.30	22.0	8
Ti	M/ICP	%	0.02	0.00	0.0	54
U	M/ICP	ppm	1.5	0.0	0.0	7
V	M/ICP	ppm	17.2	1.4	4.1	55
W	M/ICP	ppm	7.7	8.0	52.1	31
Y	M/ICP	ppm	10.4	1.0	5.0	8
Yb	M/ICP	ppm	0.69	0.52	37.6	8
Zr	M/ICP	ppm	52.5	20.7	19.7	8