



A division of Set Point Industrial Technology (Pty) Limited (Reg. No. 1989/000201/07)
Tel: +2711 923 7000 Fax: +2711 923 7027 e-mail: info@amis.co.za web: www.amis.co.za
30 Electron Avenue, Isando (Johannesburg), 1600. P.O. Box 856, Isando, 1600, South Africa.

AMIS0036

Reference Material

Copper Sulphide Ore
Kansanshi Mine, Zambia¹.

Certificate of Analysis

Recommended Concentrations and Limits^{2, 3}
(at two Standard Deviations)

Certified Concentrations

Cu (F)	13405 ppm	(1.3405%)	±	696 ppm	(0.0696%)
Cu (P)	13588 ppm	(1.3588%)	±	1094 ppm	(0.1094%)
Cu (T/ICP)	13806 ppm	(1.3806%)	±	630 ppm	(0.0630%)
Specific Gravity	2.78 g/cc		±	0.16 g/cc	

Provisional Concentrations

Au (Pb Collection)	0.14	±	0.02 ppm
Ag (T)	3.3	±	0.8 ppm
As (P)	23	±	3.4 ppm
As (T/ICP)	22	±	4.6 ppm
Co (P)	10	±	1.1 ppm
Co (T/ICP)	11	±	2.4 ppm
Pb (P)	11	±	2.4 ppm
Ni (P)	26	±	3.3 ppm
Ni (T/ICP)	29	±	5.7 ppm
U (T/ICP)	5.76	±	1.18 ppm
Zn (T/ICP)	35	±	8 ppm

Informational Mean

Pb (T/ICP)	13 ppm
Zn (P)	31 ppm

1. Please refer to the erratum regarding the origin of this material on p2.
2. 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, 8 and 16.
3. There are additional certified major element data presented on p3.

1. Intended Use: AMIS0036 is suitable to monitor the accuracy of a single analysis of copper ore. The material can be used for routine quality control by inserting within a batch of samples, method development and for the calibration of equipment.

It is a 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: This standard was made using sulphide ore sourced from the Kansanshi Mine, located in the North Western Province of Zambia, approximately 15 kilometres north of the town of Solwezi and 16 kilometres south of the Democratic Republic of Congo border. The Kansanshi project is majority owned by Cyprus Amax Kansanshi Holdings Limited, which is 100% owned by First Quantum Minerals Ltd (FQM).

The Kansanshi deposit occurs within the Lufilian arc, a major tectonic province characterized by broadly north directed fold and thrust structures, which hosts the world class Central African Copperbelt. The property geology is dominated by the northwest-trending Kansanshi Antiform, which exposes rocks of the Late Proterozoic Kansanshi Mine Formation in the core of a major refolded fold. Copper mineralization occurs both in and between steeply dipping, generally north-south trending quartz-carbonate veins and vein swarms, and as foliation parallel stratabound mineralization, within albite and carbonate altered phyllitic rocks of the Mine Formation.

Deep tropical weathering has resulted in supergene enrichment and subsequent partial oxidation of the deposit. Mineralization comprises copper oxide and mixed copper oxide/chalcocite mineralization hosted by saprolitized phyllites, decalcified marbles and schists. This secondary mineralization is underlain by a large tonnage of primary sulphide mineralization, with chalcopyrite and subordinate bornite as the dominant minerals. Oxide and mixed oxide/sulphide copper mineralization grading plus 0.5% copper occurs principally within two essentially flat lying orebodies, separated by a mostly barren marble unit. In some areas, the marble unit has been completely decalcified during weathering and in these cases the two ore bodies are combined. Deeper primary sulphide mineralization occurs in other discrete flat lying phyllite units.

(for more information, refer to the First Quantum Minerals Ltd Kansanshi Fact Sheet, Sept 2006, www.first-quantum.com.)

Erratum, 5 October 2009: *This reference material was originally described as having been made of ore sourced from Lonshi Mine. We have subsequently been informed that this was not correct. This material was in fact sourced from the Kansanshi Mine, as is evidenced by it's gold content. African Mineral Standards apologises for any inconvenience caused.*

2. Chemical Composition: (Other elements). The major element chemistry has been certified by analyses from 13 of the laboratories using X-Ray Fluorescence techniques. The consensus mean values and confidence limits at two standard deviations are presented below.

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations

Al ₂ O ₃	3.07%	+ -	0.08%
CaO	1.97%	+ -	0.08%
Fe ₂ O ₃	2.78%	+ -	0.06%
K ₂ O	1.04%	+ -	0.06%
MgO	1.80%	+ -	0.12%
P ₂ O ₅	0.07%	+ -	0.01%
SiO ₂	83.12%	+ -	1.96%
TiO ₂	0.32%	+ -	0.02%
LOI	3.95%	+ -	0.42%

Provisional Concentrations

MnO	0.11%	+ -	0.11%
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Indicated Means

Cr ₂ O ₃	0.06%
Na ₂ O	0.03%

3. Appearance: The material is a very fine pale yellowish brown powder (Corstor Colour Gauge - 10YR 6/4).

4. 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.

5. 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 100% <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.

6. Methods of Analysis requested:

1. Co, Cu, As, Ni, Pb, Zn and Ag; multi-acid digestion, including HF, with ICP-OES or ICP-MS (T). Cu; fusion ICP-OES or MS (F).
2. Co, Cu, As, Ni, Pb, Zn by XRF.
3. Co, Cu, As, Ni, Pb, Zn, aqua regia digestion with ICP-OES or ICP-MS (P).
4. Pb collection for Au.
5. Specific gravity either by gas pycnometer or by water displacement using a pycnometer bottle.

7. Information requested:

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. All results to be reported in ppm.
4. Report all QC data, to include replicates, blanks and certified reference materials used.

8. Method of Certification: Twenty laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Nineteen laboratories reported back. 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, 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".

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

1. ACME Analytical Laboratories Ltd., (Canada).
2. Activation Laboratories Ltd., (ActLabs, Ancaster, ON, Canada).
3. ALS Chemex, (Vancouver, Canada).
4. ALS Chemex South Africa (Pty) Ltd.
5. Ultra Trace (Pty) Ltd. (Australia)
6. SRC Labs., (Canada).
7. Amdel Limited, (Perth, Australia).
8. Anglo Research (Crown Campus, South Africa).
9. Assayers Canada, (Vancouver).
10. Genalysis Laboratory Services (Pty) Ltd., (Australia).
11. Geoscience Laboratories, (Geo Labs, Sudbury, Canada).
12. Geoservice Centre, Geolaboratory, (GTK. Finland).
13. Pt Intertek Utama Services (Intertek, Indonesia)
14. Nkomati JV Laboratory
15. OMAC Laboratories (Ireland).
16. SGS Lakefield Research Africa (Pty) Ltd. (Joburg, South Africa)
17. Set Point Laboratories (Pty) Ltd (South Africa)
18. SGS Welshpool (Australia).
19. SGS Lakefield Research (Canada)

10. Assay Data: Data as received from the laboratories for the important economic 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 data (cont)

AMIS0036																	
Lab Code	Cu F ppm	Cu P ppm	Cu T ppm	Co P ppm	Co T ppm	Ag T ppm	As P ppm	As T ppm	Au g/t	Ni P ppm	Ni T ppm	Pb P ppm	Pb T ppm	Zn P ppm	Zn T ppm	U T ppm	SG g/cc
A	13200	13300	13388	10	11	3		23	0	20	32		31		39	6	2.57
A	13600	13250	13784	10	12	3		24	0	20	29		18		38	7	2.51
A	13400	13590	13298	10	10	3		30	0	20	28		15		38	6	2.49
A	13600	13510	13627	10	12	3		25	0	20	31		22		39	7	2.58
A	13700	13560	13467	10	11	3		23	0	20	33		19		39	7	2.44
A	13000	13060	13745	10	10	3		21	0	20	31		14		38	6	2.60
A	13200	13110	13403	10	11	3		21	0	20	29		14		37	7	2.63
A	13500	13190	14110	10	12	3		25	0	20	31		13		36	6	2.63
B	13800			10	11	3	21	17	0	26	27	13	14	31	28	6	2.72
B	13800			11	10	3	22	17	0	28	28	14	14	37	27	6	2.68
B	13500			10	11	3	21	17	0	27	30	13	14	36	32	6	2.73
B	13400			10	10	3	22	19	0	27	29	13	14	32	41	6	2.71
B	13600			10	10	3	21	19	0	26	28	13	14	31	28	6	2.73
B	13400			10	9	3	21	18	0	27	27	13	13	31	27	6	2.74
B	13800			10	10	3	21	19	0	26	28	12	14	30	29	6	2.77
B	13600			10	10	3	21	17	0	27	26	13	12	31	27	7	2.70
C																	
C																	
C																	
C																	
C																	
C																	
C																	
D	13650	13900	13600	9	11	3	23	24	0	29	27	12	14	38	30	5	2.65
D	13500	14000	13500	9	12	3	22	22	0	23	26	11	15	30	34	5	2.69
D	12950	14100	14200	9	10	3	22	22	0	23	26	11	12	29	29	5	2.77
D	13650	13900	13700	9	10	3	23	22	0	24	25	11	12	30	30	5	2.76
D	13350	14100	14150	9	11	3	22	24	0	24	27	11	13	26	36	5	2.75
D	13000	14000	13850	10	9	3	22	22	0	23	24	12	12	28	29	5	2.66
D	13400	14000	14050	9	10	3	22	22	0	23	26	11	12	28	31	5	2.76
D	13350	13900	13600	9	11	3	22	23	0	23	27	11	13	28	32	5	2.76
E		15500	13300						0								5
E		15500	13900						0								5
E		14900	13950						0								5
E		14500	13800						0								5
E		13500	14350						0								5
E		14800	13400						0								5
E		13700	13650						0								5
E		14200	13550						0								5
F	13800	14000	13700	12	15	3	26	20	0	24	34	11	11	28	34	6	2.71
F	13700	13700	13900	10	10	3	24	21	0	24	34	11	12	28	32	6	2.66
F	13800	14000	13900	12	15	3	25	23	0	24	32	11	13	27	34	6	2.65
F	13700	14000	13700	12	10	3	25	22	0	24	34	11	12	28	32	6	2.75
F	13700	13800	13900	12	10	3	24	21	0	24	32	11	12	27	34	6	2.70
F	13800	13600	13700	10	15	3	24	23	0	24	34	11	12	28	34	6	2.64
F	13800	14100	13900	10	15	3	24	23	0	24	30	11	12	27	32	6	2.70
F	13800	13600	13800	12	15	3	25	22	0	24	34	11	12	27	32	6	2.73
G		13800		9		3	21		0	29		12		36		7	
G		13500		9		3	23		0	28		10		36		7	
G		13300		11		3	22		0	28		9		39		7	
G		13100		9		3	21		0	29		11		37		7	
G		13200		9		3	23		0	27		10		37		7	
G		13500		9		3	22		0	29		10		37		7	
G		13400		10		3	21		0	28		11		37		7	
G		13500		9		3	22		0	30		11		37		7	
H	13600	10400	13200	8	10	3	12	22	0	32	9	11	14	27	43	6	2.13
H	15400	10700	14200	8	10	3	13	20	0	33	9	11	14	23	31	6	2.73
H	15700	10800	13300	7	10	3	12	18	0	30	9	9	12	22	38	6	2.87
H	14500	10700	13300	8	11	3	12	21	0	32	10	10	12	21	33	6	2.72
H	13700	11300	13800	12	10	3	24	22	0	32	10	16	13	33	32	6	2.88
H	12600	10200	14800	7	10	3	12	22	0	31	9	11	12	20	30	6	2.66
H	12600	9240	13000	7	11	3	11	22	0	29	7	10	27	19	48	6	2.81
H	12900	10200	13700	8	10	3	14	21	0	31	8	11	12	22	31	5	2.80
I	13900								0								2.79
I	13700								0								2.81
I	13400								0								2.83
I	13500								0								2.85
I	13100								0								2.77
I	13000								0								2.78
I	13200								0								2.80
I	13500								0								2.80
J	13400	12900	14400	9	14	4	12	27	0	22	32	16	27	25	37	22	
J	14000	12500	14400	9	14	4	14	32	0	21	37	14	18	25	37	18	
J	14000	12700	14300	11	13	4	14	27	0	22	31	16	26	26	34	9	
J	13600	12700	14200	8	13	4	12	26	0	22	32	16	24	25	35	22	
J	13400	12400	14800	8	14	5	13	31	0	21	32	16	29	25	37	18	
J	13600	12700	14500	9	14	4	11	27	0	21	32	15	16	25	35	20	
J	13800	11600	14200	8	14	4	10	27	0	20	31	14	19	23	35	19	
J	13400	12300	14900	9	15	4	13	27	0	21	31	14	27	24	37	11	

Assay data (cont)

Lab Code	Cu F ppm	Cu P ppm	Cu T ppm	Co P ppm	Co T ppm	Ag T ppm	As P ppm	As T ppm	Au g/t	Ni P ppm	Ni T ppm	Pb P ppm	Pb T ppm	Zn P ppm	Zn T ppm	U T ppm	SG g/cc	
K	12796	13570	13593	8	11	3	23	22	0	33	32	9	13	32	32	6		
K	13123	13398	13665	8	10	3	22	23	0	30	29	10	13	30	32	6	2.88	
K	12771	13043	13518	8	11	3	21	22	0	31	29	9	14	29	33	6	2.91	
K	13152	13488	13516	8	11	3	22	23	0	31	28	10	13	30	31	6	2.93	
K	13166	13731	13578	8	12	3	24	22	0	31	29	10	13	30	32	6	2.82	
K	12837	13640	13786	8	11	3	23	22	0	30	30	10	13	33	30	6	2.98	
K	12702	13619	13571	8	10	3	24	22	0	30	29	8	13	30	32	6		
K	12954	13603	13741	8	12	3	23	23	0	30	29	10	14	31	32	5	2.84	
L		12606		10							24							
L		12397		10							24							
L		12410		10							24							
L		12423		10							25							
L		11947		10							23							
L		12522		10							24							
L		11735		10							24							
L		12686		11							24							
M	12800	14500	13100		12	5		25	0		33		13		52	6		
M	13600	14400	11300		9	4		20	0		25		11		42	5		
M	13500	14400	12000		11	4		23	0		27		12		42	6		
M	13300	14500	10900		10	4		19	0		24		12		38	5		
M	13400	14300	12600		12	5		24	0		29		12		48	6		
M	13300	14300	11200		9	4		22	0		27		11		36	5		
M	13300	14400	12300		11	5		22	0		29		13		44	6		
M	13300	14300	10900		9	4		18	0		23		11		42	5		
N		11800	13400	10	12	3	21		0	24	25	13		41				
N		11600	13500	11	12	3	21		0	24	26	13		43				
N		11200	13900	11	13	3	21		0	23	28	13		42				
N		11100	13700	10	12	3	20		0	23	26	12		41				
N		11000	13900	10	12	3	20		0	23	27	12		40				
N		11300	14000	10	12	3	20		0	23	27	12		41				
N		11100	13700	10	11	3	20		0	23	27	13		41				
N		11000	13500	11	10	3	21		0	24	27	13		44				
O	19859				3						544							
O	19288				2						439							
O	19701				3						409							
O	19306				3						468							
O	19153				4						608							
O	18899				2						541							
O	20374				3						552							
O	20695				3						463							
P		13621	13888	10	11	3	26	24	0	27	28	12	14	32	39	5		
P		13556	13915	10	11	4	25	25	0	27	30	11	14	32	38	5		
P		13587	13869	10	11	4	26	25	0	26	30	11	13	32	39	5		
P		13560	13860	10	11	4	26	25	0	27	30	11	13	32	37	5		
P		13525	13888	10	11	4	26	24	0	27	28	10	13	32	35	5		
P		13604	13772	10	12	4	25	25	0	27	30	11	13	33	37	5		
P		13601	13875	10	11	4	26	25	0	27	30	11	13	33	35	5		
P		13617	13765	10	11	4	25	26	0	27	30	11	12	33	40	5		
Q						3			0								2.90	
Q						4			0								2.89	
Q						3			0								2.89	
Q						3			0								2.90	
Q						4			0								2.85	
Q						3			0								2.87	
Q						4			0								2.87	
Q						3			0								2.86	
R		13780	14040	13	15			22	13	0	30	59	12	17	49	56	4	2.72
R		13590	13770	15	15			30	14	0	31	43	14	15	50	57	4	2.72
R		13500	14130	14	15			23	14	0	29	56	12	17	46	56	4	2.72
R		13590	13410	15	14			25	14	0	30	68	13	17	49	55	3	2.72
R		15480	13680	14	15			25	15	0	33	52	13	17	52	57	3	2.73
R		15030	13700	15	16			25	14	0	34	79	14	16	51	55	3	2.72
R		14130	14310	13	15			23	16	0	31	70	13	17	46	55	4	2.73
R		13950	13720	13	14			23	14	0	31	56	12	16	47	54	3	2.73
S		13600			10	3		25	20	0	29	33			69	35	5	2.85
S		13500			10	3		25	20	0	27	34			73	37	6	2.86
S		13600			10	3		24	20	0	27	35			72	36	5	2.85
S		13800			9	3		24	20	0	26	31			72	33	5	2.85
S		14100			9	3		23	20	0	26	32			71	36	6	2.90
S		13800			9	3		24	20	0	26	32			73	35	5	2.83
S		13600			10	3		24	20	0	26	32			72	35	6	2.88
S		13500			9	3		24	20	0	26	32			72	34	5	2.87
T		13500	14000	11	12	4			0	23	25						2.74	
T		13600	14000	10	12	7			0	22	26						2.77	
T		13300	14000	11	11	8			0	25	26						2.78	
T		13500	14000	11	12	3			0	23	27						2.75	
T		13600	14000	11	11	3			0	22	25						2.79	
T		13800	14000	11	11	3			0	23	24						2.77	
T		13700	14000	10	11	3			0	22	26						2.78	
T		13700	14000	10	11	3			0	23	24						2.77	

11. **Certified values:** The Certified, Provisional and Informational 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.

12. **Certification:** AMIS0036 is a new material.

13. **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.

14. **Minimum sample size:** The majority of laboratories reporting used a 0.5g sample size for the ICP, 10g for the XRF, 25 or 30 gm for the fire assay. These are the recommended minimum sample sizes for the use of this material.

15. **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.

16. **Recommended use:** The data used to characterize this RM 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 40 analyses using this CRM. User set limits should normally be within the limits recommended on p1 of this certificate.

17. **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.

Certified 8 October 2007, revised 5 November 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.)