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A Division of Set Point Industrial Technology ( Pty ) Ltd. Reg.No. 1989/000201/07.

# African Mineral Standards

## *Certificate of Analysis*

Copper Sulphide Ore  
Reference Material from Kansanshi, Zambia

AMIS0119

**Recommended Concentration and two “Between Laboratory” Standard Deviations**

### *Certified Concentrations*

Cu F	0.640	±	0.021	%
Cu M/ICP	0.637	±	0.054	%
Cu P	0.634	±	0.047	%
Cu XRF	0.641	±	0.027	%
SG	2.70	±	0.17	g/cc

### *Provisional Concentrations*

Co M/ICP	34.7	±	5.1	ppm
Ni M/ICP	154	±	20	ppm
U M/ICP	7.0	±	1.1	ppm

**Intended Use:** AMIS0119 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.

The recommended mean and "Between Lab" standard deviations for this standard reflect the average 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 and this is acceptable. Good laboratories however will report results within the two standard deviation levels with a failure of <10 %.

**Origin of Material:** This standard was made using sulphide ore sourced from the Kansanshi project, 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](http://www.first-quantum.com).)*

**Chemical Composition:** The major element chemistry below was determined from (predominantly) XRF data supplied by fourteen of the laboratories.

	mean	2SD	RSD%	n
Al <sub>2</sub> O <sub>3</sub>	5.23	0.10	0.96	89
CaO	0.57	0.03	2.81	94
Cr <sub>2</sub> O <sub>3</sub>	0.063	0.008	6.50	69
Fe <sub>2</sub> O <sub>3</sub>	3.79	0.06	0.79	70
K <sub>2</sub> O	0.87	0.04	2.19	87
LOI	1.82	0.51	13.9	77
MgO	0.72	0.04	2.73	76
MnO	0.035	0.009	12.17	80
Na <sub>2</sub> O	1.18	0.10	4.07	93
P <sub>2</sub> O <sub>5</sub>	0.068	0.006	4.66	60
S	0.40	0.03	4.29	70
SiO <sub>2</sub>	84.1	1.46	0.86	93
TiO <sub>2</sub>	0.45	0.02	2.20	86

**Appearance:** The material is a very fine Medium Light Grey powder (Corstor Colour Gauge – 10Y 6/2).

**Method of Preparation:** The material was crushed, dry-milled and air-classified to 100% <54µm. Wet sieve particle size analysis of random samples confirmed the material was 100% <54µm. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. 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 the consensus test results were carried out by an independent statistician.

**Methods of Analysis Requested:**

1. Cu, Fusion AAS or ICP-OES.
2. Multi-acid digest multi-element scan - ( to include Cu, Co, Ni, Pb, As, Zn, Ag, U. ). ICP-OES or ICP-MS.
3. Aqua regia digest - Cu, Co. ICP-OES or ICP-MS.
4. Pressed pellet multi-element scan - ( to include Cu, Co, Ni, Pb, As, Zn, Ag, U. ). XRF.
5. Fusion ( Majors ). XRF.
6. Au. Pb collection ICP-OES or ICP-MS.
7. Cu QBM/AAS Acid Soluble Copper – as per Bwana Mkubwa method supplied.
8. SG. Gas pycnometer.

**Method of Certification:** Twenty two laboratories were each given eight randomly selected packages of sample. Results from the sixteen laboratories that reported back timeously were used for the determinations below:

The mean and standard deviation for all data was calculated. Outliers were defined as samples beyond the mean  $\pm$  2 Standard Deviations from all data. These outliers were removed from the data and a new mean and standard deviation was determined. Total results from some laboratories that reported significant failures were also removed. This method is different from that used to calculate the Confidence Interval shown on many Government-produced standards in that the actual “between-laboratory” standard deviation is used in the calculations. This produces upper and lower limits that reflect actual individual analyses rather than a grouped set of analyses. The limits can therefore be used to monitor accuracy from individual analyses, unlike the Certified Limits published on other standards which quote a Confidence Interval.

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

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

**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.

Insufficient results were received for certification of Cu Acid Soluble, Au and Ag, but the data is also provided in this table. Additional data from this round robin on the other elements is available on p2 and in the appendix.

Lab Code	Ag ppm M/ICP	Au g/t PbColl	Co ppm M/ICP	Cu ppm Acid sol	Cu ppm F	Cu ppm M/ICP	Cu ppm P	Cu ppm XRF	Ni ppm M/ICP	SG g/cc	U ppm M/ICP	
A			31.90		6342			6167	142		7.50	
A			32.20		6369			6163	146		7.17	
A			30.80		6330			6308	139		7.53	
A			32.10		6408			6172	141		7.45	
A			31.50		6354			6175	141		7.18	
A			31.50		6312			6147	145		7.71	
A			33.00		6484			6186	152		7.08	
A			32.00		6300			6165	143		7.29	
B			38.00			6500	6556		161			
B			37.00			6550	6682		164			
B			37.00			6640	6428		164			
B			37.00			6570	6582		167			
B			37.00			6536	6490		165			
B			37.00			6484	6615		165			
B			38.00			6686	6493		165			
B			37.00			6654	6586		163			
C			38.00			6480	6320		163			
C			37.00			6460	6380		162			
C			37.00			6430	6370		160			
C			37.00			6450	6390		159			
C			37.00			6460	6330		160			
C			37.00			6460	6380		161			
C			37.00			6500	6330		163			
C			38.00			6510	6360		161			
D			32.40		6380	5780	6290	6421	141		6.38	
D			31.60		6320	5870	6310	6403	148		6.48	
D			32.70		6270	5820	6290	6403	135		6.37	
D			31.80		6300	5860	6190	6379	139		6.26	
D			32.30		6280	5850	6250	6353	138		6.68	
D			31.80		6260	5880	6200	6387	140		6.60	
D			30.30		6270	5860	6290	6404	129		6.24	
D			32.60		6230	5850	6230	6400	137		6.49	
E					6561							
E					6411							
E					6662							
E					6412							
E					6401							
E					6409							
E					6460							
E					6543							
F			36.26			6588	6652		160		6.40	
F			36.54			6595	6690		161		6.58	
F			37.01			6627	6630		162		6.25	
F			36.19			6638	6648		161		5.98	
F			36.80			6769	6667		164		7.46	
F			36.87			6603	6661		162		5.32	
F			36.71			6605	6683		161		7.33	
F			36.57			6675	6648		163		5.79	
H	0.20		31.00			6690		6500	163		6.71	
H	0.20		32.00			6920		6500	198		6.95	
H	0.20		32.00			6940		6500	174		6.94	
H	0.20		31.00			6870		6500	170		6.72	
H	0.20		30.00			6710		6600	167		6.51	
H	0.20		31.00			6790		6500	166		6.49	
H	0.20		31.00			6780		6600	168		6.98	
H	0.20		30.00			6710		6500	168		6.80	
I			39.00		6400	6000	6100	6340	150		2.67	
I			37.00		6300	6000	6000	6320	150		2.64	
I			36.00		6400	5900	6100	6230	140		2.68	
I			37.00		6300	5900	6000	6350	150		2.67	
I			38.00		6500	6000	6000	6410	150		2.67	
I			37.00		6500	5900	5900	6400	140		2.68	
I			38.00		6600	6200	6000	6340	150		2.67	
I			35.00		6300	6000	6000	6310	140		2.68	
K								6450	6500	6370		6.00
K								6500	6550	6490		6.50
K								6450	6450	6570		6.00
K								6500	6490	6390		6.70
K								6450	6450	6430		6.50
K								6550	6450	6370		6.50
K								6600	6590	6430		6.40
K								6500	6520	6350		6.30
L								6300	6390	6500		6.00
L								6200	6560	6290		6.50
L								6100	6320	6450		6.50
L								6400	6330	6620		6.50
L								6300	6450	6350		6.50
L								5900	6260	6290		6.50
L								6600	6260	6410		6.50
L								6400	6590	6300		6.50
M	0.06		39.30			6420	6690	6010	6600	180	2.65	9.50
M	0.09		37.10			6380	6500	6060	6530	175	2.69	7.60
M	0.08		38.70			6220	6710	6150	6580	181	2.71	8.20
M	0.09		38.60			6330	6360	6320	6560	195	2.66	7.10
M	0.06		35.70			6240	6060	6080	6520	163	2.72	7.10
M	0.09		35.80			6410	6290	5990	6570	168	2.63	7.20
M	0.09		35.30			6510	6110	6500	6580	164	2.79	7.40
M	0.11		37.00			6290	6360	6590	6650	174	2.70	7.60
N								3393				
N								3253				
N								3272				
N								3278				
N								3334				
N								3330				
N								3399				
N								3261				
O	0.03		32.20		4550	6530	5790	5920	6520	144	2.63	7.30
O	0.05		32.90		4780	6500	6040	5940	6460	149	2.64	7.60
O	0.01		32.80		4770	6510	5930	5870	6500	147	2.60	7.50
O	0.01		32.80		4640	6420	5950	5860	6490	145	2.57	7.50
O			32.90		4540	6450	6150	5910	5900	148	2.64	7.70
O	0.06		33.80		4580	6450	6250	5840	6420	152	2.62	7.90
O	0.04		32.70		4550	6520	6040	5870	6430	147	2.66	7.30
O	0.03		33.90		4510	6520	6000	5880	6430	147	2.60	7.50
P	0.12		32.00		2540	6300	6250	6600		146	2.67	7.30
P	0.11		31.10		2360	6440	5990	6600		144	2.78	7.20
P	0.09		31.20		2470	6320	6230	6600		146	2.70	7.20
P	0.10		30.30		2360	6390	6150	6500		142	2.72	7.00
P	0.11		32.90		2240	6340	6070	6600		145	2.71	7.30
P	0.10		31.60		2440	6380	5870	6800		143	2.71	7.10
P	0.10		31.40		2230	6210	5940	6400		142	2.67	7.00
P	0.09		29.70		2650	6300	6150	6600		144	2.72	7.00
T	0.50		33.60					6625	6130		147	6.70
T	0.50		35.00					6596	5880		199	6.70
T	0.50		36.40					6522	6090		160	6.90
T	0.50		34.20					6312	5940		147	6.70
T	0.50		36.40					6468	5970		154	6.80
T	0.50		36.10					6465	6050		159	6.70
T	0.50		34.40					6596	5720		142	6.50
T	0.50		35.10					6637	5970		155	6.70
V		0.07	36.00		2100	6400	6082	5977		153	2.83	7.80
V		0.07	37.00		2100	6500	6130	6060		156	2.82	7.16
V		0.07	35.00		2300	6900	6059	6211		153	2.76	7.41
V		0.08	37.00		2200	6500	6127	6192		156	2.81	7.58
V		0.08	35.00		2400	6300	6008	6147		157	2.83	7.31
V		0.06	36.00		2300	6400	6062	6174		156	2.87	7.57
V		0.06	37.00		2200	6400	6088	6101		157	2.81	7.77
V		0.05	36.00		2400	6400	6080	6573		155	2.74	7.99

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

**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.

28 August 2008

**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

Thirteen laboratories supplied additional trace element data. The iterated but uncertified statistics are presented below.

	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.19	0.340	90.59	39
Al	M/ICP	%	2.77	0.192	3.46	68
As	M/ICP	ppm	2.87	1.12	19.57	51
Au	PbColl	ppm	0.07	0.021	15.33	8
Ba	M/ICP	ppm	96.2	9.36	4.87	93
Be	M/ICP	ppm	1.00	0.154	7.71	61
Bi	M/ICP	ppm	0.26	0.061	11.59	63
Ca	M/ICP	%	0.41	0.040	4.87	96
Ce	M/ICP	ppm	73.9	4.84	3.27	68
Cr	M/ICP	ppm	396	46.7	5.89	92
Cs	M/ICP	ppm	0.70	0.036	2.56	54
Dy	M/ICP	ppm	2.82	0.722	12.81	47
Er	M/ICP	ppm	1.72	0.539	15.66	47
Eu	M/ICP	ppm	0.80	0.074	4.57	38
Fe	M/ICP	%	2.69	0.194	3.60	85
Ga	M/ICP	ppm	8.026	1.24	7.72	78
Gd	M/ICP	ppm	4.11	0.474	5.75	39
Hf	M/ICP	ppm	2.30	0.639	13.90	55
Ho	M/ICP	ppm	0.63	0.251	19.96	48
K	M/ICP	%	0.72	0.043	2.96	77
La	M/ICP	ppm	40.0	2.82	3.53	77
Li	M/ICP	ppm	6.37	0.962	7.55	76
Lu	M/ICP	ppm	0.37	0.093	12.50	40
Mg	M/ICP	%	0.42	0.051	6.02	95
Mn	M/ICP	ppm	264	24.5	4.65	86
Mo	M/ICP	ppm	4.38	0.803	9.16	79
Na	M/ICP	%	0.85	0.066	3.89	85
Nb	M/ICP	ppm	9.021	3.91	21.70	93
Nd	M/ICP	ppm	28.4	1.31	2.30	39
P	M/ICP	ppm	286	50.1	8.76	64
Pb	M/ICP	ppm	3.81	2.03	26.61	69
Pr	M/ICP	ppm	7.85	0.783	4.99	40
Rb	M/ICP	ppm	29.2	1.78	3.05	53
Sb	M/ICP	ppm	10.6	2.18	10.32	79
Sc	M/ICP	ppm	7.42	0.818	5.51	87
Sm	M/ICP	ppm	4.83	0.251	2.60	38
Sn	M/ICP	ppm	2.88	0.274	4.76	70
Sr	M/ICP	ppm	28.7	3.37	5.88	92
Ta	M/ICP	ppm	0.84	0.204	12.07	48
Tb	M/ICP	ppm	0.56	0.079	7.01	47
Te	M/ICP	ppm	1.04	0.181	8.68	47
Th	M/ICP	ppm	6.60	1.08	8.16	78
Ti	M/ICP	%	0.19	0.056	14.39	85
Tl	M/ICP	ppm	0.13	0.027	10.84	45
Tm	M/ICP	ppm	0.28	0.093	16.52	47
V	M/ICP	ppm	49.4	5.20	5.27	86
W	M/ICP	ppm	1.65	0.695	21.10	63
Y	M/ICP	ppm	12.0	2.41	10.05	79
Yb	M/ICP	ppm	2.10	0.595	14.16	48
Zn	M/ICP	ppm	27.5	8.19	14.88	84
Zr	M/ICP	ppm	77.2	9.22	5.97	71