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African Mineral Standards

Certificate of Analysis

Copper Sulphide Ore
Reference Material from Kansanshi, Zambia

AMIS0128

Recommended Concentration and two “Between
Laboratory” Standard Deviations

Certified Concentrations

Cu F	1.56	±	0.073	%
Cu M/ICP	1.55	±	0.078	%
Cu P	1.55	±	0.060	%
Cu XRF	1.59	±	0.024	%
Ag M/ICP ¹	2.04	±	0.20	ppm
Ni M/ICP	100	±	10	ppm
U M/ICP	10.4	±	1.0	ppm
SG	2.76	±	0.12	

Provisional Concentrations

Co M/ICP	40.4	±	4.3	ppm
Zn M/ICP	33.6	±	6.8	ppm

Indicated Mean

Pb M/ICP	8.8	ppm
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1. Note, these Ag limits have been corrected from the wrong ± 0.02 ppm on the original certificate (McW 2 Apr. 2012).

Intended Use: AMIS0128 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.)

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

	mean	2SD	RSD%	n
Al ₂ O ₃	7.75	0.18	1.14	92
CaO	1.17	0.04	1.66	85
Cr ₂ O ₃	0.05	0.01	8.06	70
Fe ₂ O ₃	4.41	0.26	2.92	82
K ₂ O	1.44	0.03	1.09	80
LOI	3.66	0.75	10.28	79
MgO	1.29	0.08	3.25	84
MnO	0.09	0.01	5.72	96
Na ₂ O	1.58	0.11	3.50	88
P ₂ O ₅	0.12	0.01	4.48	60
S	0.48	0.04	3.84	53
SiO ₂	75.5	1.01	0.67	81
TiO ₂	0.67	0.02	1.80	81

Appearance: The material is a very fine light grey powder (Corstor Colour Gauge – 5Y 7/1).

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. SG. Gas pycnometer.

Method of Certification: Nineteen 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. Additional data from this round robin on the other elements is available in the appendix.


Lab Code	Ag M/ICP ppm	Co M/ICP ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Ni M/ICP ppm	Pb M/ICP ppm	SG g/cc	U M/ICP ppm	Zn M/ICP ppm
A	3.24	40.20	15700	15700	15700	15870	105	6.60		9.00	24.00
A	3.54	41.10	15400	15600	14800	15800	103	6.63		8.88	30.10
A	3.30	38.60	15300	15500	14900	15870	99	7.28		8.79	31.90
A	3.51	42.30	15400	15600	14900	15940	100	6.63		9.03	28.30
A	3.02	38.70	15700	15500	15100	15600	100	7.11		8.32	29.30
A	3.59	43.90	15300	15600	14800	15820	100	8.01		9.01	29.90
A	3.25	38.70	15500	15400	15000	15840	96	6.80		9.00	30.50
A	3.62	44.60	15300	15500	15000	15880	103	7.37		8.94	44.60
B											
B											
B											
B											
B											
B											
B											
C					15484						
C					15357						
C					16010						
C					15435						
C					15288						
C					15706						
C					15778						
C					15668						
D	2.00	42.00		15700	14300		103	11.00			
D	2.10	40.00		15700	14500		103	9.00			
D	2.10	42.00		15800	14800		107	9.00			
D	2.20	39.00		15500	14500		103	11.00			
D	2.10	42.00		15600	14800		105	11.00			
D	2.20	40.00		15700	14400		103	10.00			
D	2.20	43.00		15800	14400		107	10.00			
D	2.20	42.00		15700	14500		107	9.00			
E	2.00	40.00	15500	15600	15200		104	11.00	11.00	40.00	
E	2.00	35.00	15400	15600	15300		104	10.00	11.40	36.00	
E	2.00	40.00	15400	15500	14900		100	10.00	11.30	36.00	
E	2.00	40.00	15700	15600	15000		104	10.00	10.90	36.00	
E	2.00	40.00	15500	15500	14600		102	10.00	11.60	36.00	
E	2.00	40.00	15600	15600	14400		102	10.00	10.90	36.00	
E	2.00	40.00	15700	15600	14800		100	13.00	10.90	34.00	
E	2.00	35.00	15400	15700	14600		100	11.00	11.00	40.00	
F				14600		15800	157		2.82		
F				14900		15900	157		2.82		
F				14200		15800	156		2.85		
F				14300		16000	160		2.85		
F				14400		16000	156		2.85		
F				13700		15800	158		2.86		
F				14500		15900	158		2.84		
F				14000		15600	156		2.81		
G	2.00	41.90					104	9.30		11.40	37.00
G	2.10	43.30					106	9.10		11.20	37.00
G	2.10	41.40					104	8.30		10.80	37.00
G	2.20	43.20					109	9.10		11.20	38.00
G	2.00	42.10					103	8.60		10.60	37.00
G	2.00	42.10					107	9.40		10.70	38.00
G	2.20	45.20					112	9.00		11.10	41.00
G	2.00	43.70					107	8.20		10.60	37.00
H	4.50	41.82	17417	15920	16160	16782	98	33.00	2.76		33.00
H	4.30	45.97	18351	15635	16740	17012	91	26.00	2.74		35.00
H		46.06	18008	15541	15980	17074	97	25.00	2.76		37.00
H	6.80	45.26	17802	16002	16198	17027	90	25.00	2.77		42.00
H	7.30	43.29	18198	16204	17453	17153	98	19.00	2.74		37.00
H		44.31	18621	15635	16255	16633	94	27.00	2.76		32.00
H		44.39	18556	15593	16027	17108	88	21.00	2.76		26.00
H		42.51	18527	16109	16075	16970	96	18.00	2.74		35.00
I											
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I											
J		38.80	15989				98	7.00		9.85	30.00
J		36.90	15992				97	7.10		9.84	30.00
J		37.80	16010				99	6.90		10.08	31.00
J		38.90	15989				96	6.90		9.73	30.00
J		38.20	15995				97	7.00		10.03	30.00
J		36.70	16585				96	7.30		10.23	29.00
J		37.90	16290				96	6.90		10.20	32.00
J		36.60	16708				95	6.70		10.09	29.00
K				40.00	15100	15770	15650				
K	4.00	40.00	15200	15430	15650		100				
K	4.00	40.00	14900	15820	15560		100				
K	3.00	40.00	15900	15150	15630		100				
K	4.00	40.00	14800	15380	15480		100				
K	3.00	40.00	15300	15540	15380		100				
K	3.00	40.00	15900	14860	15460		90				
K	3.00	40.00	15000	14980	15540		100				
L	1.97	36.80		15350			96	10.30	2.59	10.60	34.00
L	1.80	35.50		15800			90	8.50	2.61	10.40	29.00
L	1.85	35.10		15650			92	8.60	2.64	10.20	34.00
L	1.90	37.20		15700			94	8.30	2.61	10.30	33.00
L	1.87	35.70		15850			93	8.10	2.60	10.00	31.00
L	1.81	35.40		15800			93	8.40	2.63	10.80	34.00
L	1.89	35.80		15900			94	9.00	2.63	10.00	35.00
L	1.79	35.50		15750			94	7.90	2.59	9.60	31.00
M	2.12	41.20	15050	12950	15800		99	8.70	2.82	10.70	43.00
M	2.14	40.50	15250	14900	16000		97	8.60	2.72	10.20	28.00
M	2.18	40.00	15350	15450	15800		99	8.80	2.81	10.70	39.00
M	2.21	40.70	15200	15500	15800		102	8.70	2.73	10.50	29.00
M	2.15	39.70	15350	15550	15500		99	8.30	2.75	10.20	32.00
M	2.05	39.80	15050	15400	15800		101	8.80	2.75	9.00	33.00
M	2.07	40.20	15000	15950	15700		99	8.50	2.73	10.70	28.00
M	2.09	39.50	15100	15050	15500		100	8.50	2.69	10.50	33.00
N											
N											
N											
N											
N											
N											
N											
N											
N											
N											
O	1.81	43.00	15500	16500		16140	121	10.80	2.73	9.70	32.80
O	2.06	44.10	15400	16500		15980	126	10.30	2.66	9.90	33.10
O	2.00	42.40	15900	17300		16060	117	9.60	2.74	10.00	30.10
O	2.08	43.60	15600	17300		16699	123	10.40	2.71	10.20	31.90
O	2.07	45.10	15600	17300		16779	126	10.40	2.77	9.70	32.60
O	1.88	42.10	15200	17000		16060	118	9.70	2.68	9.70	30.30
O	1.99	44.10	15500	16400		15581	121	10.40	2.67	10.00	35.60
O	2.08	42.90	15400	16400		16060	124	10.30	2.69	10.00	35.50
P	1.90	38.00	15700			15900	109	18.00		10.70	34.00
P	2.00	38.00	15700			15800	109	20.00		10.20	34.00
P	2.00	37.00	15500			15900	110	20.00		10.20	34.00
P	2.00	38.00	15700			15900	110	20.00		10.20	32.00
P	2.00	39.00	15600			15900	108	18.00		10.90	31.00
P	2.00	37.00	16200			15900	107	17.00		10.20	33.00
P	2.10	37.00	15700			16000	111	17.00		10.30	31.00
P	2.10	38.00	16000			15900	109	21.00		10.30	32.00
Q						16000	15000	16100	15320	89	2.67
Q											
Q				16100	15000	16700	15220	89		2.68	
Q				16300	15000	16100	15380	88		2.70	
Q				15800	15000	15900	15300	90		2.69	
Q				16200	15000	16600	15420	87		2.70	
Q											
Q				16000	15000	16500	15360	91		2.69	
R		39.00	15700	14747	15352	14264	102			10.18	34.00
R		40.00	15800	14914	15419	14294	104		2.78	6.08	32.00
R		39.00	16600	14756	15427	14170	99		2.83	6.91	31.00
R		40.00	16500	15085	15062	14442	104		2.83	5.21	34.00
R		39.00									

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.

	Unit	Mean	2SD	RSD%	
Al	%	4.07	0.21	2.62	66
As	ppm	3.72	2.70	36.3	55
Ba	ppm	499	47.8	4.79	93
Be	ppm	1.39	0.34	12.1	59
Bi	ppm	0.597	0.12	10.4	71
Ca	%	0.839	0.06	3.52	82
Ce	ppm	94.5	6.65	3.52	60
Cr	ppm	326	44.3	6.80	93
Cs	ppm	1.16	0.09	3.71	62
Dy	ppm	3.83	1.03	13.4	48
Er	ppm	2.23	0.65	14.5	48
Eu	ppm	1.17	0.10	4.36	38
Fe	%	3.13	0.19	2.96	85
Ga	ppm	11.5	2.41	10.5	70
Gd	ppm	5.58	0.67	6.01	46
Hf	ppm	2.93	0.74	12.6	64
Ho	ppm	0.756	0.26	17.4	48
K	%	1.18	0.10	4.04	76
La	ppm	51.9	3.60	3.47	68
Li	ppm	17.1	2.80	8.19	56
Lu	ppm	0.452	0.12	13.3	47
Mg	%	0.746	0.07	5.02	80
Mn	ppm	656	63.8	4.87	86
Mo	ppm	4.88	1.05	10.7	61
Na	%	1.11	0.14	6.17	70
Nb	ppm	12.9	7.81	30.2	95
Nd	ppm	37.4	1.53	2.05	37
P	ppm	536	60.7	5.67	66
Pr	ppm	10.8	1.83	8.47	47
Rb	ppm	42.5	3.05	3.59	60
Sb	ppm	10.8	2.02	9.38	71
Sc	ppm	10.1	0.39	1.95	52
Sm	ppm	6.54	0.33	2.51	37
Sn	ppm	2.92	0.45	7.69	52
Sr	ppm	45.9	4.44	4.83	95
Ta	ppm	0.928	0.45	24.4	61
Tb	ppm	0.781	0.08	5.30	40
Te	ppm	2.05	0.32	7.78	47
Th	ppm	8.11	0.43	2.68	51
Ti	%	0.301	0.07	12.4	66
Tl	ppm	0.185	0.04	10.6	63
Tm	ppm	0.364	0.14	18.9	48
V	ppm	78.0	8.31	5.33	77
W	ppm	1.99	0.53	13.4	47
Y	ppm	19.9	8.66	21.7	88
Yb	ppm	2.67	0.77	14.4	48
Zr	ppm	121	53.8	22.2	88