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

African Mineral Standards

Certificate of Analysis

Uranium standard made from
calcretized fluvial sediment,
Langer Heinrich, Namibia

AMIS0090

Recommended Concentration and two “Between Laboratory”
Standard Deviations

Certified Concentrations*

U M/ICP	890	±	59	ppm
U XRF	903	±	42	ppm
Ba M/ICP	298	±	22	ppm
Sr M/ICP	199	±	20	ppm
V M/ICP	229	±	16.5	ppm
Zn M/ICP	49	±	5.1	ppm
Specific Gravity	2.67	±	0.18	no units

Provisional Concentrations*

Co M/ICP	6.9	±	1.2	ppm
Cr M/ICP	115	±	29	ppm
Cu M/ICP	21.6	±	5.0	ppm
Mn M/ICP	358	±	59	ppm
Ni M/ICP	70	±	9	ppm
P M/ICP	416	±	66	ppm
Zr M/ICP	46.7	±	13.6	ppm

***This material has had additional major elements certified. This data is presented on p2.
Uncertified trace element data is available as an appendix.**

**** Or, by applying a chemical conversion factor of U x 1.1793 = U₃O₈
U₃O₈ by multi acid digestion: 1050 ± 70 ppm
U₃O₈ by XRF: 1065 ± 50 ppm**

Intended use: AMIS0090 is suitable for monitoring the accuracy of a single analysis of uraniferous calcareous grit. The material can be used for routine quality control by inserting within a batch of samples.

Additional geochemical data is presented for this material that will enable its use for 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 material was supplied by Paladin Energy from their Langer Heinrich Mine, 80km east of Swakopmund in Namibia. This deposit is a "calcrete deposit"; one of the surficial uranium occurrences discovered in Southern Africa during the 1970's.

Uranium mineralization is associated with calcretization of valley-fill fluvial sediments in an extensive tertiary palaeo-channel drainage system. These sediments, also known as the Langer Heinrich Formation, comprise mainly grits and conglomerates. Detrital components include quartz- and feldspar granules, minor mica flakes as well as rock fragments derived from surrounding Proterozoic country rock.

Uranium mineralization occurs in the form of carnotite, which is a secondary uranium and vanadium mineral and has been precipitated from groundwater. Uranium as well as vanadium originates from the Proterozoic country rock, the former was most likely sourced from granites, whereas the latter was probably sourced from mafic schists.

Mineral and chemical composition:

The major element chemistry for this material has also been certified and is set out below.

Recommended Concentrations and two "Between Laboratory" Standard Deviations for the major elements are:

Al ₂ O ₃	Certified at	8.65% ± 0.12%
CaO	Certified at	13.83% ± 0.22%
Cr ₂ O ₃	Indicated mean of	0.02%
Fe ₂ O ₃	Certified at	2.24% ± 0.10%
K ₂ O	Certified at	2.68% ± 0.12%
LOI	Certified at	12.52% ± 1.04%
MgO	Certified at	1.21% ± 0.06%
MnO	Provisional mean of	0.047% ± 0.008%
Na ₂ O	Certified at	1.68% ± 0.09%
P ₂ O ₅	Certified at	0.096% ± 0.01%
S	Provisional mean of	0.065% ± 0.008%
SiO ₂	Certified at	56.50% ± 1.1%
TiO ₂	Certified at	0.26% ± 0.016%

Iterated but uncertified data for an additional 43 trace elements is set out in the Appendix.

Appearance: The material is a very fine powder. It is coloured a Very Light Grey (Corstor 5Y 8/1).

Radioactivity: Shipments of this material do not require special marking, labeling or placarding. AMIS0091 does contain U (3.3 Bq/g) and Th (0.03 Bq/g), but due to low activity concentrations it is classified as EXEMPT MATERIAL in terms of "Safety Standards Series No. TS-R-1: Regulations for the Safe Transport of Radioactive Material, International Atomic Energy Agency, 2005, para 403, Table 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. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis for the consensus test results were carried out by an independent statistician. Explorer Packs are subdivided from the Laboratory packs as required.

Methods of analysis requested:

1. Multi-acid digest, including HF, ICP- OES or ICP-MS. Multi element scan (to include U).
2. U XRF.
3. Majors (Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, SiO₂, TiO₂. LOI.) XRF fusion.
4. SG (gas pycnometer).

Method of certification: Twenty laboratories were each given eight randomly selected packages of sample. The results from the eighteen laboratories that issued results timeously were used for the certification.

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.

Standards with an RSD of near or less than 5 % are then certified, RSD's of between near 5 % and 15 % are given Provisional Concentrations and limits, those with RSD's over 15 % are given Indicated Concentrations.

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 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 Johannesburg SA
5. ALS Chemex Laboratory Group Vancouver CA
6. Ammtec Limited WA
7. Anglo Gold Ashanti - Vaal River Laboratory SA
8. Assayers Canada
9. Genalysis Laboratory Services WA
10. Intertek Utama Services (Indonesia)
11. Labtium Inc Finland
12. OMAC Laboratories Limited (Ireland)
13. Performance Laboratories SA
14. Set Point Laboratories (Isando) SA
15. SGS Australia Pty Ltd (Newburn) WA
16. SGS Lakefield Research Africa Pty Ltd (Booyens) SA
17. SGS Mineral Services Lakefield (Canada)
18. 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 is available on request.

Lab Code	U	U	Ba	Co	Cr	Cu	Mn	Ni	P	SG	Sr	V	Zn	Zr	Al ₂ O ₃	CaO	Cr ₂ O ₃	Fe ₂ O ₃	K ₂ O	LOI	MgO	MnO	Na ₂ O	P ₂ O ₅	S	SiO ₂	TiO ₂		
	M/ICP	XRF	M/ICP	M/ICP	M/ICP	M/ICP	M/ICP	M/ICP	M/ICP		M/ICP	M/ICP	M/ICP	M/ICP	XRF %	XRF %	XRF %	XRF %	XRF %	%	XRF %	XRF %	XRF %	XRF %	XRF %	XRF %	XRF %	XRF %	
A		886																											
A		895																											
A		891																											
A		899																											
A		895																											
A		899																											
A		896																											
A		898																											
B	877	884	301	8.0	150	36	358	73	381	2.75	189	245	49	51	8.68	13.97			2.71	11.89	1.25		1.74		0.06	57.52	0.26		
B	889	888	300	9.0	155	23	355	75	395	2.80	187	246	49	47	8.60	13.84			2.69	11.98	1.24		1.72		0.07	56.91	0.26		
B	883	892	298	9.0	148	32	357	75	390	2.79	192	245	49	49	8.63	13.83			2.69	11.96	1.24		1.72		0.07	57.18	0.25		
B	890	891	300	9.0	153	27	354	75	393	2.80	190	244	49	49	8.66	13.86			2.71	11.94	1.25		1.72		0.07	57.18	0.25		
B	881	892	294	8.0	149	26	352	74	390	2.77	195	244	50	50	8.66	13.88			2.70	11.97	1.26		1.72		0.07	57.07	0.26		
B	873	894	298	8.0	154	28	346	76	385	2.77	188	240	52	49	8.67	13.88			2.70	11.95	1.25		1.72		0.07	57.57	0.26		
B	875	893	299	8.0	149	48	352	73	392	2.78	195	243	48	50	8.73	13.95			2.72	11.91	1.28		1.74		0.07	57.53	0.26		
B	868	889	302	9.0	154	43	356	76	400	2.78	199	245	51	50	8.62	13.73			2.68	11.87	1.24		1.72		0.07	57.21	0.25		
D	904	864	307	6.1	116	21	346	74	555	2.76	191	231	49	39	8.71	13.81		2.21	2.67	12.90	1.23	0.04	1.70	0.10	0.08	57.90	0.26		
D	920	861	300	6.1	132	20	336	69	477	2.75	195	236	52	41	8.71	13.76		2.19	2.66	13.00	1.22	0.04	1.72	0.10	0.07	57.90	0.27		
D	878	863	301	5.9	131	19	337	69	515	2.76	188	225	52	39	8.74	13.83		2.21	2.67	13.00	1.24	0.04	1.71	0.10	0.06	58.00	0.27		
D	882	862	303	6.0	111	20	333	72	426	2.75	190	223	51	37	8.68	13.77		2.19	2.66	12.90	1.22	0.05	1.72	0.10	0.06	57.80	0.27		
D	899	859	307	5.9	124	23	344	70	495	2.74	191	227	49	39	8.72	13.78		2.21	2.67	13.00	1.23	0.04	1.73	0.10	0.06	57.90	0.27		
D	873	862	307	6.0	109	18	341	68	674	2.75	188	227	47	38	8.69	13.69		2.20	2.65	12.80	1.22	0.05	1.73	0.10	0.07	57.80	0.27		
D	889	854	301	6.1	106	18	332	70	570	2.75	189	228	49	39	8.72	13.76		2.20	2.67	12.70	1.23	0.04	1.71	0.10	0.06	58.00	0.27		
D	876	852	307	6.4	123	17	336	64	636	2.75	188	226	49	44	8.65	13.74		2.18	2.66	12.90	1.22	0.04	1.71	0.10	0.06	57.90	0.27		
E	928	903	413	7.1	103	34	423	94		2.60	253	238	51	34	8.58	13.67	0.02	2.25	2.51	12.82	1.15	0.05	1.60	0.09		55.76	0.25		
E	925	897	396	6.8	127	31	399	84		2.63	247	225	49	47	8.54	13.59	0.03	2.32	2.45	12.98	1.15	0.05	1.62	0.09		56.17	0.25		
E	963	900	414	7.1	112	31	404	95		2.61	262	233	51	44	8.52	13.69	0.02	2.24	2.43	12.87	1.14	0.05	1.65	0.09		55.63	0.25		
E	918	905	391	6.8	111	30	394	89		2.62	242	225	48	15	8.62	13.76	0.02	2.28	2.52	12.79	1.11	0.05	1.63	0.09		56.04	0.25		
E	938	895	411	7.2	109	35	401	86		2.59	255	229	51	45	8.63	13.69	0.03	2.27	2.47	13.17	1.14	0.05	1.64	0.09		55.98	0.25		
E	894	899	397	6.9	106	33	377	82		2.63	243	216	46	41	8.57	13.75	0.02	2.28	2.48	12.78	1.13	0.05	1.66	0.09		56.03	0.25		
E	906	904	411	6.9	100	35	401	93		2.62	252	217	50	35	8.56	13.66	0.02	2.25	2.48	12.88	1.12	0.05	1.64	0.09		55.41	0.24		
E	883	901	390	6.6	111	34	385	84		2.62	243	220	48	40	8.56	13.76	0.02	2.27	2.54	12.78	1.12	0.05	1.64	0.09		55.73	0.25		
F	870	912	258	7.0	130	26	320		370		198	218		58	8.66	13.80	0.02	2.23	2.69	12.30	1.18	0.05	1.66		0.11	56.70	0.27		
F	875	917	261	7.0	130	26	330		350		199	218		60	8.62	13.80	0.02	2.22	2.68	12.20	1.18	0.05	1.66			56.80	0.28		
F	857	915	256	7.0	130	26	320		390		196	216		59	8.64	13.80	0.02	2.22	2.69	12.20	1.19	0.05	1.68		0.11	56.70	0.27		
F	862	913	253	6.0	120	25	320		350		195	216		59	8.66	13.90	0.02	2.23	2.70	12.20	1.18	0.05	1.68		0.11	56.70	0.28		
F	849	913	263	6.0	130	24	330		320		201	221		60	8.64	13.80	0.02	2.22	2.69	12.30	1.19	0.04	1.67		0.11	56.80	0.27		
F	853	933	259	6.0	130	23	330		390		196	219		60	8.64	13.80	0.02	2.23	2.69	12.20	1.19	0.05	1.67		0.11	56.70	0.28		
F	868	905	261	7.0	130	24	330		390		199	219		59	8.61	13.90	0.03	2.23	2.68	12.30	1.18	0.04	1.66		0.11	56.70	0.26		
F	836	904	262	6.0	130	24	330		420		200	221		59	8.64	13.80	0.02	2.22	2.69	12.20	1.20	0.05	1.68		0.11	56.70	0.27		
G	870	970	310			22		61		2.64	200				8.54	13.80	0.02	2.21	2.68	13.00	1.20	0.05	1.72	0.10		55.60	0.25		
G	870	1030	300			21		60		2.64	190				8.58	13.90	0.03	2.22	2.67	12.90	1.21	0.04	1.71	0.10		55.90	0.27		
G	860	970	300			21		58		2.65	190				8.59	14.00	0.02	2.24	2.69	12.90	1.21	0.05	1.73	0.10		56.10	0.26		
G	850	990	300			21		60		2.64	190				8.61	14.00	0.02	2.26	2.70	12.90	1.21	0.04	1.73	0.10		56.50	0.27		
G	900	980	310			22		62		2.64	200				8.59	13.90	0.02	2.22	2.67	12.90	1.19	0.05	1.70	0.10		56.00	0.26		
G	860	980	300			22		57		2.64	190				8.60	14.00	0.02	2.25	2.69	12.90	1.22	0.05	1.74	0.10		56.30	0.27		
G	900	980	310			22		63		2.64	200				8.60	13.80	0.02	2.20	2.68	12.90	1.22	0.04	1.71	0.10		55.60	0.26		
G	850	1030	300			22		61		2.63	190				8.59	13.90	0.02	2.22	2.71	12.80	1.21	0.04	1.71	0.09		55.90	0.26		
H	911	941	300			20	404	67	470	2.68		231	51		13.60			2.14	2.55	12.95	1.17	0.05	1.63	0.09		55.80	0.25		
H	917	939	305			20	417	67	400	2.66		231	51		13.80			2.27	2.58	13.00	1.16	0.06	1.53	0.08		56.40	0.26		
H	917	925	304			20	407	70	530	2.68		230	50		13.80			2.28	2.58	12.98	1.18	0.06	1.63	0.09		56.80	0.26		
H	915	932	302			19	406	67	410	2.66		229	51		13.50			2.22	2.53	13.04	1.16	0.04	1.57	0.09		55.50	0.24		
H	916	935	296			20	401	68	430	2.67		229	51		13.80			2.23	2.59	13.00	1.19	0.06	1.60	0.09		56.80	0.25		
H	915	935	307			20	403	67	440	2.68		231	51		13.70			2.19	2.58	13.02	1.19	0.05	1.56	0.10		56.10	0.25		
H	916	940	302			21	403	67	500	2.67		229	51		13.80			2.22	2.59	12.84	1.17	0.04	1.65	0.09		56.60	0.25		
H	913	939	313			21	412	68	400	2.68		229	50		13.60			2.17	2.53	12.62	1.20	0.04	1.56	0.09		56.20	0.25		
I	907		241	8.0	108	21	330	60	425		160	191	49																

11 October 2008

Certifying officers:



African Mineral Standards: _____

Mike McWha
BSc (Hons), FGSSA, MSAIMM, Pr.Sci.Nat



Geochemist: _____

Barry W. Smee
BSc, PhD, P.Geo, (B.C.)

APPENDIX - Uncertified trace element data from 16 laboratories

	method	unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.192	0.14	5.2	77
Al	M/ICP	%	4.64	0.42	4.5	93
As	M/ICP	ppm	8.65	2.12	4.3	32
Be	M/ICP	ppm	2.01	0.34	8.2	39
Bi	M/ICP	ppm	0.367	0.079	26.3	24
Ca	M/ICP	%	9.77	0.54	2.8	99
Cd	M/ICP	ppm	0.062	0.048	8.4	77
Ce	M/ICP	ppm	30.6	3.16	7.1	71
Cl	XRF	ppm	0.046	0.024	12.3	91
Cs	M/ICP	ppm	4.53	0.42	7.8	40
Dy	M/ICP	ppm	2.26	0.69	16.3	46
Er	M/ICP	ppm	1.08	0.14	10.3	38
Eu	M/ICP	ppm	0.659	0.12	8.9	39
Fe	M/ICP	%	1.59	0.11	3.4	104
Ga	M/ICP	ppm	10.2	1.30	13.8	85
Gd	M/ICP	ppm	2.76	0.57	13.2	32
Hf	M/ICP	ppm	1.60	0.42	13.2	72
Ho	M/ICP	ppm	0.391	0.064	4.6	63
In	M/ICP	ppm	0.024	0.008	36.2	46
K	M/ICP	%	2.20	0.19	4.3	75
La	M/ICP	ppm	16.1	1.43	6.8	62
Li	M/ICP	ppm	40.8	4.84	7.0	76
Lu	M/ICP	ppm	0.143	0.038	10.7	69
Mg	M/ICP	%	0.71	0.07	5.2	108
Mo	M/ICP	ppm	2.74	0.42	5.9	92
Na	M/ICP	%	1.21	0.12	4.9	94
Nb	M/ICP	ppm	5.94	1.26	14.2	90
Nd	M/ICP	ppm	13.4	0.89	3.5	69
Pb	M/ICP	ppm	28.4	4.99	15.0	47
Pr	M/ICP	ppm	3.68	0.57	8.8	101
Rb	M/ICP	ppm	102	8.17	11.1	48
Sb	M/ICP	ppm	3.32	0.95	3.3	38
Sc	M/ICP	ppm	4.84	0.62	4.0	80
Sm	M/ICP	ppm	2.77	0.24	7.6	75
Sn	M/ICP	ppm	2.40	0.66	4.4	78
Tb	M/ICP	ppm	0.401	0.036	15.4	39
Th	M/ICP	ppm	7.45	0.52	6.4	66
Ti	M/ICP	%	0.15	0.02	6.1	99
Tl	M/ICP	ppm	0.538	0.073	6.7	39
Tm	M/ICP	ppm	0.163	0.049	38.1	37
W	M/ICP	ppm	3.25	0.46	10.6	69
Y	M/ICP	ppm	10.4	1.45	4.5	40
Yb	M/ICP	ppm	1.05	0.23	6.4	94