

African Mineral Standards

Certificate of Analysis

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

AMIS0092

Recommended Concentration and two "Between Laboratory"
Standard Deviations

Certified Concentrations*

U (XRF)**	338	+ -	21	ppm
U (M/ICP)**	338	+ -	35	ppm
Ba (M/ICP)	307	+ -	18	ppm
Sr (M/ICP)	210	+ -	17	ppm
V (M/ICP)	122	+ -	10	ppm
Specific Gravity	2.69	+ -	0.12	g/cc

Provisional Concentrations*

Co (M/ICP)	6.5	+ -	1.6	ppm
Cu (M/ICP)	17.8	+ -	3.7	ppm
Mn (M/ICP)	298	+ -	46	ppm
Ni (M/ICP)	15.3	+ -	3.5	ppm
P (M/ICP)	418	+ -	86	ppm
S	0.08	+ -	0.02	%
Zn (M/ICP)	96	+ -	12	ppm
Zr (M/ICP)	85	+ -	12.6	ppm

Indicated Mean

Cr (M/ICP) 126 ppm

***Additional uncertified major and trace elements data is presented on p2 and as an appendix.**

**** Or, by applying a chemical conversion factor of U x 1.1793 = U₃O₈
U₃O₈ by multi acid digestion: 399 ± 41 ppm
U₃O₈ by XRF: 399 ± 25 ppm**

Intended use: AMIS0092 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:

Statistics for the major and trace element chemistry are also reported, although they have not been certified, because they might be useful for instrument calibration and method development. The major element chemistry is set out below. The additional trace element chemistry is set out in the Appendix.

	mean	2SD	RSD%	n	unit
Al ₂ O ₃	8.9	0.2	1.3	85	%
BaO	0.04	0.01	14.8	16	%
C	2.8	0.1	1.1	14	%
CaO	13.7	0.3	1.0	93	%
Cr ₂ O ₃	0.02	0.01	19.6	77	%
Fe ₂ O ₃	2.2	0.1	1.8	79	%
K ₂ O	2.8	0.1	2.3	102	%
LOI	12.8	0.6	2.3	85	%
MgO	1.2	0.1	4.9	91	%
MnO	0.04	0.01	9.5	96	%
Na ₂ O	1.7	0.1	4.3	93	%
P ₂ O ₅	0.09	0.01	4.9	68	%
S	0.08	0.01	7.8	55	%
SiO ₂	56.4	1.1	1.0	76	%
TiO ₂	0.24	0.02	4.8	101	%
V ₂ O ₅	0.02	0.01	21.5	51	%

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. AMIS0092 does contain U (5.0 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: Sixteen laboratories were each given eight randomly selected packages of sample. All results were issued timeously and 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., (Canada).
2. ALS Chemex South Africa (Pty) Ltd.
3. ALS Chemex, (Perth, Australia).
4. ALS Chemex, (Vancouver, Canada).
5. Assayers Canada, (Vancouver).
6. Genalysis Laboratory Services (Pty) Ltd., (Australia).
7. Geoscience Laboratories, (Geo Labs, Sudbury, Canada).
8. Labtium Inc. (Finland)
9. Langer Heinrich Mine Laboratory (Namibia)
10. OMAC Laboratories (Ireland).
11. Pt Intertek Utama Services (Intertek, Indonesia)
12. Set Point Laboratories (Pty) Ltd (South Africa)
13. SGS Lakefield Research (Canada)
14. SGS Lakefield Research Africa (Pty) Ltd. (Joburg, South Africa)
15. SGS Welshpool (Australia).
16. Ultra Trace (Pty) Ltd. (Australia)

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	Ba (M/ICP) ppm	Co (M/ICP) ppm	Cr (M/ICP) ppm	Cu (M/ICP) ppm	Mn (M/ICP) ppm	Ni (M/ICP) ppm	P (M/ICP) ppm	S %	Specific Gravity g/cc	Sr (M/ICP) ppm	U (M/ICP) ppm	U (XRF) ppm	V (M/ICP) ppm	Zn (M/ICP) ppm	Zr (M/ICP) ppm
A	311	6.50	165	17.00		17.00				207		353	120	77	85
A	307	6.50	168	17.00		17.00				206		353	120	77	86
A	308	6.80	165	17.00		17.00				208		354	119	79	87
A	307	6.10	163	16.00		17.00				207		355	120	76	86
A	304	6.80	159	16.00		17.00				203		354	116	74	87
A	303	6.80	161	17.00		17.00				206		355	117	79	87
A	281	6.30	159	16.00		17.00				188		354	117	77	87
A	303	6.90	159	17.00		17.00				199		354	114	78	83
B												336			
B												348			
B												338			
B												336			
B												330			
B												337			
B												335			
B												337			
C	290	6.90	138	20.00	288	21.90	420	0.08	2.52	212	322		124	94	57
C	310	7.00	142	19.00	303	21.50	440	0.09	2.52	221	339		127	97	45
C	300	8.30	126	22.10	301	18.70	420	0.09	2.55	225	360		123	94	49
C	320	7.10	138	19.80	312	20.50	460	0.09	2.59	235	344		124	95	47
C	330	7.00	134	19.80	322	20.40	470	0.09	2.49	241	358		123	95	57
C	310	7.30	134	20.20	304	21.30	450	0.09	2.52	226	331		125	94	46
C	300	7.00	128	20.30	291	20.70	420	0.09	2.56	216	329		121	93	56
C	290	6.50	129	18.80	288	19.90	430	0.08	2.53	212	326		119	90	43
D	290	5.50	125	16.90	274	13.80	390	0.07	2.52	205	271	280	118	87	53
D	300	5.90	121	17.50	284	15.10	390	0.08	2.49	213	273	290	123	89	53
D	300	6.10	115	17.50	284	14.90	390	0.08	2.53	214	278	290	122	88	55
D	300	6.00	115	18.20	281	15.10	390	0.08	2.51	210	274	290	121	87	55
D	300	6.00	124	17.60	286	14.90	400	0.08	2.52	214	283	290	122	89	56
D	310	5.60	120	17.40	291	14.60	400	0.08	2.51	218	279	290	126	90	53
D	280	7.60	121	19.30	282	15.50	390	0.08	2.51	216	289	280	118	86	54
D	280	7.40	123	19.00	285	14.90	390	0.08	2.52	215	286	280	119	89	54
E	320	7.30	119	17.10	303	17.90	430	0.09	2.62	236	325	332	121	102	58
E	330	7.60	125	17.40	315	16.70	460	0.09	2.68	251	338	329	126	100	58
E	320	7.20	126	16.90	309	17.10	430	0.09	2.66	245	332	328	121	97	55
E	320	7.10	131	17.10	309	16.70	430	0.09	2.73	243	332	330	122	101	58
E	290	6.50	116	21.70	287	13.50	410	0.10	2.63	226	314	328	115	88	54
E	320	6.80	118	16.50	305	15.90	440	0.09	2.59	243	331	328	118	96	54
E	310	7.00	110	16.80	291	16.10	420	0.08	2.61	232	317	325	118	95	58
E	320	7.00	113	17.30	306	16.40	420	0.08	2.67	243	336	325	118	99	59
F	319	5.00	135	20.00	306	15.00	416	0.07	2.76	228	316	322	126	97	51
F	313	6.00	140	21.00	316	16.00	429	0.07	2.74	224	319	324	130	99	50
F	320	7.00	175	24.00	353	18.00	470	0.07	2.74	224	314	323	148	112	52
F	316	5.00	138	20.00	307	14.00	414	0.07	2.74	219	327	325	126	96	48
F	312	6.00	141	19.00	299	14.00	402	0.07	2.76	218	323	321	124	94	50
F	316	6.00	146	23.00	310	15.00	416	0.07	2.75	221	331	325	128	96	48
F	315	6.00	149	28.00	303	15.00	410	0.07	2.75	225	322	326	123	97	50
F	318	6.00	139	19.00	300	15.00	407	0.07	2.73	223	316	318	124	96	54
G	309	6.00	135	15.60	278	18.40	471	0.08		210	258	343	122	99	
G	322	5.92	135	16.70	275	19.00	474	0.08		211	259	344	121	104	
G	308	5.93	142	15.00	276	17.40	471	0.08		211	258	345	122	98	
G	306	5.98	134	15.00	271	17.40	468	0.08		209	257	336	121	98	
G	311	5.94	139	15.30	274	16.60	478	0.08		211	258	347	122	98	
G	315	5.60	135	14.30	275	17.00	476	0.08		210	255	342	121	102	
G	310	6.52	148	15.60	276	17.40	467	0.08		210	268	348	121	100	
G	311	6.11	148	14.80	289	16.80	470	0.08		211	260	339	121	99	
H	305	7.00	98	16.30	294	14.50			2.60	217	340		124	98	94
H	309	7.00	92	18.00	314	14.70			2.60	217	335		123	96	117
H	308	6.00	97	19.60	319	14.90			2.66	217	353		126	95	103
H	310	6.00	96	19.70	313	15.50			2.60	218	337		124	92	92
H	312	7.00	97	19.80	310	16.10			2.61	215	353		125	102	90
H	304	7.00	91	17.90	309	15.90			2.60	215	336		127	116	89
H	309	7.00	97	16.80	323	14.30			2.60	216	351		124	99	90
H	308	7.00	101	17.90	316	13.50			2.59	216	352		125	118	95
I	309		139	21.40	343	30.70	530	0.37		253	346		138	136	50
I	309		153	20.90	351	31.50	550	0.34		270	345		144	144	56
I	309		158	23.60	383	29.40	590	0.43		298	353		141	160	58
I	319		150	20.30	376	28.80	560	0.38		283	342		158	148	59
I	312		172	20.20	418	32.60	710	0.61		322	360		163	151	62
I	313		169	25.50	427	32.90	750	0.73		328	373		178	146	66
I	312		177	24.70	447	33.70	710	0.73		334	381		175	153	64
I	313		167	22.80	421	32.20	680	0.68		330	364		156	148	63
J	316		200	18.00	310	16.00	450	0.08	2.75	211	332		125	94	51
J	308		150	20.00	312	16.00	450	0.08	2.78	209	327		130	90	57
J	308		200	22.00	316	16.00	500	0.08	2.75	205	332		130	90	55
J	314		200	18.00	320	16.00	450	0.08	2.73	211	330		130	94	62
J	315		200	22.00	326	18.00	400	0.08	2.74	212	334		135	92	47
J	309		200	18.00	324	18.00	450	0.08	2.72	209	334		130	96	61
J	312		200	18.00	318	18.00	450	0.08	2.75	210	336		125	94	54
J	314		200	20.00	318	18.00	450	0.08	2.74	216	332		135	96	58
K	311	6.48	142	17.20	315	16.28	442	0.08		217	317		123	106	46
K	306	6.53	141	17.67	311	16.41	441	0.08		212	316		120	110	46
K	307	6.16	145	16.63	313	15.41	421	0.08		215	318		121	102	44
K	310	6.46	142	17.04	318	16.27	436	0.08		217	323		124	104	45
K	314	6.51	147	16.82	315	15.60	433	0.08		217	322		125	108	50
K	308	6.36	144	16.59	366	15.26	416	0.08		211	314		123	101	45
K	307	6.80	144	16.47	317	15.39	438	0.08		216	316		125	104	46
K	311	6.51	145	17.22	314	15.73	448	0.08		214	323		122	106	46

Assay Data (cont):

Lab Code	Ba (M/ICP) ppm	Co (M/ICP) ppm	Cr (M/ICP) ppm	Cu (M/ICP) ppm	Mn (M/ICP) ppm	Ni (M/ICP) ppm	P (M/ICP) ppm	S %	Specific Gravity g/cc	Sr (M/ICP) ppm	U (M/ICP) ppm	U (XRF) ppm	V (M/ICP) ppm	Zn (M/ICP) ppm	Zr (M/ICP) ppm
L	300		99	16.00	280		370		2.65	200	370	380	110	81	
L	310		110	16.00	300		400		2.64	200	370	380	120	89	
L	310		100	15.00	270		380		2.66	200	370	380	120	82	
L	300		96	15.00	270		380		2.64	200	360	380	110	80	
L	300		100	16.00	290		390		2.66	190	360	380	110	84	
L	300		87	16.00	270		400		2.64	200	370	380	120	83	
L	310		110	16.00	290		400		2.64	200	390	380	120	86	
L	290		86	16.00	270		380		2.67	200	370	380	110	88	
M	261		100	16.00	250	12.00	330	0.10		188	278	332	99	57	46
M	268		110	16.00	270	12.00	330	0.10		193	285	325	102	59	49
M	284		120	17.00	280	13.00	350	0.11		205	287	330	109	63	54
M	269		120	15.00	260	12.00	330	0.10		194	284	326	102	61	47
M	282		120	16.00	270	13.00	350	0.11		201	293	339	108	60	52
M	267		120	15.00	250	13.00	330	0.11		192	287	335	101	59	47
M	266		110	16.00	260	13.00	320	0.10		188	285	327	98	61	50
M	267		110	17.00	260	13.00	330	0.10		191	292	335	100	59	48
N	287	6.80	100	20.00	240	10.00	340		2.77	200	260	350	100	90	50
N	287	7.00	100	20.00	240	20.00	340		2.73	204	270	350	110	90	60
N	283	7.00	100	20.00	240	10.00	320		2.74	192	250	349	100	90	60
N	288	6.90	90	20.00	240	20.00	440		2.73	203	260	351	100	100	60
N	297	7.00	80	30.00	250	20.00	340		2.74	203	270	352	110	90	60
N	305	6.80	110	20.00	250	20.00	360		2.72	210	280	348	110	100	60
N	304	7.10	100	20.00	250	10.00	360		2.74	212	280	350	110	100	60
N	300	7.10	90	30.00	250	20.00	350		2.70	205	270	348	110	90	60
O	598	7.56	176	20.02	346	15.00	453	0.04	2.71	238	329	334	125	114	47
O	458	6.72	187	20.02	349	15.00	461	0.04	2.72	236	344	332	126	99	46
O	855	8.40	159	20.02	340	12.00	454	0.04	2.72	232	332	337	125	106	49
O	249	7.56	181	19.11	336	13.00	425	0.04	2.74	233	336	334	121	94	39
O	464	7.56	195	19.11	353	18.00	465	0.04	2.73	239	348	337	128	95	44
O	496	9.08	146	20.93	363	12.00	484	0.05	2.71	243	358	339	131	99	47
O	796	9.92	165	21.84	387	14.00	513	0.05	2.71	263	377	339	140	113	53
O	760	9.08	206	20.93	353	14.00	472	0.04	2.71	246	350	336	130	108	48
P	309	5.00	116	17.00	278	15.00				211			120	103	42
P	303	4.00	115	18.00	274	13.00				206			118	103	40
P	300	5.00	118	18.00	269	13.00				207			116	104	41
P	300	5.00	123	17.00	287	13.00				202			117	97	38
P	294	5.00	129	17.00	283	13.00				205			118	96	39
P	291	5.00	113	18.00	266	13.00				204			120	99	37
P	291	4.00	128	16.00	283	13.00				200			117	96	39
P	293	5.00	122	18.00	267	14.00				202			117	99	37

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.

12 May 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

Additional useful data collected during the round robin exercise includes these iterated but uncertified certified trace element statistics:

	mean	2SD	RSD%	n	unit
Ag	0.133	0.087	33.0	31	ppm
Al	4.60	0.49	5.3	78	%
As	6.85	1.01	7.4	60	ppm
Ba	306.8	21.4	3.5	110	ppm
Be	1.94	0.25	6.4	79	ppm
Bi	0.356	0.076	10.7	63	ppm
Ca	9.43	1.00	5.3	73	%
Ce	30.4	6.1	9.9	96	ppm
Cs	4.34	0.53	6.1	64	ppm
Dy	2.04	0.47	11.6	55	ppm
Er	1.04	0.32	15.4	56	ppm
Eu	0.570	0.089	7.8	45	ppm
Fe	1.48	0.18	6.2	85	%
Ga	10.8	2.2	10.2	74	ppm
Gd	2.47	0.31	6.2	46	ppm
Hf	1.60	0.40	12.4	72	ppm
Ho	0.358	0.086	12.1	40	ppm
In	0.023	0.008	17.0	32	ppm
K	2.35	0.17	3.5	78	ppm
La	15.9	2.5	7.9	95	ppm
Li	40.1	3.8	4.8	83	ppm
Lu	0.139	0.026	9.4	37	ppm
Mg	0.712	0.088	6.2	87	%
Mo	1.77	0.63	17.8	92	ppm
Na	1.22	0.18	7.4	94	%
Nb	5.99	1.29	10.8	80	ppm
Nd	14.0	1.2	4.3	46	ppm
Pb	25.1	3.6	7.2	92	ppm
Pr	3.63	0.56	7.7	46	ppm
Rb	105.8	14.3	6.8	84	ppm
Sb	8.67	1.61	9.3	86	ppm
Sc	4.96	1.32	13.3	79	ppm
Sm	2.76	0.23	4.2	45	ppm
Sn	2.63	0.54	10.2	80	ppm
Ta	0.616	0.234	19.0	58	ppm
Tb	0.366	0.055	7.5	38	ppm
Th	6.50	1.50	11.6	94	ppm
Ti	0.136	0.025	9.1	93	%
Tm	0.148	0.067	22.6	48	ppm
W	3.49	0.41	5.9	62	ppm
Y	10.4	2.1	10.2	86	ppm
Yb	0.964	0.235	12.2	48	ppm