

African Mineral Standards

Certificate of Analysis

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

AMIS0091

Recommended Concentration and two "Between Laboratory"
Standard Deviations

Certified Concentrations*

U (M/ICP)**	245	+ -	22	ppm
U (XRF)**	264	+ -	18	ppm
Ba (M/ICP)	324	+ -	26	ppm
Mn (M/ICP)	309	+ -	32	ppm
Sr (M/ICP)	216	+ -	18	ppm
V (M/ICP)	106	+ -	6.7	ppm
Zn (M/ICP)	157	+ -	17	ppm
Specific Gravity	2.65	+ -	0.16	g/cc

Provisional Concentrations*

Co (M/ICP)	6.6	+ -	1.7	ppm
Cr (M/ICP)	149	+ -	32	ppm
Cu (M/ICP)	16	+ -	4	ppm
Ni (M/ICP)	18	+ -	4	ppm
P (M/ICP)	425	+ -	50	ppm
Zr (M/ICP)	153	+ -	22	ppm

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

** Or, by applying a chemical conversion factor of $U \times 1.1793 = U_3O_8$
 U_3O_8 by multi acid digestion: 289 ± 26 ppm
 U_3O_8 by XRF: 311 ± 21 ppm

Intended use: AMIS0091 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 and trace element chemistry for this material has also been certified. The major element chemistry is set out below. The additional trace element chemistry is set out in the Appendix.

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

	Mean		2SD	
Al ₂ O ₃	8.91	+-	0.30	%
CaO	12.05	+-	0.24	%
Fe ₂ O ₃	2.16	+-	0.14	%
K ₂ O	2.89	+-	0.10	%
LOI	11.54	+-	0.74	%
MgO	1.28	+-	0.10	%
MnO	0.039	+-	0.00	%
Na ₂ O	1.70	+-	0.14	%
P ₂ O ₅	0.09	+-	0.02	%
S	0.10	+-	0.02	%
SiO ₂	59.0	+-	1.4	%
TiO ₂	0.24	+-	0.02	%

Indicated means for the major elements are:

Cr ₂ O ₃	0.03	%
V ₂ O ₅	0.02	%

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: Sixteen laboratories were each given eight randomly selected packages of sample. The results from the thirteen 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., (Canada).
2. ALS Chemex, (Perth, Australia).
3. ALS Chemex, (Vancouver, Canada).
4. Assayers Canada, (Vancouver).
5. Genalysis Laboratory Services (Pty) Ltd., (Australia).
6. Geoscience Laboratories, (Geo Labs, Sudbury, Canada).
7. Labtium Inc. (Finland)
8. Langer Heinrich Mine Laboratory (Namibia)
9. OMAC Laboratories (Ireland).
10. Pt Intertek Utama Services (Intertek, Indonesia)
11. SGS Lakefield Research (Canada)
12. SGS Welshpool (Australia).
13. 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	U (M/ICP) ppm	U (XRF) ppm	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 (LECO) %	Sr (M/ICP) ppm	V (M/ICP) ppm	Zn (M/ICP) ppm	Zr (M/ICP) ppm	Specific Gravity g/cc
A	252		347	6	161	17	325	18	431	0.11	211	105	173	142	
A	250		332	6	158	16	326	18	446	0.11	214	105	177	147	
A	246		328	7	159	16	331	17	434	0.11	211	106	179	156	
A	246		330	6	167	16	321	17	422	0.11	211	106	180	144	
A	244		326	6	178	17	317	17	424	0.11	210	104	172	153	
A	248		329	6	165	17	325	17	455	0.11	214	105	190	150	
A	243		323	8	167	16	323	18	421	0.10	215	104	165	142	
A	248		327	7	166	17	322	17	422	0.11	212	106	170	150	
B	260	300	320	8		17					200		120		2.65
B	240	300	300	7		15					200		120		2.69
B	250	290	320	7		16					210		130		2.70
B	260	300	320	7		18					200		130		2.69
B	240	290	300	7		14					190		120		2.68
B	240	300	300	6		14					190		120		2.68
B	250	290	310	7		17					200		120		2.69
B	240	300	300	8		15					190		130		2.67
C	223	249	279	10	120	13	290	14	340	0.13	191	87	116	145	
C	231	255	276	9	130	13	290	13	320	0.12	188	85	113	146	
C	228	260	288	10	140	13	300	14	340	0.13	198	90	124	149	
C	229	257	275	9	140	13	290	14	330	0.12	190	86	109	145	
C	229	246	285	10	140	14	300	14	340	0.13	195	88	115	153	
C	224	252	263	10	110	12	270	13	310	0.12	180	81	106	135	
C	223	261	270	9	100	13	280	12	320	0.12	184	85	109	139	
C	226	249	283	10	120	14	300	14	340	0.12	194	88	113	149	
D															
D															
D															
D															
D															
D															
D															
E	285		346	7	116	18	324	17	109		222	109	178	135	2.58
E	243		315	7	136	23	336	18	114		230	114	183	139	2.59
E	231		307	7	120	18	331	19	110		222	110	155	138	2.58
E	231		307	7	121	22	333	15	107		219	107	177	135	2.59
E	242		307	7	121	21	334	20	108		221	108	156	143	2.59
E	232		306	7	126	24	341	16	108		220	108	159	139	2.59
E	233		306	9	116	23	315	19	109		219	109	158	135	2.58
E	214		309	7	122	22	333	17	112		226	112	157	142	2.59
F															
F															
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H	213	210	320	6	154	17	302	17	400	0.10	216	106	151	171	2.56
H	213	210	320	6	154	17	299	17	400	0.10	212	106	146	165	2.52
H	220	220	320	6	157	18	296	17	390	0.10	215	106	161	167	2.52
H	219	210	320	6	158	18	299	17	420	0.10	217	109	151	171	2.49
H	213	210	320	6	148	18	294	17	410	0.10	209	104	149	172	2.48
H	211	210	310	6	147	17	289	16	390	0.10	209	105	146	165	2.47
H	203	200	300	6	145	17	272	17	380	0.09	200	99	139	164	2.51
H	204	210	310	6	148	16	287	16	400	0.10	207	103	146	162	2.53
I	264	258	340	9	160	17	320	20	450	0.13	239	102	164	172	2.69
I	260	257	340	9	164	17	323	17	440	0.12	244	110	174	183	2.66
I	239	255	310	7	142	18	298	15	420	0.11	224	99	153	162	2.64
I	235	255	320	7	153	15	303	18	430	0.11	232	102	156	160	2.71
I	242	258	310	8	143	22	304	15	420	0.12	231	101	153	159	2.65
I	238	260	310	7	144	15	295	18	430	0.11	222	98	161	162	2.67
I	245	259	320	7	149	16	306	18	430	0.11	233	102	162	167	2.60
I	239	258	320	7	148	15	297	18	420	0.11	228	101	155	158	2.68
J	254	270	333	5	250	18	318	22	350	0.10	219	110	154	200	2.75
J	259	280	346	5	250	14	318	18	400	0.10	220	110	162	220	2.76
J	260	280	332	5	250	18	316	18	400	0.10	220	110	154	210	2.76
J	253	260	335	5	250	18	318	20	350	0.10	218	110	154	290	2.74
J	251	280	338	5	250	16	316	18	400	0.10	220	115	156	240	2.73
J	263	270	341	10	250	16	322	22	400	0.10	219	115	158	180	2.73
J	267	280	344	10	250	16	322	22	450	0.10	225	115	156	220	2.76
J	254	270	337	5	250	16	318	20	400	0.10	223	115	154	230	2.74
K	245	264	317	6	217	37	309	16	406	0.09	218	105	151	165	
K	246	256	320	5	204	26	307	16	406	0.09	218	105	175	166	2.74
K	248	255	318	6	208	31	306	16	407	0.10	217	105	147	158	2.65
K	240	257	325	6	206	29	308	16	403	0.11	220	104	148	165	2.76
K	244	256	314	5	202	20	309	16	405	0.09	217	105	146	154	
K	247	256	327	6	206	25	306	16	408	0.10	224	104	148	164	2.76
K	246	257	321	6	199	24	313	16	410	0.09	221	105	147	164	2.76
K	244	256	327	6	200	20	320	17	426	0.10	223	109	148	173	2.75

Assay Data (cont):

Lab Code	U (M/ICP) ppm	U (XRF) ppm	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 (LECO) %	Sr (M/ICP) ppm	V (M/ICP) ppm	Zn (M/ICP) ppm	Zr (M/ICP) ppm	Specific Gravity g/cc
L	251		345	7	147	18	309	22	430	0.11	220	103	149	111	
L	255		355	7	155	19	328	22	410	0.10	230	114	161	125	
L	256		336	7	143	18	324	22	410	0.07	222	105	154	119	
L	258		347	7	140	19	329	22	450	0.13	227	109	184	115	
L	252		356	8	139	20	342	23	430	0.17	230	116	169	116	
L	249		339	7	146	19	312	22	440	0.16	223	103	174	114	
L	247		346	8	151	19	318	22	430	0.14	232	104	165	116	
L	256		358	7	162	19	329	23	440	0.16	231	105	157	115	
M		276													
M		278													
M		277													
M		277													
M		279													
M		277													
M		276													
M		277													
N		262													
N		258													
N		263													
N		268													
N		280													
N		270													
N		263													
N		263													
O			336	4	154	16	305	16			210	108	155	148	
O			342	4	161	17	309	16			215	109	161	147	
O			336	3	166	15	317	16			211	107	156	149	
O			347	4	164	16	313	16			214	111	159	147	
O			333	4	162	16	305	14			208	106	153	145	
O			342	5	149	16	307	16			211	110	160	147	
O			336	4	158	16	305	15			210	107	157	142	
O			324	5	153	16	300	15			203	105	157	141	
P	199	255	321	6	167	14	283	18	472	0.10	207	103	152		
P	196	262	321	6	159	15	278	19	470	0.10	206	104	159		
P	211	261	324	6	150	15	287	24	455	0.10	206	103	155		
P	206	263	325	6	166	14	282	20	475	0.10	208	105	159		
P	203	262	322	7	164	15	288	19	473	0.10	208	103	155		
P	202	261	323	6	166	16	287	19	473	0.10	207	104	167		
P	215	260	322	7	177	15	279	21	480	0.10	209	104	153		
P	207	258	325	6	167	16	280	19	483	0.10	207	104	155		

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.

30 January 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

Other certified trace elements

Recommended Concentration and two "Between Laboratory" Standard Deviations

Certified Concentrations

Al	4.88	+-	0.44	%
Ca	8.35	+-	0.74	%
Ce	31	+-	3.5	ppm
Cs	4.2	+-	0.5	ppm
Fe	1.48	+-	0.14	%
Gd	2.5	+-	0.22	ppm
K	2.38	+-	0.16	%
La	15.8	+-	1.8	ppm
Li	39.6	+-	3.6	ppm
Mg	0.75	+-	0.06	%
Na	1.25	+-	0.15	%
Nd	14	+-	1.4	ppm
Rb	108	+-	11	ppm
Ti	0.14	+-	0.02	%

Provisional Concentrations

As	11	+-	2.1	ppm
Be	1.97	+-	0.28	ppm
Bi	0.39	+-	0.04	ppm
Dy	2.2	+-	0.54	ppm
Ga	10.7	+-	1.5	ppm
Mo	1.9	+-	0.5	ppm
Nb	6.1	+-	1.1	ppm
Pb	27	+-	8	ppm
Sc	5.1	+-	0.5	ppm
Sn	2.5	+-	0.6	ppm
Ta	0.7	+-	0.2	ppm
Th	7.4	+-	0.9	ppm
Tl	0.59	+-	0.08	ppm
W	3.1	+-	0.7	ppm
Y	11.8	+-	3.4	ppm
Yb	1.04	+-	0.18	ppm

Indicated Means

Er	1.2	ppm
Hf	4.1	ppm
Ho	0.43	ppm
Lu	0.14	ppm
Sb	5.9	ppm
Zr	174	ppm