



Minerals – Consulting and Process Development Specialists

T: +61 2 9717 3858 www.ansto.gov.au/minerals

CERTIFICATE OF ANALYSIS

Certificate Number: 231205 XRF
Company / Organisation:
Client Identification: La Modified Bentonite/Zeolite
AM Identification: AWC-061123-1 to -3
AM Request Number: 2302490
Analysis Requested: Oxides by XRF and Bottle Roll Testing

Three samples of La modified bentonite/zeolite, labelled ZF #5, ZF #15 and ZF #20, were received on 6 November 2023. The samples were analysed as received.

The samples were fused with 12:22 flux (lithium meta/tetraborate) and the oxide concentrations of the fused solids determined using XRF (Rigaku Primas IV WD XRF), according to ANSTO Minerals controlled document G-5915 XRF Procedures Manual. The XRF results are given in Table 1 (oxides) and Table 2 (elemental) and the following errors apply:

10% for concentrations ≥ 10 times detection limit
20% for concentrations 5 to <10 times detection limit
50% for concentrations 2 to 4 times detection limit
100% for concentrations equal to detection limit

A 5 g sample of each of the solids was added to one litre of deionised water and bottle rolled for 12 hours. An aliquot of each leachate was filtered through both a 0.45 μm and a 0.2 μm syringe filter assembly and analysed for La and Ce by ICPMS, according to ANSTO Minerals controlled document G-5913 Analytical Methods Manual.

At the client's request, the same filtered samples were then analysed using the low-level environmental instrument, according to ANSTO Nuclear Science and Technology controlled document I-8143 Agilent Triple Quadrupole ICPMS. Note that this assay was carried out approximately 1.5 weeks after the initial Minerals assay.

The results, including the % of La and Ce in each solid reporting to each respective leachate, are given in Table 3. The results in Table 3 indicate that some La has been lost, presumably precipitated out, between the initial Minerals and later Environmental assays.

Dr Sue Brown, Senior Radiochemist

Date: 5 December 2023

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

New Illawarra Road, Lucas Heights (Locked Bag 2001, Kirrawee DC 2232) T +61 2 9717 3111 www.ansto.gov.au

Table 1 – Oxide Concentrations (%)

Description	ZF #5	ZF #15	ZF #20	Detection
ANSTO ID	AW-061123-1	AW-061123-2	AW-061123-3	Limit*
Al ₂ O ₃	9.82	6.15	4.29	0.01
As ₂ O ₃	0.003	0.001	0.001	0.001
BaO	0.017	0.030	0.050	0.001
CaO	1.18	0.88	0.81	0.001
CeO ₂	0.09	0.15	0.26	0.01
Co ₂ O ₃	<0.001	<0.001	<0.001	0.001
Cr ₂ O ₃	0.001	0.001	<0.001	0.001
Cs ₂ O	0.004	0.004	0.003	0.001
CuO	<0.001	<0.001	<0.001	0.001
Dy ₂ O ₃	<0.01	<0.01	<0.01	0.01
Er ₂ O ₃	<0.01	<0.01	<0.01	0.01
Eu ₂ O ₃	<0.01	<0.01	<0.01	0.01
Fe ₂ O ₃	1.12	0.97	0.89	0.001
Gd ₂ O ₃	0.011	<0.01	<0.01	0.01
HfO ₂	<0.001	0.003	0.002	0.001
Hb ₂ O ₃	<0.01	<0.01	<0.01	0.01
K ₂ O	2.94	1.75	1.15	0.001
La ₂ O ₃	5.6	17.3	22.1	0.01
Lu ₂ O ₃	<0.01	<0.01	<0.01	0.01
MgO	0.37	0.35	0.38	0.01
MnO	0.081	0.050	0.037	0.001
MoO ₃	0.001	0.002	0.003	0.001
Na ₂ O	2.70	2.58	3.01	0.05
Nb ₂ O ₅	0.007	0.007	0.003	0.001
Nd ₂ O ₃	<0.01	<0.01	<0.01	0.01
NiO	<0.001	<0.001	<0.001	0.001
P ₂ O ₅	0.024	0.048	0.064	0.001
PbO	0.002	0.001	<0.001	0.001
Pr ₆ O ₁₁	<0.01	<0.01	0.010	0.01
Rb ₂ O	0.011	<0.001	<0.001	0.001
SO ₃	0.05	0.17	0.22	0.001
Sc ₂ O ₃	<0.001	<0.001	<0.001	0.001
SiO ₂	66.9	56.3	50.5	0.01
Sm ₂ O ₃	<0.01	<0.01	<0.01	0.01
SnO ₂	0.003	0.003	<0.001	0.001
SrO	0.028	0.018	0.017	0.001
Ta ₂ O ₅	0.001	0.003	0.003	0.001
Tb ₄ O ₇	<0.01	<0.01	<0.01	0.01
ThO ₂	0.003	<0.001	<0.001	0.001
TiO ₂	0.15	0.11	0.09	0.001
Tm ₂ O ₃	<0.01	<0.01	<0.01	0.01
U ₃ O ₈	0.001	<0.001	<0.001	0.001
V ₂ O ₅	0.001	0.004	0.006	0.001
Y ₂ O ₃	0.005	0.003	0.003	0.001
Yb ₂ O ₃	<0.01	<0.01	<0.01	0.01
ZnO	0.008	0.011	0.010	0.001
ZrO ₂	0.027	0.019	0.011	0.001
LOI*	8.8	13.0	16.0	

* Detection limit.

* From XRF.

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

New Illawarra Road, Lucas Heights (Locked Bag 2001, Kirrawee DC 2232) T +61 2 9717 3111 www.ansto.gov.au

Table 2 – Elemental Concentrations (%)

Description	ZF #5	ZF #15	ZF #20	Detection
ANSTO ID	AW-061123-1	AW-061123-2	AW-061123-3	Limit*
Al	5.20	3.25	2.27	0.01
As	0.002	0.001	0.001	0.001
Ba	0.015	0.027	0.045	0.001
Ca	0.85	0.63	0.58	0.001
Ce	0.07	0.12	0.21	0.01
Co	<0.001	<0.001	<0.001	0.001
Cr	0.001	0.001	<0.001	0.001
Cs	0.004	0.004	0.003	0.001
Cu	<0.001	<0.001	<0.001	0.001
Dy	<0.01	<0.01	<0.01	0.01
Er	<0.01	<0.01	<0.01	0.01
Eu	<0.01	<0.01	<0.01	0.01
Fe	0.785	0.678	0.622	0.001
Gd	0.010	<0.01	<0.01	0.01
Hf	<0.001	0.003	0.002	0.001
Ho	<0.01	<0.01	<0.01	0.01
K	2.44	1.46	0.95	0.001
La	4.8	14.8	18.8	0.01
Lu	<0.01	<0.01	<0.01	0.01
Mg	0.22	0.21	0.23	0.01
Mn	0.063	0.039	0.029	0.001
Mo	0.001	0.001	0.002	0.001
Na	2.00	1.92	2.24	0.05
Nb	0.005	0.005	0.002	0.001
Nd	<0.01	<0.01	<0.01	0.01
Ni	<0.001	<0.001	<0.001	0.001
P	0.010	0.021	0.028	0.001
Pb	0.002	0.001	<0.001	0.001
Pr	<0.01	<0.01	<0.01	0.01
Rb	0.010	<0.001	<0.001	0.001
S	0.019	0.066	0.089	0.001
Sc	<0.001	<0.001	<0.001	0.001
Si	31.3	26.3	23.6	0.01
Sm	<0.01	<0.01	<0.01	0.01
Sn	0.002	0.002	<0.001	0.001
Sr	0.024	0.015	0.014	0.001
Ta	0.001	0.002	0.002	0.001
Tb	<0.01	<0.01	<0.01	0.01
Th	0.003	<0.001	<0.001	0.001
Ti	0.089	0.068	0.056	0.001
Tm	<0.01	<0.01	<0.01	0.01
U	0.001	<0.001	<0.001	0.001
V	0.001	0.002	0.003	0.001
Y	0.004	0.002	0.002	0.001
Yb	<0.01	<0.01	<0.01	0.01
Zn	0.006	0.009	0.008	0.001
Zr	0.020	0.014	0.008	0.001
LOI*	8.8	13.0	16.0	

* Detection limit.

* From XRF.

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

New Illawarra Road, Lucas Heights (Locked Bag 2001, Kirrawee DC 2232) T +61 2 9717 3111 www.ansto.gov.au

Table 3 – Bottle Roll Results
a. 0.2 µm filtered samples

		Sample			Limit of Reporting	Error (%)
		ZF #5	ZF #15	ZF #20		
La in solid (%)	XRF	4.79	14.8	18.8	0.01	10
La in leachate (mg/L)	Minerals	0.02	0.03	0.02	0.01	50
	Environment	0.0225	0.0272	0.0166	0.0001	10
La in leachate (%)	Minerals	0.008	0.004	0.002	-	-
	Environment	0.0094	0.0037	0.0018	-	-
Ce in solid (%)	XRF	0.07	0.12	0.21	0.01	20 (#5); 10 (#15, #20)
Ce in leachate (mg/L)	Minerals	< 0.01	< 0.01	< 0.01	0.01	-
	Environment	0.0003	0.0003	0.0002	0.0001	50
Ce in leachate (%)	Minerals	-	-	-	-	-
	Environment	0.009	0.005	0.002	-	-

b. 0.45 µm filtered samples

		Sample			Limit of Reporting	Error (%)
		ZF #5	ZF #15	ZF #20		
La in solid (%)	XRF	4.79	14.8	18.8	0.01	10
La in leachate (mg/L)	Minerals	0.03	0.04	0.04	0.01	50
	Environment	0.0123	0.0194	0.0156	0.0001	10
La in leachate (%)	Minerals	0.01	0.005	0.004	-	-
	Environment	0.0051	0.0026	0.0017	-	-
Ce in solid (%)	XRF	0.07	0.12	0.21	0.01	20 (#5); 10 (#15, #20)
Ce in leachate (mg/L)	Minerals	< 0.01	< 0.01	< 0.01	0.01	-
	Environment	0.0003	0.0003	0.0003	0.0001	50
Ce in leachate (%)	Minerals	-	-	-	-	-
	Environment	0.0087	0.0050	0.0028	-	-