SNO-STR-90-43

Radioactivity of Aluminum April 9, 1990

J.J. Simpson and P. Jagam

A number of samples of reflector grade aluminum have been analyzed for uranium and thorium by neutron activation analysis (INAA), and some of these have also been analyzed for uranium and thorium and for secular equilibrium, by direct γ-ray counting. INAA detects ^{238}U and ^{232}Th. Direct γ-ray counting detects ^{226}Ra daughters and, with much less sensitivity, a close daughter of ^{238}U, ^{234m}Pa, and ^{235}U. In the thorium chain γ-ray counting detects ^{228}Th daughters and a ^{228}Ra daughter, ^{228}Ac. An interesting result of the present work is that in new, reflector-grade aluminum there appears to be enhancement of ^{228}Th relative to both ^{228}Ra and ^{232}Th.

Table 1 lists the ^{238}U concentrations determined by INAA, and the ^{238}U-equivalent concentrations, assuming secular equilibrium, from direct γ-ray counting. The errors in the INAA results are relative; an error of about 10% from the standard should be added in quadrature. It is seen from the table that INAA and direct counting give the same result for ^{238}U as they should (compare columns 2 and 3), but that aluminum is very depleted in radium (compare column 4 with 2 or 3). This is the usual case in aluminum.

Table 2 gives the results for thorium from INAA, and the ^{232}Th-equivalent concentrations, assuming secular equilibrium, from direct γ-ray counting. Again the errors on the INAA results are relative; an error of about 3% from the standard should be added in quadrature. One sees that radium is depleted, as expected if the aluminum is new, (compare column 4 to 2 or 3), but that, remarkably, ^{228}Th, a daughter of ^{228}Ra is very high and is much higher (a factor of 6 in the case of sample #1) than the secular equilibrium value inferred from the INAA results for ^{232}Th. How this situation arises is not known to us. However, like good wine these aluminums will improve with age.

Table 1

Uranium in Aluminum

Sample No.	^{238}U INAA (ppb)	Direct Counting (^{238}U + ^{234}Pa) equivalent (ppb)	^{226}Ra equivalent (ppb)
#1	350 ± 36	410 ± 80	< 4
#2	890 ± 89	$940 \pm 200^{+500}$	< 20
#3	180 ± 18		
#4	580 ± 58		
#5	910 ± 90		
#6		740 ± 40	< 5
Foil #2	1110 ± 110	990 ± 60	< 25

+LBL

Table 2

Thorium in Aluminum

Sample No.	^{232}Th INAA (ppb)	Direct Counting ^{228}Th equivalent ^{232}Th (ppb)	^{228}Ra equiv. ^{232}Th
#1	67 ± 3	440 ± 10	< 6
#2	118 ± 4	$400 \pm 20^{+500}$	13 ± 20^{0}
#3	41 ± 3		
#4	39 ± 2		
#5	180 ± 5		
#6		180 ± 10	< 10
Foil #2	61 ± 2	180 ± 25	30 ± 20

+LBL

Identification of Aluminum Samples

No.	Type	Source
1	Alcan 66250 HO Alloy	Walter D.
2	Omega Mirror	Chris W.
3	Reflector Aℓ #1	Walter D.
4	Reflector Aℓ #2	Walter D.
5	Reflector Aℓ #3	Walter D.
6	Aluminum Alloy 1350	Chris W.
Foil #2	Reynolds Kitchen Foil	Jagam

Tube (Area A)	Th		Tot Th	U		Total U	K		Total K
	*Total	Glass	A	*Total	Glass	A	*Total	Glass	A
	μg	μg	μg/cm²	μg	μg	μg/cm²	μg	μg	μg/cm²
(cm²)									
Burle (433)	270	150	0.60	200	150	0.46	0.22	0.11	0.51
†Ham 20" (1662)	520	210	0.31	430	210	0.27	1.23	0.16	0.74
†Ham 8" (284)	60	20	0.21	75	20	0.26	0.56	0.002	1.97
Philips (330)	80	20	0.25	40	20	0.13	0.80	0.02	2.42
EMI									

* Total does not include SS parts, except for Philips

† Does not include black bakelite plug

SN03

	Th pg/g	U pg/g	^{235}U (equiv natU) pg/g
CY/RO#1	23±7	58±18	1700
CY/RO#2	29±6	240±40	4000
P2	15±6	1720±130	2400

---------- SELECTION CRITERIA
C06 RQ A Q ALL

TOTAL ACTIVITIES CONSIDERED..... 734
ACTIVITIES SELECTED..... 36

---------- SORTING CRITERIA

SORTED BY AS ES TY ACT

NUMBER OF ACTIVITIES SORTED = 36

RADIOACTIVITY – SIMPSON

SNO - J.D. SEPHUSEN - AECL | PRIMAVERA PROJECT PLANNER | Sudbury Neutrino Observatory

REPORT DATE 11APR90 RUN NO. 68 | SNO - CONSOLIDATED | START DATE 2JAN90 FIN DATE 27APR01

SNO - ALL RADACT QA ACTIVITIES | DATA DATE 10APR90 PAGE NO. 1

work days

MONTHLY-TIME PER. 1

ACTIVITY ID	OD	RD	PCT	CODES	FLOAT	SCHEDULE	01 JAN 90	01 JUL 90	01 JAN 91	01 JUL 91	01 JAN 92	01 JUL 92	01 JAN 93	01 JUL 93	01 JAN 94	01 JUL 94	01 JAN 95	01 JUL 95
DEVELOP ACRYLIC RADIOACTIVITY MEAS METHODS						RAR/LAT	AAAAMMK/KLLLL.	.	.	.	.	.	.	.	.	.	.	.
31100884	120	96	20	RARLK	92		MMKMMKLLLLLL.	.	.	.	.	.	.	.	.	.	.	.
LEARN RADACT./RNCH QA DATABASE PROCEDURES						RAR/LAT	. KK++++++LL.	.	.	.	.	.	.	.	.	.	.	.
31100829	20	20	0	BOE	168		K++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
R&D RADACT TESTS ON PMT INTERNAL COMPONENTS						RAR/LAT	. LKK/	.	.	.	.	.	.	.	.	.	.	.
04012883	60	60	0	MAK	-12		.KK/KLL	.	.	.	.	.	.	.	.	.	.	.
PREPARE DATABASE PROTOCOL FOR RADACT QA PROCEDUR						RAR/LAT	. * KKK++++++++LL	.	.	.	.	.	.	.	.	.	.	.
04000851	30	30	0	SIMPSO	232		. * KKK++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
PROD. SELECT LOW RADACT PMT INTERNAL COMPONENTS						RAR/LAT	. * .KKKK++++++++++LLLL	.	.	.	.	.	.	.	.	.	.	.
04012884	60	60	0	MAK	281		. * .KKKK++++++++++LLLL	.	.	.	.	.	.	.	.	.	.	.
R&D RADACT MEASUREMENTS ON SMALL SAMPLES						RAR/LAT	. * . KKK+LLLL	.	.	.	.	.	.	.	.	.	.	.
31100810	60	60	0	BOE	92		. * KKKK+++LLL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON SCHOTT RAW GLASS MATERIALS						RAR/LAT	. * . KK++++++LL.	.	.	.	.	.	.	.	.	.	.	.
04012882	20	20	0	MAK	163		. * KK++++++++LL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON WALL MATERIALS						RAR/LAT	. * . KKK++++++++++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
04003981	30	30	0	SIMPSO	367		. * . KK++++++++++++++++++LL.	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA: PMT BASE SEALANTS						RAR/LAT	. * . KKK++LL	.	.	.	.	.	.	.	.	.	.	.
04003983	20	20	0	SIMPSO	956		. * .KK++LL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA: DECK STRUCTURAL STEEL						RAR/LAT	. * . K/L	.	.	.	.	.	.	.	.	.	.	.
04011803	20	20	0	SIMPSO	13		. * . KK+LL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON OMEGA/AL REFLECTOR BODY MAT'L						RAR/LAT	. * . .KKKK++++LLLL	.	.	.	.	.	.	.	.	.	.	.
04007881	60	60	0	SIMPSO	163		. * . KKKK++++LLLL.	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON CAVITY DRAIN SYSTEM COMPONENT						RAR/LAT	. * . .KKK++++++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
04010802	40	40	0	SIMPSO	314		. * . KKK++++++++++++LLL.	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON SHIELDING/BACKFILL MATERIAL						RAR/LAT	. * . .KKK++++++++++++++LLL.	.	.	.	.	.	.	.	.	.	.	.
04010801	40	40	0	SIMPSO	331		. * . KKK++++++++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON CAVITY MAGNETIC COIL MATERIAL						RAR/LAT	. * . .KKK++++++++++++++++LL	.	.	.	.	.	.	.	.	.	.	.
04010885	30	30	0	SIMPSO	378		. * . .KK++++++++++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
PROD. RADACT QA ON PMT BASE MATERIALS						RAR/LAT	. * . . KKK++++++++++++++++LLL	.	.	.	.	.	.	.	.	.	.	.
04004881	30	30	0	SIMPSO	420		. * . .KK++++++++++++++++++LL.	.	.	.	.	.	.	.	.	.	.	.

SNO - J.D. [illegible] - AECL PRIMAVERA PROJECT PLANNER Sudbury Neutrino Observatory

REPORT DATE 11APR90 RUN NO. 66 SNO - CONSOLIDATED START DATE 2JAN90 FIN DATE 27APR01

SNO - ALL RADACT QA ACTIVITIES DATA DATE 10APR90 PAGE NO. 2

MONTHLY-TIME PER. 1

ACTIVITY DESCRIPTION / ACTIVITY ID	OD	RD	PCT	CODES	FLOAT	SCHEDULE	01 JAN 90 – 01 JUL 95
PROD. RADACT QA ON OTHER-GLASS FOR REFL BORIES						EAR/LAT	EEEE+LLL
04007H04	60	60	0	SIMPSO	103		EEE++LLLL
PROD. RADACT QA ALL TYPES REFL COATING MATERIAL						EAR/LAT	EEEE+++++LLL
04007H02	60	60	0	SIMPSO	203		EEEE++++++LLLL
PROD. RADACT QA ON COVER GAS SYSTEM COMPONENTSE						EAR/LAT	EE+++++++++++++++++++++++++++++++++LL
04011H01	30	30	0	SIMPRO	699		EEE+++++++++++++++++++++++++++++++++LLL
PROD. RADACT QA ON PMT CABLE & CONNECTOR MATERIA						EAR/LAT	EE++++++++++++++++LL
04006H02	30	30	0	SIMPSO	360		EEE+++++++++++++++++LL
R&D RADACT TESTS ON BIG ACRYLIC SHEETS						EAR/LAT	EEELL
31100R17	30	30	0	EARLE	51		EE/LL
PROD. RADACT QA ON VESSEL SKIRT MATERIALS						EAR/LAT	EE+++LL
04010H11	30	30	0	SIMPSO	96		EE++LLL
PROD. RADACT QA ON CAVITY LINER MATERIALS						EAR/LAT	EEEE+++LLL
04013H01	50	50	0	SIMPSO	151		EEEE+++++LLLL
PROD. RADACT QA ON VESSEL MONITOR COMPONENTS						EAR/LAT	EE+++++++LLL
04010H10	30	30	0	SIMPSO	191		EE+++++++LL
PROD. RADACT QA ON CAVITY DECK MATERIALS						EAR/LAT	EEE/LL
04011H02	50	50	0	SIMPSO	61		EEEELLL
PROD. RADACT QA ON CLEAN ROOM COMPONENTS						EAR/LAT	EE++++++++++++++++++++++++++++++++LLL
04011H06	30	30	0	SIMPSO	735		EE++++++++++++++++++++++++++++++++LL
PROD. RADACT QA ON RELATIVE CALIB SYSTEM COMPONE						EAR/LAT	EE+++++++++++++++++++++++++LLL
04011H30	30	30	0	SIMPSO	595		EEE++++++++++++++++++++++++++LL
PROD. RADACT QA ON H2O SYSTEM MATERIALS						EAR/LAT	EEE+++++++LLL
04010H22	40	40	0	SIMPSO	233		EEE+++++++++LL
PROD. RADACT QA: ACRYLIC MATERIAL FOR VESSEL						EAR/LAT	E/EEEL
04005H05	90	90	0	EARLE	21		/EEEEL
PROD. RADACT QA ON CAVITY CRANES						EAR/LAT	EE++L
04010H03	15	15	0	SIMPSO	76		EE+++LL
PROD. RADACT QA ON H2O SYSTEM MATERIALS						EAR/LAT	EE+++++++++LLL
04010H21	40	40	0	SIMPSO	263		EEE+++++++LLL

ACTIVITY ID	OD	RD	PCT	COORS	FLOAT	SCHEDULE	01 JAN 90	01 JUL 90	01 JAN 91	01 JUL 91	01 JAN 92	01 JUL 92	01 JAN 93	01 JUL 93	01 JAN 94	01 JUL 94	01 JAN 95	01 JUL 95
PROD. RADACT QA ON ABSOLUTE CALIB SYSTEM COMPONE						EAR/LAT	.	*	.	.	.	.	RE++++++++++++++++++++++++++++LLL				.	.
04011H31	30	30	0	SIMPSO	555		.	*	.	.	.	.REE++++++++++++++++++++++++++++LL					.	.
PROD. RADACT QA ON NaCl SYSTEM COMPONENTS						EAR/LAT	.	*	.	.	.	.	REE++++++++++++++++++++++++++++++++++++LLL					
04010H23	40	40	0	SIMP90	718		.	*	.	.	.	.	REE++++++++++++++++++++++++++++++++++++LLL					
PROD. RADACT QA ON PMT SUPPORT MATERIALS						EAR/LAT	.	*	.	.	.	.	.	REELLL	.	.	.	.
04004H01	40	40	0	SIMPSO	74		.	*	.	.	.	.	.	REE++LLL	.	.	.	.
PROD. RADACT QA ON PMT ATTACHMENT MATERIALS						EAR/LAT	.	*	.	.	.	.	.	. REE++LLL	.	.	.	.
04004H03	30	30	0	SIMPSO	104		.	*	.	.	.	.	.	REE+++++LL	.	.	.	.
PROD. RADACT QA ON PMT LIGHT CURTAIN MATERIALS						EAR/LAT	.	*	.	.	.	.	.	. REE++LLL	.	.	.	.
04004H04	30	30	0	SIMPSO	104		.	*	.	.	.	.	.	RE++++++LL	.	.	.	.
PROD. RADACT QA ON PMT PANEL MATERIALS						EAR/LAT	.	*	.	.	.	.	.	. RE++LLL	.	.	.	.
04004H02	30	30	0	SIMPSO	94		.	*	.	.	.	.	.	REE++++LL	.	.	.	.