U. S. Department of Commerce
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Standard Reference Material 4350

Environmental Radioactivity Standard: River Sediment

This Standard Reference Material (SRM) consists of approximately 100 g of freeze-dried, sieved, river sediment in a screw-cap glass bottle. The certified, NBS-determined radioactivities in nuclear transformations per second per gram of dry material on January 1, 1975, were as follows:

Radionuclide	$nts^{-1}g^{-1}$(1)	Uncertainty, % Random	Systematic	Total	Methods Code(2)
^{40}K	5.4×10^{-1}	2.4	6.4	8.8	1, 2
^{54}Mn	2.1×10^{-3}	7.0	4.6	11.6	1
^{60}Co	1.48×10^{-1}	0.7	4.9	5.6	1, 2
^{65}Zn	1.3×10^{-2}	3.5	10.0	13.5	1
$^{90}Sr+^{90}Y$	1.03×10^{-2}	9.7	5.3	15.0	3a
^{137}Cs	1.00×10^{-1}	0.6	3.9	4.5	1, 2
^{152}Eu	2.4×10^{-1}	0.7	5.1	5.8	1
^{154}Eu	5.2×10^{-2}	2.4	5.1	7.5	1
^{228}Ac	3.4×10^{-2}	9.3	9.8	19.1	1
$^{239+240}Pu$	1.4×10^{-3}	3.2	5.3	8.5	5b

(1) The gamma-ray abundances and half lives used in determining these values are from Atomic Data and Nuclear Data Tables, Vol. 13, Nos. 2-3, February 1974.

(2) See last page of supplemental information for explanation.

Each reported radioactivity is the weighted mean of individual values for that nuclide, the weights being the reciprocals of the individual variances.

The stated uncertainty of each activity is the linear sum of the random error, computed as three times the standard error of the weighted mean of the individual measurements, and the estimated upper limits of conceivable systematic errors, including inhomogeniety. The stated uncertainties are for sample sizes of 10 g or greater.

Prior to weighing working samples of this SRM, they should be dried in air at 40°C for at least 24 hours.

This Standard Reference Material was prepared in the NBS Center for Radiation Research under the direction and coordination of the Radioactivity Section, W. B. Mann, Chief.

J. Paul Cali, Chief
Office of Standard Reference Materials

Washington, D.C. 20234
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UNCERTIFIED ACTIVITIES

The following uncertified activity values include other NBS measurements and measurements reported by other laboratories. Each reported value is the weighted mean of individual values from a single laboratory for that radionuclide, the weights being the reciprocals of the individual variances. The names of the cooperating laboratories and the analytical methods corresponding to the method codes are given on the last page.

Radio-nuclide	$nts^{-1}g^{-1}$	Laboratory Initials	Method Code
^{40}K	4.63×10^{-1}	HASL	1[1]
^{54}Mn	2.3×10^{-3}	HASL	1
^{55}Fe	1.6	UH	3d
^{60}Co	1.36×10^{-1}	HASL	1
^{65}Zn	1.2×10^{-2}	HASL	1
$^{90}Sr+^{90}Y$	1.1×10^{-2}	HASL	6c
^{125}Sb	3.5×10^{-3}	NBS	1
^{137}Cs	8.95×10^{-2}	HASL	1
	9.41×10^{-2}	HASL	6c
^{152}Eu	1.60×10^{-1}	HASL	1
^{154}Eu	4.37×10^{-2}	HASL	1
^{155}Eu	1.4×10^{-2}	NBS	1
^{208}Tl	1.4×10^{-2}	NBS	1
^{212}Pb	6×10^{-2}	NBS	1
^{212}Bi	5×10^{-2}	NBS	1
^{214}Pb	4.1×10^{-2}	NBS	1
^{214}Bi	3.4×10^{-2}	NBS	1

(continued)

Radio-nuclide	$nts^{-1}g^{-1}$	Laboratory Initials	Method Code
^{226}Ra	3.1×10^{-2}	HASL	1(1,2)
^{228}Th	3.95×10^{-2}	HSL	4b
^{230}Th	3.66×10^{-2}	HSL	4b
^{232}Th	3.1×10^{-2}	HASL	1(2)
	3.78×10^{-2}	HSL	4b
^{231}Pa	1.75×10^{-3}	HSL	4b
^{234}U	$4.9_6 \times 10^{-2}$	HSL	4b
^{235}U	1.85×10^{-3}	HSL	4b
^{238}U	$4.2_2 \times 10^{-2}$	HSL	4b
^{238}Pu	7.6×10^{-5}	HSL	4b
	5.8×10^{-5}	WHOI	5b
$^{239+240}Pu$	1.4×10^{-3}	HASL	3b
	$1.2_7 \times 10^{-3}$	HSL	4b
	1.45×10^{-3}	WHOI	5b
^{241}Am	3.1×10^{-4}	HSL	4b
	3.19×10^{-4}	WHOI	5b
^{244}Cm	$< 8 \times 10^{-6}$	HSL	4b
	$1.5_5 \times 10^{-5}$	WHOI	5b

(1) The gamma-ray abundances and half lives used by HASL are from the HASL Procedures Manual, USAEC Report HASL-300, 1973, and are, in some cases, different from values taken from the Atomic Data and Nuclear Data Tables to calculate the certified activities.

(2) Values are based on measurements made of the gamma-ray-emission rates of two subsequent members in its radioactive decay series.

The lower members of natural thorium (4N) and uranium (4N+2) radioactivity series appear to be in radioactive equilibrium, within experimental uncertainties. The gamma-ray-emission rates of members of the uranium series below ^{222}Rn should be made on a sample that has been in a closed, air-tight container for at least a month in order to ensure equilibrium of the gamma-ray emitters.

SUPPLEMENTAL INFORMATION

The river sediment for this SRM was freeze dried through the courtesy of Dr. J. H. Harley, U.S.E.R.D.A., Health and Safety Laboratory. The dried sediment was passed through a 44 μm (325 mesh) sieve without grinding, and mixed for 10 hours in a V-cone blender. The material was then packaged in glass, screw-cap bottles.

Samples from 19 randomly selected bottles were examined in the NBS $4\pi\gamma$, 8" x 8" NaI(Tl) detector system for inhomongenieties in their gamma-ray-emission rates. The results are summarized as follows:

Energy Region, MeV	Principal Radionuclide	Half of Range (% of mean)
0.17 - 0.43	^{152}Eu	1.9
0.52 - 0.79	^{137}Cs	1.7
2.30 - 2.90	^{60}Co (sum peak)	2.4

These 19 samples were also counted, with the bottles upside down, on a 5" NaI(Tl) detector over the energy range of 0.01 to 3.0 MeV, and one of the samples was counted 19 times. From these measurements, the net contribution of sample-to-sample inhomogenieties to the uncertainty in the gamma-ray-emission rates was 2.0% of the mean.

Nineteen other, smaller samples with masses of 6 to 16 g were prepared by subdividing larger samples into plastic vials. The 19 subsamples were gamma-ray counted in a 5" NaI(Tl) well detector over the energy region of 0.01 to 3.0 MeV, and one sample was counted 19 times on this detector. The net contribution of subsample-to-subsample inhomogenieties to the uncertainty in the gamma-ray-emission rates was 2.2%.

All of the 100-g bottled samples were examined for inhomogenieties in their gamma-ray-emission rates by counting them upside down in a 5" NaI(Tl) well detector coupled to a multichannel analyzer. The count rates from each bottle were compared over each of six selected energy regions, and also over the total gamma-ray spectrum (0.01 to 3.0 MeV). Bottles giving outlying results were rejected. One bottle was similarly counted 19 times. The net sample-to-sample inhomogenieties in the gamma-ray-emission rates of the accepted bottles are summarized below:

Energy Region, MeV	Half of Range(% of mean)
.04 - .160	1.8
.165 - .285	1.9
.290 - .410	2.2
.600 - .870	2.4
.900 - 1.250	2.6
1.270 - 1.530	2.8
.01 - 3.00	1.9

Inhomogenieties in alpha- and beta-particle-emitting radionuclides were estimated from measured activity values of groups of 10-g and 50-g samples to be less than 5% except for ^{238}Pu, ^{239}Pu, ^{241}Am and ^{244}Cm, for which the inhomogenieties were estimated to be less than 10%.

The laboratories that made radioactivity measurements on the sediment and the analytical methods they employed are as follows:

Laboratory

HASL — Health and Safety Laboratory
U.S. Energy Research and Development Administration
New York, New York
(Mr. G. A. Welford)

HSL — Health Services Laboratory
U.S. Energy Research and Development Administration
Idaho Falls, Idaho
(Mr. C. W. Sill)

NBS — Radioactivity Section
National Bureau of Standards
Washington, D.C.
(Dr. J.M.R. Hutchinson, Dr. J. R. Noyce and Miss P. A. Mullen)

UH — Department of Radiochemistry
University of Helsinki
Helsinki, Finland
(Dr. J. K. Miettinen and Dr. T. Jaakkola)

WHOI — Woods Hole Oceanographic Institution
Woods Hole, Massachusetts
(Dr. V. T. Bowen and Dr. H. D. Livingston)

Analytical Methods

1 Ge(Li) γ-ray detector

2 NaI(Tl) γ-ray detector

3 Acid dissolution

4 Fluoride-pyrosulfate fusion

5 Acid leaching

6 Sodium carbonate fusion

a Thin-window beta-particle proportional counter

b Alpha-particle spectrometry with surface-barrier detector

c Plastic-phosphor beta-particle scintillation detector

d Liquid scintillation counter