U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 4355

Environmental Radioactivity

Source description	Peruvian Soil (Activation-and Fission-Product Blank)
Source Identification	4355
Reference time	June 1, 1982

General Comments(1)*

This Standard Reference Material (SRM), which has been developed in cooperation with member laboratories of the International Committee for Radionuclide Metrology, consists of approximately 75 grams of dried soil(2) in a polyethylene bottle. This material has non-measureable radioactivity concentrations for many fallout radionuclides and is intended as a blank(3) or a very low-level standard in tests of measurements of environmental radioactivity. Upper limits of the radioactive concentrations are given for some common activation and fission products for the purposes of determining laboratory contamination and background counting rates.

This material has been the subject of an extensive trace element study sponsored by the IAEA(4). Results of this study are given in the notes accompanying this certificate. It should be noted that the radioactivity concentrations of some natural radioelements may be deduced from this table and a knowledge of natural abundances. Examples of such radioelements are ^{40}K and ^{87}Rb (which interferes with ^{137}Cs in some analyses at low levels).

Working samples of this SRM should be dried in air at 40°C for at least 24 hours prior to weighing. The material has been tested for homogeneity and the results are summarized in note (5).

When additional data become available, it is expected that other radioactivity concentrations will be certified and purchasers will be notified. To aid in these certifications, users are requested to send their measurement results for uncertified radioactivities, together with the methods used, to NBS(1).

*See notes pages 3-8

CERTIFIED VALUES

Radionuclide	Activity Concentration (Bq g^{-1} (6))	Estimated Detection Limits (Bq g^{-1})	Total Uncertainty (Percent (7))	Method (8)
^{60}Co	not detected,	1.6×10^{-5}		4a, 4e
^{125}Sb	not detected,	1.4×10^{-4}		4a, 4f
^{137}Cs	3.3×10^{-4}		13	4a, 4f
^{152}Eu	not detected,	2.3×10^{-4}		4a, 4f
^{154}Eu	not detected,	2×10^{-4}		4a, 4f
^{155}Eu	not detected,	2×10^{-4}		4a, 4f
^{228}Th	4.22×10^{-2}		5	2c
^{230}Th	3.97×10^{-2}		5	2c
^{232}Th	4.30×10^{-2}		5	2c
$^{239}Pu + ^{240}Pu$	7.6×10^{-6}		28	1c, 3c
^{241}Am	4×10^{-6}		36	3c

This Standard Reference Material was prepared in the Center for Radiation Research, Nuclear Radiation Division, Radioactivity Group, D.D. Hoppes, Group Leader.

Washington, D.C. 20234

George G. Uriano, Chief
Office of Standard Reference Materials

Notes

(1) For further information contact K.G.W. Inn (301) 921-2383 or J.M.R. Hutchinson (301) 921-2396, National Bureau of Standards, Room C114, Building 245, Washington, D.C., 20234.

(2) This sample was collected at and by the IAEA Agricultural Experimental Station LaMolina, Lima, Peru. After an IAEA study[3], the material was pulverized with a "pancake"style air-jet mill and homogenized in a 3 ft^3 V-cone blender. The average particle diameter for the resulting powder is 8 μm. More than 99 percent, by weight, of the particles are less than 20 μm in diameter.

(3) Efficiency vs energy curves for four SRM materials in 4 oz counting bottles, filled with material to the same height and placed directly on a 60 cm^3 Ge(Li) detector, show the same apparent efficiency to within 5 percent for gamma rays from radionuclides common to all matrices.

(4) Reference DTS 78, and attached data sheets "IAEA Summary of Intercomparison Results".

(5) Summary of homogeneity measurements

Eight 75g bottled samples were examined for differences in their gamma-ray-emission rates by counting them in a 5-in NaI(Tl) well detector coupled to a multichannel analyzer. The count rates from each bottle were compared over each of thirteen selected energy regions and also over the total gamma-ray spectrum (0.05 - 1.97 MeV). The net sample-to-sample inhomogeneities in the gamma-ray-emission rates are summarized below:

Energy Region (MeV)	Standard deviation of the mean (%)
0.05 - 0.11	0.80
0.11 - 0.16	0.79
0.16 - 0.20	0.66
0.20 - 0.27	0.58
0.27 - 0.31	1.03
0.31 - 0.41	0.97
0.41 - 0.54	0.45
0.54 - 0.69	0.66
0.69 - 0.81	0.59
0.81 - 1.02	0.34
1.02 - 1.28	0.68
1.28 - 1.59	0.32
1.59 - 1.97	1.43
0.05 - 1.97	0.67

(6) Certified values are those measured by two or more laboratories and/or two or more methods.

(7) The random and systematic uncertainties have been combined in quadrature at a level corresponding to a standard deviation of the mean; the stated overall uncertaint is 3 times this value.

(8) Analytical Methods (References in parentheses)

Chemical Treatment

1. HF-HNO_3 or HF-HNO_3-$HClO_4$ dissolution
2. KF-pyrosulfate fusion (SHA79)
3. HCl, HNO_3 or HCl-HNO_3 leaching (HAR80, LM875, WN870)
4. None

Counting Technique

a. Gamma-ray spectrometry with Ge(Li) detector
b. Beta-particle counting with thin-window Geiger counter
c. Alpha-particle spectrometry with surface-barrier detector
d. X-ray photons or beta-particle counting with gas-flow proportional counter
e. Gamma-ray spectrometry by NaI(Tl) multiparameter
f. Gamma-ray spectrometry by Ge(Li) with NaI(Tl) shield

PARTICIPATING IN THE ASSAYS

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Radiation and Environmental Sciences
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(Reference laboratory for the
U.S. Nuclear Regulatory Commission)
Idaho Fall, Idaho
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Woods Hole Oceanographic Institution
Woods Hole, Massachusetts
(Dr. V.T. Bowen and Dr. H.D. Livingston)

UNCERTIFIED VALUES

The following activities are uncertified because there are no corroborative measurements.

Radionuclide	Activity Concentration (Bq g^{-1})	Laboratory	Method Code
^{40}K	5.85×10^{-1}	BPNL	4e
^{55}Fe	2×10^{-3}	WHOI	3d
^{90}Sr	2.2×10^{-4}	WHOI	3b
^{208}Tl	1.2×10^{-2}	NBS	4a
^{208}Tl	1.5×10^{-2}	BPNL	4e
^{214}Bi	4.2×10^{-2}	NBS	4a
^{214}Bi	3.9×10^{-2}	BPNL	4e
^{238}Pu	3×10^{-6}	WHOI	3c

REFERENCES

DTS 78 R. Dybczynski, A. Tugsavul and O. Suschny, Report on the intercomparison run Soil-5 for the determination of trace elements in soil.

HAR 80 Environmental Measurements Laboratory Procedures Manual, HASL 300 with 8 supplements, J.H. Harley, ed., New York (1980).

LMB 75 H.D. Livingston, D.R. Mann and V.T. Bowen, Analytical procedures for transuranic elements in seawater and marine sediments, Analytical Methods in Oceanography, Advances in Chemistry Series No. 147, T.R.P. Gibb, Jr., ed., American Chemical Society, New York, 124 (1975).

SHA 79 C.W. Sill, F.D. Hindman and J.I. Anderson, Simultaneous determination of alpha-emitting nuclides of radium through californium in large environmental and biological samples, Analytical Chemistry, 51 (8), 1307 (1979).

WNB 70 K.M. Wong, V.E. Noshkin and V.T. Bowen, Radiochemical procedures for the analysis of strontium, antimony, rare earths, caesium, and plutonium in seawater samples, Reference Methods for Marine Radiochemistry Studies, International Atomic Energy Agency Technical Report Series No. 118, International Atomic Energy Agency, Vienna, 119 (1970).

IAEA Summary of Intercomparison Results (OTS 78)

Concentration of elements which can be recommended with a relatively high degree of confidence*)

Major and Minor Constituents

Element	Content (Wt.%)
Aluminum	8.19 ± 0.28
Potassium	1.86 ± 0.15
Sodium	1.92 ± 0.11

Trace Constituents

Element	Content (ug/g)
Arsenic	93.9 ± 7.5
Barium	561 ± 53
Cerium	59.7 ± 3.0
Cobalt	14.8 ± 0.76
Cesium	56.7 ± 3.3
Copper	77.1 ± 4.7
Gallium	18.4 ± 1.6
Lanthanum	28.1 ± 1.5
Rubidium	138 ± 7.4
Scandium	14.8 ± 0.66
Thorium	11.3 ± 0.73
Zinc	368 ± 8.2

*) The reported uncertainties are confidence limits of the mean for a significance level of $\alpha = 0.05$.

(From DTS 78)

Concentrations of elements which can be recommended with a reasonable degree of confidence *)

Major and Minor Constituents

Element	Content (Wt.%)
Iron	4.45 ± 0.19

Trace Constituents

Element	Content (µg/g)
Beryllium	1.77 ± 0.27
Bromine	5.4 ± 1.0
Chromium	28.9 ± 2.8
Dysprosium	4.0 ± 1.0
Europium	1.18 ± 0.08
Hafnium	6.30 ± 0.30
Holmium	0.82 ± 0.83
Lithium	52.1 ± 33
Lutetium	0.336 ± 0.044
Manganese	852 ± 37
Neodymium	29.9 ± 1.6
Lead	129 ± 26
Antimony	14.3 ± 2.2
Samarium	5.42 ± 0.39
Tantalum	0.764 ± 0.056
Terbium	0.665 ± 0.075
Uranium	3.04 ± 0.51
Ytterbium	2.24 ± 0.20

*) The reported uncertainties are confidence limits of the mean for a significanc level of $\alpha = 0.05$.

(From DTS 78)

Non-certified values for concentrations of certain elements (Information values only)

Major and Minor Constituents

Element	Content (Wt.%)
Calcium	(2.2)
Magnesium	(1.5)
Phosphorus	(0.11)
Silicon	(33)
Titanium	(0.47)

Trace Constituents

Element	Content (µg/g)
Silver	(1.9)
Boron	(63)
Bismuth	(12)
Cadmium	(1.5)
Gadolinium	(35)
Fluorine	(682)
Mercury	(0.79)
Molybdenum	(1.7)
Niobium	(9)
Nickel	(13)
Praseodymium	(5.0)
Selenium	(1.4)
Strontium	(330)
Thulium	(0.42)
Vanadium	(151)
Tungsten	(5.1)
Yttrium	(21)
Zirconium	(221)