INTERCOMPARISON OF RADIONUCLIDE MEASUREMENTS IN MARINE SEDIMENT SAMPLE IAEA-368

by

S. Ballestra, J.J. Lopez, J. Gastaud, P. Parsi,
D. Vas, V. Noshkin

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International Atomic Energy Agency
Marine Environment Laboratory
19, Avenue des Castellans
MC 98000 Monaco
Principality of Monaco

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ABSTRACT

The results of an intercomparison exercise on a Pacific Ocean sediment sample, IAEA-368, designed for the determination of artificial and natural radionuclides levels, are reported. The data from 89 laboratories representing 37 countries have been evaluated.

The following are the recommended values, with confidence intervals, for ^{60}Co, ^{154}Eu, ^{210}Pb, ^{226}Ra, ^{238}U, ^{238}Pu and $^{239+240}Pu$ (Reference date: 1 January 1990). Information values for ^{40}K, ^{90}Sr, ^{137}Cs, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U and ^{241}Am are also reported.

Artificial radionuclides

	Recommended value* (Bq kg^{-1})	Confidence interval** (Bq kg^{-1})
^{60}Co	0.6	0.5-0.7
^{154}Eu	3.8	3.4-4.3
^{238}Pu	8.5	7.6-8.9
$^{239+240}Pu$	31	29-34

	Information value* (Bq kg^{-1})	Range (Bq kg^{-1})
^{90}Sr	1.8	0.45-6.9
^{137}Cs	0.34	0.2-0.44
^{241}Am***	1.3	1.2-1.5

Natural radionuclides

	Recommended value* (Bq kg^{-1})	Confidence interval** (Bq kg^{-1})
^{210}Pb•	23.2	19.8-27.2
^{226}Ra	21.4	20.3-22.6
^{238}U	31	25-33

	Information value* (Bq kg^{-1})	Range (Bq kg^{-1})
^{40}K	5.4	5-8
^{228}Th	1	0-2
^{230}Th	26.7	24.1-28
^{232}Th	0.3	0.06-2.3
^{234}U	35.7	21.5-44.8
^{235}U	1.9	1.6-2.6

* Activities are expressed on dry-weight basis
** At the significance level of α= 0.05
*** Information value may become a reference value if additional ^{241}Pu concentration results become available
• ^{210}Pb and ^{210}Po are considered to be in equilibrium.

1. Introduction

In 1989-1990, the Marine Environment Laboratory (MEL) in Monaco, formerly International Laboratory of Marine Radioactivity, prepared and distributed new marine sediment samples with quantities of some artificial and natural radionuclides for intercomparison and certification. Herein are the results for a sediment from the Pacific Ocean coded IAEA-368 collected in 1989. It was anticipated that the concentrations of the artificial radionuclides in this sediment could be higher than the global fallout levels.

All participants were informed that the expected concentration range for the artificial radionuclides in the IAEA-368 sediment was 0-10 Bq kg^{-1} and 1-50 Bq kg^{-1} for the gamma emitters and the transuranic elements, respectively and the concentration range for the natural radionuclides was 0-50 Bq kg^{-1}.

2. Scope of the study

This intercomparison material is designed for measurements of man-made and natural radionuclides. Participating laboratories were requested to determine as many radionuclides as possible by gamma spectrometry and any possible transuranic and other radionuclides requiring radiochemical separation and alpha or beta counting.

3. Description of the material

The sediment sample was collected in June 1989 by the "Service Mixte de Sécurité Radiologique" of the "Commissariat à l'Energie Atomique" (Montlhéry, France) and by the "Direction des Applications Militaires" of the "Ministère de la Défense" (France) in the Pacific Ocean at the Mururoa Atoll. Since 1966 this atoll has been used by France to test different nuclear devices.

The sedimentary material, mainly composed of a mixture of carbonate species, was sieved (2.5 mm perforation) and the fraction less than 2.5 mm retained. This material was dried in an oven at 100°C, ground in a ball mill and further homogenized by mixing in a stainless steel rotating drum for about a week. A sieving test showed that 98% of the material was below 500 µm and more than 70% was in the size range 63µm-250µm. The remaining material was equally divided between the fractions below 63 µm and 250µm-500µm. More than 73% was below 125 µm.

The moisture content of the sample, determined at the time of packaging by drying several aliquots at 80°C to constant weight, was found to be about 0.5%. Forty-seven laboratories reported moisture content: 41 values were below 1%, 4 values were between 1% and 3% and 2 values were between 4% and 5%.

Plastic bottles were filled with 100 g of the sediment and labelled with the code name IAEA-368. Participants were requested to report results on a dry-weight basis. The reference date for reporting the radionuclide concentrations was 1 January 1990.

Prior to release any intercomparison sample from MEL, it is a requirement to assure that the radionuclides are homogeneously distributed in the sediment material. The homogeneity was assessed by measuring the activity of ^{40}K, ^{60}Co, ^{155}Eu, ^{210}Pb, $^{239+240}Pu$ and ^{241}Am in several samples from bottles taken at random. ^{40}K, ^{60}Co, ^{155}Eu, ^{210}Pb and ^{241}Am were determined by gamma spectrometry while $^{239,240}Pu$ was determined by alpha spectrometry. Results for these radionuclides expressed as relative activities are shown in Table 1. Homogeneity was determined using one-way analysis of variance and, taking into account the respective levels of the different elements, it was concluded that the material satisfied the homogeneity criteria for the radionuclides measured.

4. Sample dispatch and data return

The samples were distributed to 121 laboratories. The deadline for reporting the data was set for 31 December 1990. Many of the participants met this deadline. Other laboratories expressed their intention to report later.

As of 15 February 1991, results were received from 77 laboratories. An interim report was issued showing that some of the reported values were far from the mean values determined from a statistical analysis of the available data base. Participants were urged to look over their data and inform us of any errors. We received several replies and corrected the data accordingly. As of 15 April 1991, 89 sets of results (including MEL) were received from 37 countries.

Concentrations of 16 artificial and 12 natural radionuclides were reported. These 28 radionuclides are shown in Table 2 with the number of laboratories submitting results together. The number of reported "less than" values are shown in parentheses. The results for the most frequently measured radionuclides are shown in Tables 3 to 10 while the less frequently measured artificial radionuclides are presented in Table 11.

The list of contributing laboratories can be found in the Annex.

5. Evaluation of the results

5.1. Data treatment

The results submitted by the participants are shown under their laboratory code numbers in Tables 3 to 11. Laboratory averages were calculated when necessary from individual results and are given either as arithmetical means with corresponding standard deviation when more than two results were reported or as weighted means with weighted errors in the case of only two reported results. All values have been rounded off to the most significant figure when necessary.

5.2. Evaluation procedure

The "less than" values were segregated from the results and the remaining values were checked for the presence of outliers using a box and whisker plot test (1). Outliers are identified with an asterisk in Tables 3

to 10. Median values were calculated from all results passing the test. These values are the most reliable estimates of the unknown true values.

Confidence intervals were taken from a non-parametric sample population (2). They represent a two-sided interval at a significance level of 0.05.

5.3. Explanation of the tables

5.3.1. Laboratory code: each laboratory was assigned an individual code number to ensure anonymity.

5.3.2. Method code: the analytical techniques employed by the participants are:

Method code	Method
Aln*, t*	Alpha spectrometry after chemical separation
AAS	Atomic absorption spectrometry
B	Beta measurements after chemical separation
Em	Radon Emanation method
F	Fluorometry
G	Gamma spectrometry: not specified
G1	" " : direct Ge(Li) /Ge(HP)
G2	" " : indirect (of a daughter radionuclide assumed in equilibrium)
NAA	Neutron activation analysis
S	Spectrophotometry

* n: for acid leaching techniques
* t: for total dissolution techniques

5.3.3. Number of results: number of measurements or results reported by each participant.

5.3.4. Activity : corresponds to the arithmetical or weighted mean computed from all the individual results obtained from the participants with the corresponding standard deviation or weighted error.

5.4. Criteria for certification and recommended values

For data sets comprising 5 or more accepted laboratory means, median values and confidence intervals were calculated as estimations of true activity concentrations.

Please note that the following criteria are specially designed for this report.

The median values of the overall data, excluding outliers, were considered as the recommended values when:

1. More than 10 laboratory means were available
2. The percentage of outliers was not greater than 20%
3. The relative uncertainty of the overall median did not exceed ± 10% for activity concentrations equal or higher than 100 Bq kg^{-1} and ± 30% for activity lower than 100 Bq kg^{-1}.

An activity concentration value is classified as an information value when it is based on at least 3 laboratory means that are within the same order of magnitude.

6. Results and discussion: artificial radionuclides

Results for ^{60}Co, ^{90}Sr, ^{137}Cs, ^{155}Eu, ^{238}Pu, $^{239+240}Pu$ and ^{241}Am are presented in Tables 3 to 5.

Strontium-90

Twelve results were reported that included three "less than" value (Table 3). No outlying value was found in the data set while the results spread over a range of 0.18-8.6 Bq kg^{-1}. The median of these values is 1.8 Bq kg^{-1} with a confidence interval of 0.45-6.9 Bq kg^{-1}.

Most of the laboratories have used conventional techniques based on: acid leaching of the material followed by carbonate or oxalate precipitation; separation of Sr and Cs with fuming nitric acid; purification with $BaCrO_4$ and $Fe(OH)_3$ precipitations and then precipitation and counting of Sr as Sr carbonate or by milking and beta counting of ^{90}Y. Quantities of material used by the participants were included between 0.9 and 50 g.

No correlation could be found between the quality of the result and the use of ^{85}Sr and/or stable strontium as yield monitor. The screening of the results shows that the recent members of the ILMR exercises produced a set of data with a higher mean than the laboratories which have participated for several years in the Intercomparison Programme. Although on a statistical basis we have no reason to reject any of the accepted 9 values, we suggest that the mean concentration of ^{90}Sr may be low and possibly lower than 1 Bq kg^{-1}.

Cobalt-60

Thirty-seven results were reported that included 10 "less than" values (Table 4). Four of the reported results were determined to be outliers. The median of the accepted values is 0.6 Bq kg^{-1} with a confidence interval of 0.5-0.7 Bq kg^{-1}. All results were obtained by using gamma spectrometry.

Caesium-137

Fifty results were reported including 31 "less than" values (Table 4). All results but one have been obtained by using gamma spectrometry techniques. Lab. 68 leached the sample with acid, adsorbed Cs on AMP, purified the Cs fraction and precipitated Cs_2PtCl_6 followed by beta counting.

Nine results were considered as outliers. The median of the accepted values is 0.34 Bq kg^{-1} with a confidence interval of 0.2-0.44 Bq kg^{-1}.

Europium-155

Twenty-four results were reported that included one "less than" value. No outlying values were found. The results give a median value of 3.8 Bq kg^{-1} with a range of 3.4-4.3 Bq kg^{-1}. All results were obtained using gamma spectrometry.

Transuranium elements

Plutonium-238 and plutonium-239+240 were reported by 24 and 30 laboratories, respectively. After excluding five outliers for ^{238}Pu, the median of the remaining 19 values is 8.5 Bq kg^{-1} with a confidence interval of 7.6-8.9 Bq kg^{-1}.

Three values were determined as outliers for $^{239+240}Pu$. The median concentration is 31 Bq kg^{-1} with a confidence interval of 29-34 Bq kg^{-1}. The ratio of the median ^{238}Pu to $^{239+240}Pu$ is 0.27, significantly different than the ratio associated with plutonium originating from global fallout.

The chemical procedures used by the participants for plutonium are based on the following: dry ashing followed by leaching with either HNO_3 conc. or 8M HNO_3 or Aqua regia or a mixture of $HNO_3/HF/HClO_4$; precipitation with iron hydroxide or calcium oxalate; separation and purification of plutonium with either anion-exchange using HCl or HNO_3 or with liquid-liquid extraction (Aliquat, TIOA, TTA); finally plutonium is electrodeposited on a small disk or adsorbed by a lanthanum fluoride precipitate and counted using solid state alpha detectors.

Thirty-nine results were reported for ^{241}Am that included 5 "less than" values. Fourteen of the reported results were determined by alpha spectrometry following radiochemical separation; 19 by direct gamma spectrometry; and one (Lab. 33) by a combination of radiochemical separation (acid leaching of the material and neodymium oxalate precipitation) followed by gamma spectrometry.

The application of a t-test to the two groups of data of ^{241}Am obtained either directly by gamma spectrometry or by alpha spectrometry shows that the mean values (and median values) obtained for the two populations are very close: 1.32 Bq kg^{-1} (1.29 Bq kg^{-1} as median) for the alpha data set and 1.37 Bq kg^{-1} (1.3 Bq kg^{-1} as median) for the gamma data set. It is extremely probable that the two data sets come from the same population of results (t=-0.5, significance level=0.62). It is therefore justified to pool all ^{241}Am results. The median value, shown in Table 5, was generated after removing the values for 3 outliers from the combined alpha and gamma spectrometry results. The median value of the pooled results is 1.3 Bq kg^{-1} with a confidence interval of 1.2-1.5 Bq kg^{-1}.

It is apparent that both techniques, direct gamma spectrometry or radiochemical separation followed by alpha spectrometry, give similar quality results at a concentration level of 1.3 Bq kg^{-1}. Laboratories that participated in the Baltic sea sediment IAEA-306 intercomparison exercise may recall that in the case of this sample, the two techniques had given different median values (at approximately 2 Bq kg^{-1}) coming from different data populations. There appears to have been an improvement in ^{241}Am methodology during the last few years.

The value for ^{241}Am is given for the reference date 1 January 1990 only. The activity of ^{241}Am will change with time as the ^{241}Pu present in the sample decays. Unfortunately, only two values, 17.1 Bq kg^{-1} and 70 Bq kg^{-1} were reported for ^{241}Pu (Table 11). On the basis of an average value of 43.6 Bq kg^{-1} and taking into account the decay of ^{241}Am, we can estimate that the activity of ^{241}Am will change to about 1.6 Bq kg^{-1} in 5 years and 1.8 Bq kg^{-1} in 10 years. These values are within the statistical uncertainty of the median; however, we hesitate to recommend a reference value since only two measurements of the parent radionuclide were reported.

Other isotopes

Several laboratories submitted results on ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{144}Ce, ^{146}Pm, ^{147}Pm, ^{237}Np, ^{241}Pu and ^{242}Cm. Those results are presented in Table 11. Most of the concentrations are reported as "less than" values.

7. Results and discussion: natural radionuclides

The results are presented in Tables 6 to 10. Application of our statistical treatment and test for outliers to the different data populations allow us to generate recommendation concentration values for some of these isotopes.

Potassium-40

Forty-three results were reported that included 14 "less than" values. Lab. 68 determined ^{40}K by measuring stable potassium by atomic absorption spectrometry and made the appropriate calculations of converting to ^{40}K using a proportional factor of 30.52 Bq per g of natural potassium. The other 28 results were obtained by gamma spectrometry. The results cover nearly two orders of magnitude from 0.5 to 245 Bq kg^{-1}. After the rejection of nine outliers, the remaining results give a median value of 5.4 Bq kg^{-1} with a confidence interval of 5-8 Bq kg^{-1}. Quantities of material used by the participants for gamma spectrometry were between 3 and 100 g.

Uranium isotopes

Twenty-five results of ^{238}U were reported including 2 "less than" values. Seventeen laboratories determined ^{238}U by gamma spectrometry of daughter products, seven have chemically separated U and measured the concentration using alpha spectrometry while one participant used NAA (Neutron Activation Analysis). The application of a t-test to the groups of data (gamma and alpha measurements) shows, after rejection of outlying values, that it is justified to pool all the data (t-statistics= 0.507 and sig. level= 0.62). The means (and medians) are not statistically different: 29.7 Bq kg^{-1} (and 32.2 Bq kg^{-1}) and 28.1 Bq kg^{-1} (and 30.2 Bq kg^{-1}) for the results obtained by alpha and gamma techniques, respectively. The net median value is 31 Bq kg^{-1} with a confidence interval of 25-33 Bq kg^{-1}.

Seventeen results of ^{235}U were reported including one "less than" value. After the rejection of two outliers, the median obtained is 1.9 Bq kg^{-1} with a confidence interval of 1.6-2.6 Bq kg^{-1}.

The data set of ^{234}U was composed of 7 results. After the rejection of one outlier, the median concentration was of 35.7 Bq kg^{-1} with a confidence interval of 21.5-44.8 Bq kg^{-1}. The ratio $^{234}U/^{238}U$ in the material is 1.15.

Three laboratories (Labs. 14, 48 and 69) reported uranium as total uranium and they have used fluorometry, spectrophotometry and gamma spectrometry techniques, respectively.

Thorium isotopes

Seventeen results were reported for ^{228}Th including six "less than" values. Three results were obtained by alpha spectrometry while the remaining were obtained by gamma spectrometry using the gamma rays of ^{208}Tl (583 keV) and ^{212}Pb (239 keV). After rejection of four outliers, the median for ^{228}Th is 1 Bq kg^{-1} with a confidence interval of 0-2 Bq kg^{-1}.

Thorium-230 concentrations were reported by seven laboratories including one "less than" value. Two values were rejected as outliers and the 4 remaining concentrations gave an information median value of 26.7 Bq kg^{-1}.

Nine results were submitted for ^{232}Th including 4 "less than" values. The median value is 0.3 Bq kg^{-1} with a confidence interval of 0.06-2.3 Bq kg^{-1}.

Radium-226

Sixty-one results were reported for ^{226}Ra. Most of the participants determined ^{226}Ra by gamma spectrometry. One result was obtained by alpha spectrometry and two results were obtained by radon emanation technique. The 58 results obtained by gamma spectrometry were divided in three groups: 3 results were obtained by measuring the 186 keV gamma ray of ^{226}Ra (Method code G1); 26 results by using the gamma rays of the daughter products $^{214}Pb/^{214}Bi$ and reporting the concentration as ^{226}Ra (Method code G2); 29 results were reported by gamma spectrometry.

Ten outliers were found in the ^{226}Ra data population which gives a median value of 21.4 Bq kg^{-1} with a confidence interval of 20.3-22.6 Bq kg^{-1}.

Lead-210 and Polonium-210

Twenty eight results including 2 "less than" values were reported for ^{210}Pb. Three participants have used radiochemical separation followed by beta counting of ^{210}Bi (Labs. 13, 14 and 47) while 5 have used alpha spectrometry (measurement of ^{210}Po ingrown). All remaining results (N=18) were obtained by measuring the 46 keV photopeak of ^{210}Pb by gamma spectrometry. After the rejection of two outliers in the gamma data set, the application of a t-test shows that the two groups of data come from the same population. Both techniques give very similar concentration means (and medians): 23.8 Bq kg^{-1} (and 23.4 Bq kg^{-1}) and 23.2 Bq kg^{-1} (and 22.4 Bq kg^{-1}) for the alpha and the gamma sets of data. The median value of the pooled data set is 23.2 Bq kg^{-1} with a confidence interval of 19.8-27.2 Bq kg^{-1}.

Nine results of ^{210}Po were submitted while, as mentionned previously, five laboratories determined ^{210}Pb through the measurement of ^{210}Po ingrowth. Some participants assumed there was equilibrium between ^{210}Pb and ^{210}Po and reported the concentrations of ^{210}Po at the reference date of 1 January 1990. Some laboratories reported the concentration of ^{210}Po at the separation dates of ^{210}Pb and ^{210}Po which, in most cases, were close to the end of 1990, e.g. more than three ^{210}Po half-lives after the collection date. Taking into account the time elapsed between the collection and the distribution of the samples and/or the analyses, the results reported show that ^{210}Pb and ^{210}Po are in equilibrium.

Other isotopes

One measurement of ^{231}Pa was reported by Lab. 82 as 2.4 Bq kg^{-1} (Table 11.). This value is rather close to the ^{234}U accepted median value of 1.9 Bq kg^{-1}.

8. Conclusion

The median concentrations for the sets of individual data -after rejection of outliers- were chosen as the most reliable estimators of the true values. A summary of the recommended and information values with confidence intervals for the most frequently reported radionuclides are given in Table 12 for sediment sample IAEA-368.

9. References

(1) J. W. Tukey. Exploratory data analysis. Addison-Wesley Publishing Company, Reading, Mass., 1977.

(2) Geigy Scientific Tables (1982) in "Statistical Methods for Environmental Pollution Monitoring", pages 173 and 266, by R. O. Gilbert, Van Nostrand Reinhold Company, New York, 1987.

10. Acknowledgments

The assistance of the "Service Mixte de Surveillance Radiologique" of the "Commissariat à l'Energie Atomique" (Montlhéry, France) and of the "Direction des Applications Militaires" (Ministère de la Défense, France) in providing the sample is gratefully acknowledged.

More than 70% of the participants responded to this intercomparison exercise and the laboratories which contributed their time and facilities to the present work are hereby acknowledged. We also acknowledge the effort made by the laboratory 60 which, in addition to supplying results for ^{60}Co, ^{90}Sr, ^{155}Eu, ^{226}Ra, ^{238}Pu, $^{239+240}Pu$ and ^{241}Am results also, reported values for ^{147}Pm, ^{237}Np and ^{241}Pu.

Note : The results presented in this report are subject to further revision and re-evaluation with the admission of additional data. Data of ^{241}Pu will be especially welcome for the certification of ^{241}Am. The users of the reference material IAEA-368 are therefore encouraged to report all

meaningful data and they will be notified of any changes in the certification status of the sample. The correspondence should be addressed to:

International Atomic Energy Agency
Marine Environment Laboratory
19, Avenue des Castellans
MC 98000 Monaco
Principality of Monaco

Your laboratory code number is : ___

TABLE 1. Homogeneity tests for IAEA-368 sediment sample

Relative activity of randomly selected samples*

Sample	Radionuclide					
No	^{40}K**	^{60}Co**	^{155}Eu**	^{210}Pb**	^{241}Am**	^{239}Pu+
1	0.93	0.89	1.03	0.73	0.70	0.99
2	1.28	1.52	1.03	0.93	0.86	1.05
3	0.74	1.14	1.02	1.13	1.14	1.04
4	1.09	0.79	1.11	0.93	1.35	0.96
5	0.67	0.40	0.81	1.03	0.64	1.01
6	1.35	0.83	1.06	1.03	1.09	1.01
7	0.53	1.39	1.00	1.18	1.09	1.03
8	0.72	0.89	0.89	0.85	1.00	0.97
9	0.43	0.91	1.18	0.85	1.09	0.96
10	1.22	0.56	0.99	1.00	0.82	1.01
11	0.63	0.76	0.96	1.20	0.91	0.91
12	0.72	0.97	0.99	0.90	1.32	1.08

	Radionuclide						
	^{40}K	^{60}Co	^{155}Eu	^{210}Pb	^{241}Am	^{239}Pu	All
Minimum	0.43	0.40	0.81	0.73	0.64	0.96	0.40
Maximum	1.28	1.52	1.18	1.2	1.35	1.08	1.52
Mean	0.87	0.92	1.01	0.98	1.00	1.00	0.96
Median	0.73	0.89	1.01	0.96	1.04	1.01	0.99
Std. Dev.	0.32	0.31	0.10	0.14	0.22	0.05	0.21
Coef. Var(%)	36.8	33.7	9.9	14.3	22	5	21.9

* =x/X (individual/mean values): initially expressed in this manner to assure confidentiality of results

** determined by gamma spectrometry

\+ determined by alpha counting

TABLE 2. Radionuclides reported in Pacific Ocean sediment IAEA-368

Radionuclide	Number of reported results
^{226}Ra	61
^{137}Cs	50 (31)
^{40}K	43 (14)
^{241}Am	39 (5)
$^{239+240}Pu$	30
^{60}Co	37 (10)
^{238}U	25 (2)
^{152}Eu	24 (1)
^{238}Pu	24
^{210}Pb	28 (2)
^{228}Th	17 (6)
^{235}U	17 (1)
^{90}Sr	12 (3)
^{134}Cs	9 (8)
^{210}Po	9
^{232}Th	9 (4)
^{230}Th	7 (1)
^{234}U	7
^{228}Ra	7 (5)
^{106}Ru	3 (3)
^{125}Sb	1 (1)
^{144}Ce	2 (2)
^{241}Pu	2
^{146}Pm	1
^{147}Pm	1
^{231}Pa	1
^{237}Np	1
^{242}Cm	1

"Less than" values shown in parenthesis

TABLE 3. Results for Sr-90 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Sr-90
1	2	B	3	6.9 ± 1.8
2	13	B	2	1.8 ± 0.4
3	14	B	3	<10
4	26	B	1	0.45 ± 0.14
5	33	B	3	1 ± 2
6	56	B	6	5 ± 2
7	59	B	3	<5
8	60	B	3	0.5 ± 0.6
9	68	B	2	0.18 ± 0.03
10	73	B	3	<3
11	77	B	3	6.7 ± 2.3
12	88	B	2	8.6 ± 0.9

* result rejected by the test for outliers

Number of reported lab.means	9
Number of accepted lab. means	9
Range of accepted lab. means	0.18-8.6
Median	1.8
Confidence interval (α=0.05)	0.45-6.9

TABLE 4. Results for Co-60, Cs-137 and Eu-155 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab Code	Method Code	No. of Results	Co-60	Cs-137	Eu-155
1	1	G1	5	≤0.4	-	4.2 ± 0.3
2	2	G1	3-7	≤1.5	-	3.1 ± 0.2
3	5	G1	2	0.8 ± 0.4	-	2.0 ± 1.5
4	8	G1	1	0.6 ± 0.2	-	-
5	9	G1	5	0.3 ± 0.2	≤0.9	3.6 ± 0.2
6	11	G1	2-5	0.3 ± 0.1	0.3 ±0.2	2.9 ± 0.2
7	13	G1	3	-	≤0.6	-
8	14	G1	3	-	≤5	-
9	16	G1	1	≤0.7	≤0.6	-
10	17	G1	6	1.2 ± 0.3	≤1.6	-
11	19	G1	5	-	≤2.5	-
12	20	G1	3	-	≤0.6	-
13	21	G1	3	-	191 ± 15*	-
14	24	G1	5	0.35 ± 0.07	≤0.3	3.1 ± 0.2
15	25	G1	1	4.9 ± 2.0*	≤LD	-
16	26	G1	1-2	0.8 ± 0.1	≤0.5	-
17	27	G1	3	≤3	≤3	-
18	28	G1	2-3	0.4 ± 0.2	≤0.45	-
19	29	G1	1	0.6 ± 0.3	≤0.4	3.8 ± 2.0
20	33	G1	3	-	40 ± 40*	-
21	34	G1	3	1.8 ± 0.4*	0.44 ± 0.02	-
22	35	G1	3	-	≤4	-
23	36	G1	6	0.5 ± 0.3	≤1	-
24	37	G1	1-3	33.8*	0.2 ± 0.9	-
25	38	G1	1	-	≤7	-
26	39	G1	4	-	6.9 ± 0.6*	-
27	40	G1	3	-	-	5.3 ± 0.9
28	41	G1	3	0.7 ± 0.4	≤0.6	-
29	43	G1	5	0.50± 0.09	-	-
30	44	G1	4	≤1	≤0.9	-
31	46	G1	1	≤2	≤2	-
32	47	G1	3	-	2.3 ± 0.2*	4.8 ± 0.6
33	48	G1	3	≤1.5	-	3.8 ± 0.2
34	49	G1	3	-	7.1 ± 0.8*	-
35	50	G1	3	-	-	4.1 ± 0.8
36	51	G1	2	0.8 ± 0.3	0.3 ± 0.2	-
37	52	G1		-	62 ± 12*	-
38	53	G1	1-4	1 ± 0.6	-	3.4 ± 1.2
39	54	G1	3	0.9 ± 0.1	-	5.7 ± 0.3
40	55	G1	6	0.5 ± 0.4	0.4 ± 0.2	-
41	56	G1	6	-	≤1	-
42	57	G1	4	-	0.4 ± 1.4	-
43	58	G1	3	≤1.1	≤1.1	≤3
44	59	G1	3	≤0.7	≤0.6	-
45	60	G1	3	1.7 ± 0.4*	-	3.3 ± 0.4

TABLE 4 (contd). Results for Co-60, Cs-137 and Eu-155 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab Code	Method Code	No. of Results	Co-60	Cs-137	Eu-155
46	62	G1	3	-	≤LD	-
47	63	G1	3	-	≤0.7	-
48	65	G1	4	-	≤1.5	-
49	66	G1	2	-	≤1	-
50	67	G1	1	0.5 ± 0.1	0.5 ± 0.1	3.7 ± 0.2
51	68	B	2	-	1.6 ± 0.1*	-
52	69	G1	1	-	-	6.5 ± 2.3
53	70	G1	1	-	≤0.65	4.3 ± 0.4
54	72	G1	4	-	≤0.5	-
55	74	G1	3	-	≤4	-
56	78	G1	1	≤3.7	≤2.3	-
57	82	G1	3	0.7 ± 0.3	0.3 ± 0.2	6.6 ± 1.9
58	83	G1	6	0.7 ± 0.2	-	3.7 ± 0.8
59	84	G1	6	0.7 ± 0.3	-	4.1 ± 1.0
60	85	G1	3	0.5 ± 0.1	0.12 ± 0.08	-
61	86	G1	6	0.6 ± 0.1	-	3.6 ± 0.5
62	87	G1	1	-	1.6 ± 0.8*	-
63	88	G1	3	-	-	5 ± 2
64	89	G1	1	-	0.37 ± 0.06	-
65	90	G1	4	0.7 ± 0.3	≤0.8	3.2 ± 1.0
66	93	G1	5	-	225 ± 12*	-

* results rejected by the test for outliers

Number of reported lab. means	27	19	23
Number of accepted lab. means	23	10	23
Range of accepted lab. means	0.3-1.2	0.12-0.5	2-6.6
Median	0.6	0.34	3.8
Confidence interval (α=0.05)	0.5-0.7	0.2-0.44	3.4-4.3

TABLE 5. Results of Pu-238, Pu-239+240 and Am-241 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Pu-238	Pu-239+240	Am-241
1	1a	A1n	4-5	12.8 ± 3.6*	36.4 ± 4.6	1.7 ± 0.3
2	1b	G1	2	-	-	0.8
3	B	A1n	5	-	39.2 ± 3.7	-
4	9a	A1n-t	11-25	8.7 ± 0.7	32 ± 2	1.2 ± 0.1
5	9b	G1	5	-	-	1.0 ± 0.2
6	11	G1	4	-	-	1.8 ± 0.2
7	13a	A1	2	9.9 ± 1.0	38.1 ± 3.0	-
8	13b	G1	3	-	-	1.2 ± 0.6
9	14	A1n	3	3 ± 1*	-	≤2
10	15	A1n	5	12.6 ± 0.7*	51.1 ±11.3*	1.5 ± 0.2
11	16	G1	1	-	-	≤4
12	18	A1	3	7.5 ± 0.4	27.4 ± 1.0	-
13	20	G1	3	-	-	≤0.5
14	21	A1t	3	-	34 ± 10	-
15	24a	A1	3-4	8.5 ± 0.5	29.9 ± 1.3	-
16	24b	G1	5	-	-	1.1 ± 0.2
17	25	A1n-t	3	7.2 ± 1.0	27 ± 3	1.2 ± 0.2
18	26	A1	1	9.1 ± 0.6	30.5 ± 2.1	1.1 ± 0.1
19	28	A1n	3	8.8 ± 0.1	31.3 ± 0.4	-
20	29	G1	1	-	-	1.5 ± 0.6
21	32	A1n	1	-	37.9 ± 1.5	1.14±0.04
22	33a	A1n	3	8.1 ± 0.3	29 ± 1	-
23	33b	G**	3	-	-	0.9 ± 0.8
24	38	A1n	1	9.5 ± 1.1	36 ± 4	0.5 ±0.2*
25	41	G	3	-	-	1.6 ± 0.2
26	43a	A1	3	8.2 ± 0.3	28.3 ± 0.7	-
27	43b	G	4	-	-	1.3 ± 0.2
28	47	A1	1	-	18.5	-
29	50	G	3	-	-	2.9 ±1.8*
30	53	A1	1	-	30 ± 6	2.6 ±0.3*
31	54	G	3	-	-	≤1.3
32	56	A1	6	8.9 ± 1.2	31.9 ± 3.4	-
33	59a	A1n	3	9 ± 5	34 ± 10	-
34	59b	G	3	-	-	1.6 ± 0.9
35	60a	A1t	3	8.5 ± 0.8	31.2 ± 2.7	1.27± 0.03
36	60b	G	3	-	-	1.4 ± 0.3
37	61a	A1n	3	6.1 ± 0.3	21.5 ± 1.5	1.1 ± 0.2
38	61b	A1t	1	7.0 ± 0.9	26.4 ± 2.6	1.3 ± 0.3
39	67	G1	1	-	-	1.2 ± 0.3
40	68	A1	2	8 ± 1	29 ± 2	-
41	69	G1	1	-	-	1.9 ± 1.0
42	70a	A1	3	8.1 ± 0.2	31.0 ± 0.6	1.4 ± 0.2
43	70b	G	1	-	-	1.6 ± 0.2
44	72	A1t	6	12.4 ± 2.4*	36.2 ± 5.0	-
45	73	A1t	3	8.6 ± 2.7	36.0 ± 9.2	1.4 ± 0.6

TABLE 5 (contd). Results of Pu-238, Pu-239+240 and Am-241 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Pu-238	Pu-239+240	Am-241
46	74	A1	2	-	30 ± 2	-
47	78	G1	1	-	-	≤2.3
48	82	G1	3	-	-	1.8 ± 0.5
49	83	G1	6	-	-	1.2 ± 0.3
50	84	G1	3	-	-	1.1 ± 0.3
51	86	G1	6	-	-	1.2 ± 0.2
52	88	A1	3	-	51.3 ± 2.6*	-
53	90	G1	4	-	-	1.3 ± 0.6
54	91	A1t	4	7.6 ± 0.4	26.9 ± 0.8	1.5 ± 0.1
55	92	A1	3	16 ± 3*	54 ± 10*	-

* results rejected by the test of outliers
G**: total dissolution + Nd oxalate ppt + Gamma spec.

Number of reported lab. means	24	30	34
Number of accepted lab. means	19	27	31
Range of accepted lab. means	6.1-9.9	18.5-39.2	0.8-1.9
Median	8.5	31	1.3
Confidence interval (α=0.05)	7.6-8.9	29-34	1.2-1.5

TABLE 6. Results for K-40 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	K-40
1	1	G1	5	≤5.3
2	2	G1	5	78.6 ± 5.8*
3	6	G1	2	54 ± 13*
4	7	G1	4	0.64± 0.07
5	8	G1	1	5.1 ± 1.0
6	9	G1	4	3.1 ± 0.7
7	10	G1	3	≤3.2
8	11	G1	3	5 ± 2
9	15	G1	4	19 ± 2*
10	16	G1	1	≤8
11	17	G1	4	7.7 ± 2.0
12	19	G1	6	≤25
13	24	G1	4	5.3 ± 1.5
14	25	G1	1	0.5 ± 0.1
15	28	G1	2	5.4 ± 2.0
16	31	G1	10	≤74
17	34	G1	3	39.3 ± 1.5*
18	35	G1	3	≤160
19	36	G1	6	≤100
20	37	G1	3	134 ± 0.1*
21	38	G1	1	38 ± 12*
22	48	G1	4	≤40
23	49	G1	3	71.5 ± 6.4*
24	51	G1	3	≤17
25	53	G1	4	11 ± 8
26	54	G1	3	13.1 ± 3.5
27	55	G1	6	3.2 ± 3.6
28	57	G1	4	≤70
29	58	G1	3	≤27.4
30	63	G1	3	≤10
31	67	G1	1	≤12.6
32	68	AAS	1	8 ± 3
33	70	G1	1	5.1 ± 0.2
34	74	G1	3	246 ± 37*
35	83	G1	6	4.3 ± 2.7
36	84	G1	6	5.4 ± 2.0
37	85	G1	3	8.4 ± 2.4
38	86	G1	6	5.4 ± 2.9
39	87	G1	1	6 ± 10
40	88	G1	3	12 ± 5
41	89	G1	1	10.4 ± 0.4
42	90	G1	4	≤10
43	94	G1	3	109 ± 3*

* results rejected by the test for outliers

TABLE 6 (Contd). Results for K-40 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

	K-40
Number of reported lab. means	29
Number of accepted lab. means	20
Range of accepted lab. means	0.5-13.1
Median	5.4
Confidence interval (α=0.05)	5-8

TABLE 7. Results for U-238, U-235 and U-234 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	U-238	U-235	U-234
1	1	G2	5	25.5 ± 1	-	-
2	3	NAA	1	7.2 ± 1.4*	-	-
3	5	G	2	-	4.8 ± 1.5*	-
4	6	A1t	3	32 ± 1.5	-	36.7± 0.6
5	9a	A1	5	32.4 ± 1.4	2.0 ±0.5	36.4± 1.1
6	9b	G1	5	-	2.6 ± 0.2	-
7	10	G2	3	≤57	-	-
8	11	G2	5	33 ± 2	-	-
9	13	A1	2	41.2 ± 3.0	1.6 ± 0.5	44.8± 3.0
10	14	F	3	---------- Total U = 180 ± 20 ---------		
11	15	G1	5	-	5.2 ± 0.4*	-
12	17	G	6	40 ± 8	-	-
13	21	A1t	3	20 ± 6	-	29 ± 7
14	24a	A1	8	33.9 ± 2.7	-	34.9± 2.7
15	24b	G1-G2	5	27.2 ± 3.2	1.8 ± 0.2	-
16	27	A1	2	18.5 ± 3.0	-	21.5± 4.0
17	28	G	3	24.3 ± 1.7	-	-
18	29	G1-G2	1	40 ± 16	1.8 ± 1.0	-
19	31	G	10	≤47	-	-
20	42	G	2	-	4 ± 1	-
21	43	G2	5	31.2 ± 2.4	-	-
22	44	G	4	31 ± 6	-	-
23	48	S	3	---------- Total U = 36 ± 4 ---------		
24	53a	A1t	1	240 ± 70*	-	180 ± 50*
25	53b	G1-G2	1-4	20 ± 7	≤4	-
26	55	G	6	46.9 ± 10.9*	2.1 ± 0.5	-
27	57	G	4		1.4 ± 1.1	-
28	59	G2	3	31 ± 10	-	-
29	69	G	4	---------- Total U = 19.6 ± 2.5 -----		
30	71	G1	5	-	1.6 ± 0.3	-
31	73	G2	1	110 ± 80*	-	-
32	76	G1	3	-	1.0 ± 0.4	-
33	83	G	6	30.2 ± 6.1	2.4 ± 1.3	-
34	84	G	5	-	1.8 ± 0.6	-
35	86	G	6	30.9 ± 7.1	2.6 ± 0.8	-
36	87	G2	1	25 ± 8	-	-
37	88	G	3	-	3.8 ± 0.8	-

* result rejected by the test for outliers

Number of reported lab. means	23	16	7
Number of accepted lab. means	19	14	6
Range of accepted lab. means	18.5-41.2	1-4	21.5-44.8
Median	31	1.9	35.7
Confidence interval (α=0.05)	25-33	1.6-2.6	21.5-44.8

TABLE 8. Results for Th-228, Th-230 and Th-232 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Th-228	Th-230	Th-232
1	3	G-G2	1	1.7 ± 1.0	-	2.3 ± 2.0
2	6	Alt	3	2.0 ± 0.9	27.8 ± 1.5	0.2 ± 0.2
3	9	A1	5	-	24.1 ± 2.1	0.3 ± 0.1
4	10	G2	3	≤1.1	-	-
5	11	G-G2	2-3	1.0 ± 0.4	28 ± 15	-
6	14	A1	3	≤10	≤500	≤500
7	16	G1	1	-	-	≤3
8	17	G	1	-	-	1.9 ± 1.1
9	21	Alt	2	-	1.6 ± 0.6*	-
10	31	G	10	4.3 ± 2.8*	-	-
11	35	G	3	-	-	≤8
12	36	G	6	≤4	-	-
13	37	G2	3	55 ± 0.1*	-	-
14	38	G2	1	11 ± 3*	-	-
15	42	G	2	14 ± 4*	-	-
16	51	G2	-	1.1 ± 0.7	-	-
17	53	G2	4	≤2	-	-
18	57	G	4	≤4	-	-
19	67	G2	3	≤0.45	-	-
20	68	A1	1	0.05 ± 0.02	26 ± 2	0.06±0.03
21	72	G2	4	1.0 ± 0.6	-	-
22	74	A1	3	-	62 ± 8*	-
23	87	G1	1	0 ± 1	-	-
24	90	G	4	-	-	≤2

* result rejected by the test for outliers

Number of reported lab. means	11	6	5
Number of accepted lab. means	7	4	5
Range of accepted lab. means	0-2	24.1-28	0.06-2.3
Median	1	26.7	0.3
Confidence interval (α=0.05)	0-2	-	-

TABLE 9. Results for Ra-226 and Ra-228 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Ra-226	Ra-228
1	1	G2	5	20.2 ± 0.2	-
2	3a	G	2	11.0 ± 3.2*	-
3	3b	Em	1	6.6 ± 3.0*	-
4	5	G	2	19 ± 3	-
5	6	G2	3	17.5 ± 1.0	-
6	8	G	1	35.7 ± 2.3*	-
7	9	G2	5	24.4 ± 1.2	-
8	10	G2	3	1.1 ± 0.2*	≤5.4
9	11	G2	5	21.8 ± 1.0	0.7± 0.4
10	13	G	3	21.3 ± 2.0	-
11	14	Em	3	22 ± 2	-
12	15	G	4	22 ± 1	-
13	16	G	1	21 ± 3	-
14	17	G	6	16.9 ± 1.3	-
15	20	G2	3	19.3 ± 3.1	-
16	24	G	5	17.5 ± 1.2	-
17	26	G	2	20 ± 2	-
18	28	G	3	29.2 ± 3.7	-
19	29a	G	1	27 ± 5	-
20	29b	G2	1	22.6 ± 1.6	-
21	30	G2	5	26.6 ± 2.5	-
22	34	G	3	26.4 ± 2.1	-
23	35	A1	3	22 ± 1	-
24	36	G	6	13.3 ± 2.3	≤4
25	37	G2	3	58.3 ± 1.1*	17.8 ± 0.1
26	38	G2	1	32 ± 4*	-
27	40	G2	3	30.0 ± 2.6	-
28	42	G	2	26 ± 4	-
29	43	G1	5	31.4 ± 3.5*	-
30	44	G	4	20.3 ± 1.0	-
31	46	G2	1	20	-
32	47	G	3	16.0 ± 5.3	-
33	49	G2	3	29.3 ± 1.3	-
34	50	G2	3	23.5 ± 1.4	-
35	51	G2	3	21.4 ± 0.9	-
36	53a	G	4	21 ± 7	-
37	53b	G2	4	17 ± 1	-
38	55	G	6	16.5 ± 2.0	-
39	57	G	4	21.2 ± 3.8	≤13
40	58	G	3	23.6 ± 1.8	-
41	59	G2	3	-	≤3
42	60	G2	3	20.6 ± 3.7	-
43	63	G	3	19.9 ± 1	≤4
44	65	G2	4	21.4 ± 0.5	-
45	66	G	2	36 ± 9*	-

TABLE 9 (contd). Results for Ra-226 and Ra-228 in sediment sample IAEA-368 (Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Ra-226	Ra-228
46	67a	G1	1	24.4 ± 1.1	-
47	67b	G2	3	19.5 ± 0.7	-
48	69	G	1	26.0 ± 1.6	-
49	71	G2	5	30.7 ± 1.6	-
50	72	G2	4	21.5 ± 0.9	-
51	73	G2	1	17.0 ± 3.1	-
52	76	G2	3	31.4 ± 2.2*	-
53	79	G2	3	24.0 ± 1.1	-
54	82a	G1	3	50.8 ± 10.5*	-
55	82b	G2	3	24.4 ± 2.4	-
56	83	G1-G2	6	22.9 ± 1.5	-
57	84	G	6	23 ± 4	-
58	85	G	4	20.8 ± 0.7	-
59	86	G	6	19.7 ± 3.1	-
60	87	G	1	28 ± 2	-
61	88	G	3	20.0 ± 1.6	-
62	90	G	4	19.2 ± 3.8	-

*result rejected by the test for outliers

Number of reported lab. means	61	2
Number of accepted lab. means	51	-
Range of accepted lab. means	13.3-30.7	-
Median	21.4	-
Confidence interval (α=0.05)	20.3-22.6	-

TABLE 10. Results for Pb-210 and Po-210 in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

No	Lab. Code	Method Code	No. of Results	Pb-210	Po-210	Reference Date Po-210
1	1	G1	5	10.2 ± 0.8	-	-
2	6	A1	8	-	23.4 ± 1.4	12-11-90
3	9a	A1	2	19.8 ± 2.8	25 ± 2	19-07-90
4	9b	G1	3	22.7 ± 4.5	-	-
5	10	G1	3	≤60	-	-
6	11	G1	3	26 ± 2	-	-
7	13	B	2	30.6 ± 2.0	-	-
8	14	B	3	30 ± 3	-	-
9	22a	A1	9	-	26.20± 0.98	*
10	22b	G1	4	20.7 ± 1.2	-	-
11	23a	Alt	3	-	24.3 ± 1.1	30-11-90
12	23b	C1	2	32.3 ± 3.9	-	-
13	24	G1	6	27.2 ± 5.4	-	-
14	26	A1	2	23.0 ± 3.9	19.4 ± 1.0	01-01-90++
15	29	G1	1	22 ± 15	-	-
16	35	G1	3	66 ± 3*	-	-
17	40	A1	3	27.0 ± 1.8	26.2 ± 1.8	27-12-90
18	41	G1	3	17.1 ± 5.0	-	-
19	44	G1	4	17.7 ± 0.6	-	-
20	45	A1	3	23.4 ± 1.3	-	01-01-90+
21	47	B	1	18.8 ± 1.2	-	-
22	48	G1	3	12.8 ± 1.4	-	-
23	49	G1	3	37.2 ± 16.3	-	-
24	53a	Alt	1	-	33 ± 3*	01-01-90
25	53b	G1	2	22 ± 17	-	-
26	54	G1	3	6.5 ± 2.6*	-	-
27	57	G1	4	≤40	-	-
28	74	Alt	3	26 ± 2	6 ± 2*	01-01-90
29	75a	A1	10	-	25.9 ± 0.9	14-01-91
30	75b	G1	1	28.8 ± 7.0	-	-
31	83	G1	6	19.6 ± 3.3	-	-
32	84	G1	2	29 ± 6	-	-
33	86	G1	6	26.5 ± 5.3	-	-

* result rejected by the test for outliers
\+ reference date 16-08-90 to 07-12-90
++ equilibrium assumed

Number of reported lab. means	26	9	-
Number of accepted lab. means	24	-	-
Range of accepted lab. means	10.2-37.2	see text	-
Median	23.2	-	-
Confidence interval (α=0.05)	19.8-27.2	-	-

TABLE 11. Results for the less frequently reported artificial and natural radionuclides in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

Isotope	Lab. Code	No.of Results	Activity Concentration
Ru-106	53	1	≤10
	78	1	≤29.8
	90	4	≤10
Sb-125	90	4	≤2
Cs-134	17	6	≤1
	19	6	≤2.5
	20	3	≤0.3
	37	3	8.3 ± 1.0
	58	3	≤1.3
	59	3	≤0.6
	70	1	≤1
	78	1	≤3.1
	93	5	≤0.28
Ce-144	78	1	≤15.4
	90	4	≤7
Pm-146m	5	2	3 ± 2
Pm-147m	60	3	13.5 ± 0.6
Pa-231	82	3	2.4 ± 0.6
Np-237	60	3	0.013 ± 0.003
Pu-241	60	3	17.1 ± 1.4
	91	4	70 ± 20
Cm-242	15	5	1.2 ± 0.4

TABLE 12. Summary of data for radionuclide concentrations in sediment sample IAEA-368
(Reference date: 1 January 1990, Bq kg^{-1} dry weight)

Radionuclide	Range of accepted values	Median of accepted values	Confidence interval (α=0.05)
Cobalt-60	0.3-1.2	0.6	0.5-0.7
Europium-155	2-6.6	3.8	3.4-4.3
Lead-210	10.2-37.2	23.2	19.8-27.2
Radium-226	13.3-30.7	21.4	20.3-22.6
Uranium-238	18.5-41.2	31	25-33
Plutonium-238	6.1-9.9	8.5	7.6-8.9
Plutonium-239+240	18.5-39.2	31	29-34
Information values			
Potassium-40	0.5-13.1	5.4	5-8
Strontium-90	0.18-8.6	1.8	0.45-6.9
Caesium-137	0.12-0.5	0.34	0.2-0.44
Thorium-228	0-2	1	0-2
Thorium-230	24.1-28	26.7	-
Thorium-232	0.06-2.3	0.3	0.06-2.3
Uranium-234	21.5-44.8	35.7	21.5-44.8
Uranium-235	1-4	1.9	1.6-2.6
Americium-241	0.8-1.9	1.3	1.2-1.5

Remarks: 1. The confidence interval is the confidence limit at 95% significance level
2. Lead-210 and Polonium-210 are considered to be in equilibrium

ANNEX

List of participating laboratories

Dr. Stephen A. Short, Manager
Environmental Radiochemistry Lab.
Australian Nuclear Science and
and Technology Organisation
Private Mail Box 1
Menai, N.S.W. 2234
Australia

Dr. E. Henrich
BALUF Wien
Abt. 14/Strahlenschutz
Berggasse 11
A-1090 Wien
Austria

Dr. F.J. Maringer
BVFA Arsenal
Geotechnisches Institut
Isotopengeophysik
Faradaygasse 3
A-1030 Wien
Austria

Dr. H. Vanmarcke
C.E.N/S.C.K
Boeretang 200
B-2400 Mol
Belgium

Dr. Ieda I.L. Cunha
IPEN-CNEN/SP
Rua do Matao
Trav. R No.400 - CEP 05508
Caixa Postal 11049 (Pinheiros)
Sao Paulo
Brazil

Dr. Kleber Ribeiro Cosenza
Furnas Centrais Eletricas S.A.
Depart. de Geracao de Angra.
DGA.N -DNPA.N-Setor Ambiental 1.
Rod. Rio Santos Km132 - CEP 23.900
Angra dos Reis - Rio de Janeiro
Brazil

Dr. Luzia Venturini
Environmental Monitoring Division
Dept. of Radiological Protection
IPEN-CNEN-SP- NP NPA
Caixa Postal 11049 - Pinheiros
05499 Sao Paulo - SP
Brazil

Ms. M.E. Vianna
Instituto de Radioprotecao
Depto. de Protecao Radiologica Amb.
Av. Americas km 11.5
Caixa Postal 37750 - RJ
22602 - Barba da Tijura
Brazil

Dr. A. Kudo
Senior Research Officer
and Visiting Professor
National Research Council of Canada
100 Sussex Drive
Ottawa, Ontario K1A OR6
Canada

Dr. Richard Nelson
Bedford Institute of Oceanography
Dept. of Fisheries and Oceans
Marine Chemistry Division
P.O. Box 1006
Dartmouth, N.S.
Canada B2Y 4A2

Dr. John Tai-Pow
Ontario Ministry of Labour
Radiation Protection Service
81 Resources Road
Weston, Ontario
M9P 3T1
Canada

Dr. L. Zikovsky
Ecole Polytechnique
C.P. 6079, Succ. "A"
Montréal, QC
H3C 3A7
Canada

Dr. Shaoming Pan
Department of GEO & OCEAN Services
Nanjing University
Nanjing 210008
China, People's Republic of

Dr. Zhu Shuzhong
Institute of Atomic Energy
P.O. Box 275-20
Beijing
China, People's Republic of

Dr. T. Bouda
Research and Development Institute
of Czechoslovak Uranium Industry
Central Laboratories
CS-471 27 Straz pod Ralskem
Czechoslavakia

Dr. A. Slavik
V Ú J E
Nuclear Power Plants
Research Institute
919 31 Jaslovske Bohunice
Czechoslovakia

Dr. Denisa Nikodemova, CSC
Research Institute of
Preventive Medicine
Limbova 14
CS-833 01 Bratislava
Czechoslovakia

Dr. I. Malatova
Laboratory of Spectrometry
Centre of Radiation Hygiene
Institute of Hygiene and Epidem.
Srobarova 48
Praha 10
Czechoslovakia

Dr. A. Aarkrog
Health Physics Department
Riso National Laboratory
DK-4000 Roskilde
Denmark

Mr. Jacques Bernard
DERS/Section de Radioécologie
CEN Cadarache
F-13108 Saint Paul-les-Durance
France

Dr. M.Lafon
Marine Nationale
Sect. de Surveillance Radiologique
B.P.61
83800 Toulon
France

Dr. P. Germain
Lab. de Radioécologie Marine
CEA - Centre de la Hague
Institut de Protection et
de Sûreté Nucléaire
F-50107 Cherbourg
France

Dr. Sabine Charmasson
IFREMER - Centre de Toulon
CEA - S.M.T.
B.P. 330
83507 La Seyne-sur-mer
France

Mr. Y. Bourlat
CEA/DIRCEN
SMSR
B.P. 16
F-91311 Montlhéry Cédex
France

Mr. C. Poletiko
CEA - IPSN
Lab. d'Etude et de Surveillance de
l'Environnement
B.P. 519
Papeete
French Polynesia

Dr. G. Kanisch
Bundesforschungsanstalt für fisher.
Labor f. Radioökologie der Gewässer
Wüstland 2
D-2000 Hamburg 55
Germany

Dr. Hans-Ulrich Fusban
Institut f. Wabohu-Hygiene
Labor BI 2
Corrensplatz 1
D-1000 Berlin 33
Germany

Dr. Harmut Nies
Federal Maritime and Hydrographic
Agency
Bernhard-Nocht-Straße 78
Postfach 30 12 20
D-2000 Hamburg 36
Germany

Dr. M. Rossbach
Institute of Applied Physical Chem.
Nuclear Research Centre - Jülich
D-5170 Jülich
Germany

Prof. Dr. med. Edmund Lengfelder
Strahlenbiologisches Institut
der Universität München
Schillerstrasse 42
D-8000 München
Germany

Dr. J. Thiele
National Board of Nuclear Safety
and Radiation Protection
Waldowallee 117
D-1157 Berlin
Germany

Dr. Wolfgang Staede
Niedersaechsisches Landesamt
für Wasser und Abfall
an der Scharlake 38
Postfach
D-3200 Hildesheim
Germany

Prof. Dr.-Ing. Rieder Schelenz
Kernforschungszentrum Karlsruhe
BFE, BAU 325
Postfach 3640
D-7500 Karlsruhe 1
Germany

Ms. H. Florou
NCRPS "Democritos"
Institute of Nuclear Technology
Environmental Radioactivity Lab.
P.O. Box 60228
15310 Aghia Paraskevi - Athens
Greece

Dr. Agota Ugron
National Research Institute for
Radiobiology and Radiohygiene
P.O. Box 101
H-1775 Budafok 1
Hungary

Dr. Peter Zombori
Central Research Institute for
Physics of the Hungarian Academy
of Sciences - Health Physics Dept.
P.O. Box 49
H-1525 Budapest 114
Hungary

Ms. Stephanie Long
Nuclear Energy Board
3 Clonskeagh Square
Clonskeagh Road
Dublin 14
Ireland

Dr. M. Terrani
Istituto di Ingegneria Nucleare
Politecnico di Milano
Via Ponzio 3413
20133 Milano
Italy

Dr. T. Kimura
Japan Chemical Analysis Centre
295-3 Sanno-cho
Chiba-Shi
Chiba 281
Japan

Dr. S. Ballestra
International Atomic Energy Agency
Marine Environment Laboratory
19, Avenue des Castellans
MC-98000 Monaco
Monaco principality

Dr. A.W. van Weers
Netherlands Energy Research
Foundation ECN
Westerduinweg 3 - Postbus 1
NL-1755 ZG Petten
Netherlands

Dr. G.W. Berger
Netherlands Institute for
Sea Research(N.I.O.Z.)
P.O.Box 59
1790 AB Den Burg
Netherlands

Dr. H.W. Köster
Project Coordinator
RIVM - Lab. for Radiation Research
P.O. Box 1
3720 BA Bilthoven
Netherlands

Dr. G.C. Christensen
Institute for Energy Technology
Health and Safety Department
P.O. Box 40
N-2007 Kjeller
Norway

Mr. Jose Manuel Osores Rebaza
Instituto Peruano
de Energia Nuclear
Avenida Canada 1470
San Borja, Apartado 1687
Lima 13
Peru

Dr. Flora Santos
Philippine Nuclear Research Inst.
Don Mariano Marcos Ave.
Diliman, Quezon City
Philippines

Dr. A. Pietrusziewski
Central Laboratory for Radiological
Protection
Department of Dosimetry
Konwaliowa 7
03-194 Warsaw
Poland

Dr. R. Bojanowski
Institute of Oceanology - PAN
ul. Powstancow Warszawy 55
81-967 Sopot
Poland

Mr. W. Walkowiak
Instytut Chemie Inorganicznej
Metallurgii Pierwiastkow Rzadkich
Politechniki Wroclawskiej
Wybrzeze St. Wyspianskiego 27
50-370 Wroclaw
Poland

Dr. A. Ortins de Bettencourt
LNETI
Dept. de Protec. e Segur. Radiolog.
Estrada Nacional No.10
2685 Sacavem
Portugal

Dr. I. Popescu
Institute for Nucl. Power Reactors
Environmental Monitoring Laboratory
P.O. Box 78
0300 Pitesti
Romania

Dr. I.I. Georgescu
Polytechnic Institute
"Georghe Georghiu-Dej"
Faculty of Chemical Engineering
Bucharest
Romania

Dr. Iolanda Osvath
Environmental Radioactivity
Research Laboratory
Inst. of Meteorology and Hydrology
P.O. Box 11, C.P. 11-2
Bucharest
Romania

Dr. M. Salegean
Institute for Physics and
Nuclear Engineering
P.O. Box MG-6
Bucharest
Romania

Mr. Ovidiu Ferdes
Scientific Research.
Institute of Food Chemistry
Str. Girlei No.1, Sect.1
Bucharest
Romania

Dr. R.J.N. Brits
Council for Nuclear Safety
P.O. Box 7106
Hennopsmeer 0046
South Africa

Mr. B. Marshall
Koeberg Nuclear Power Station
Environmental Survey Laboratory
Private Bag X10
7440 Kernkrag
South Africa

Dr. C. Gasco Leonarte
CIEMAT (P.R.Y.M.A.) ED.3
Av. de la Complutense 22
28040 Madrid
Spain

Dr. I. Valles
Instituto de Tecnicas Energeticas
Univers. Politecnicas de Barcelona
Diagonal 647, ETSIIB
8028 Barcelona 28
Spain

Dr. J.A. Sanchez-Cabeza
Servei de Fisica de les Radiacions
Universitat Autonoma de Barcelona
Environmental Radioactivity Lab.
08193 - Bellaterra (Barcelona)
Spain

Dr. Juan Palomares Lopez
Jefe Seccion Analisis y Medidas
Av. de la Complutense, 22
Ciudad Universitaria
28040 Madrid
Spain

Dr. Elis Holm
Radiation Physics Department
Lasarettet
Lund University
S-221 85 Lund
Sweden

Dr. Georg Neumann
Statens Naturvardsverk
National Swedish Environment
Protection Board
Department of Coastal Water
S-170 11 Drottningholm
Sweden

Ms. Judith Melin, Division Head
National Institute of Radiation
Protection
Environmental Laboratories
P.O. Box 60204
S-104 01 Stockholm
Sweden

Dr. F. Sinakhom
Office of Atomic Energy for Peace
Env. Radiation Poll. Studies Sect.
Waste Disposal Division
Vibhavadee Rangsit Road
Bangkok 10900
Thailand

Ms. Pornsri Polphong
Radiation Measurement Division
Office of Atomic Energy for Peace
Vibhavadee Rangsit Road, Bangkhen
Bangkok 10900
Thailand

Dr. B.R. Harvey
MAFF
Directorate of Fisheries Research
Pakefield Road
Lowestoft, Suffolk NR33 OHT
UK

Dr. D.M. Smith
N.R.P.B.
Scottish Centre
155 Hardgate Road
Glasgow, G51 4LS
UK

Dr. James Gemmill, chemist
Department of Regional Chemist
Public Analyst and
Agricultural Analyst
8 Elliot Place
Glasgow G3 8EJ
UK

Mr. P. Fannon, Leader
U.K.A.E.A.
Dounreay Nuclear Power
Caithness
UK

Dr. J. Toole
Environm. & Medical Sciences Div.
AEA Technology
Harwell Laboratory
Didcot
Oxfordshire OX11 ORA
UK

Dr. M. Williams
Cardiff City Analysts
Crofts Street
Cardiff CF2 3DY
South Wales
UK

Mr. M.J. Youngman
National Radiological
Protection Board
Chilton, Didcot
Oxfordshire OX11 ORQ
UK

Mr. I.P. Los
All-Union Scientific Centre
of Radiation Medicine
Medical Academy
Melnikova 53
Kiev 50 - 252050
UKSSR

Dr. Carlos Kremer
Catedra de Radioquimica
Facultad de Quimica
Casilla de Correo 1157
Montevideo
URuguay

Dr. I.L. Larsen
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, TN 37831-6036
USA

Dr. James B. Moore
QC Coordinator
Environmental Protection Agency
1504 Avenue A
Montgomery, AL 36115-2601
USA

Dr. K.M. Wong
Lawrence Livermore National Lab.
P.O. Box 808
7000 East Avenue
Livermore, CA 94550
USA

Dr. Liaquat Husain, Rm. D345
Laboratory of Inorganic
and Nuclear Chemistry
Wadsworth Center for Labs. & Res.
Empire State Plaza - P.O. Box 509
Albany, NY 12201-0509
USA

Dr. Shawki A. Ibrahim
Department of Radiology
339 MRB Building
Colorado State University
Fort Collins, Colorado 80523
USA

Dr. Evgeny G. Vertman, Head
Polytechnic Institute
Geological Faculty
30 Lenin Prospect
634004 Tomsk
USSR

The Director
Universidad Simon Bolivar
Laboratorio de Fisica Nuclear
Barula Valle de Sartenegas
Apartado Postal 80659
Caracas 1080
Venezuela

Mr. Pham Quang Dien
Viet Nam National
Atomic Energy Commission
67 Nguyen Du
Hanoi
Viet Nam

Dr. Alica Bauman
Inst. Med. Research & Occ. Health
Department of Radiation Protection
Mose Pijade 158 - P.O. Box 291
41001 Zagreb
Yugoslavia

Dr. Istvan Bikit
Institute of Physics
Ilije Duricica 4
21000 Novi Sad
Yugoslavia

Dr. M. Korun
Nuclear Institute "Jozef Stefan"
Jamova 39
P.O. Box 100
YU-61111 Ljubljana
Yugoslavia

Dr. Miran Kanduc, Head
Zavod SRS za varstvo pri delu
Bohoriceva 22A
YU-61000 Ljubljana
Yugoslavia

Dr. Stjepan Lulic
Institute "Rudjer Boskovic"
Bijenicka 54
P.O. Box 16
YU-41001 Zagreb
Yugoslavia

Prof. Dr. Ranko Kljajic, Head
Institute for Radiology
and Physical Therapy
Vojvode Putnika 134
YU-71000 Sarajevo
Yugoslavia