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Radioactivity of ground-level air in Poland in 1998–1999. Results from ASS-500 stations network

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Abstract The results of measurements of aerosol samples in the 1998–1999 period in the monitoring network of the ASS-500 stations in Poland are presented. The concentration of ^{137}Cs remained at a rather low level during these two years. Higher levels resulting from the Algeciras release in southern Spain were identified in the first week of June 1998 at four stations situated in southern Poland. Higher concentrations of ^{137}Cs were also observed during some other weeks of the presented period, but their origin has not been identified. The radionuclides of natural and antrophogenic origin were at their normal levels of activity. For comparison, the results from some other European stations are presented.

Key words air • high-volume samplers • radionuclides

Introduction

The ASS-500 stations network was established for performing of the measurements of artificial radioactive aerosols released from the world nuclear industry. The routine monitoring of artificial and some natural radionuclides in the air of the two years period (1998–1999) was performed in the network in the normal radiological situation. At the Dosimetry Department of CLOR monthly and quarterly reports on this monitoring were prepared for the National Atomic Energy Agency in Poland and also sent to the Integrated Measurement and Information System (IMIS) in Germany.

Methods

The aerosol sampling stations, high-volume samplers type ASS-500, were located in Warszawa, Świder, Kraków, Białystok, Katowice, Lublin, Gdynia, Wrocław, Szczecin and Sanok. The air was pumped through a Petrianov filter FPP-15-1.5. The filter was exchanged every Monday or Tuesday at 12:00. The filtered air volume ranged from 20 000 to 115 000 m^3, and the sampled mass of dust varied between 1 and 10 g. The loaded filtration web of the filters was pressed into tablets of about 5 cm in diameter and mean thickness of 3.9 mm.

The γ-spectrometric measurements of radioactivity collected on the filters from 9 sites were performed by means of high-purity germanium (HPGe) detectors of 10–40% relative efficiencies. At one site a 5% Ge/Li detector was used. A standard source of OBRI Świerk production was used for calibration purposes. Concentrations of the analized radionuclides in air, which were lower than the detection

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limit LLD (confidence level 70%) were arbitrarily assumed to be equal to the LLD values. The uncertainties of concentrations given in the text in brackets are standard deviations. In statistical evaluations of the annual mean concentrations (in Table 1 and in the text) the standard error of the mean is presented.

Results and discussion

A summary of the measured concentrations of ^{131}I, ^{137}Cs, ^{7}Be ^{40}K, ^{210}Pb, ^{226}Ra and ^{228}Ra in ground-level air in Poland is presented in Table 1.

The presence of ^{131}I in the air in Poland is detected occasionally. The highest concentrations in Poland in the 2 years amounted to 7.5(±7%) μBq/m^3 and 4.7(±6%) μBq/m^3 and were found in the third week of 1999 at the stations at Świder and Szczecin. Thanks to the international exchange of data during the years 1998–1999 the Dosimetry Department CLOR has received and stored in its archives many communications on air contamination. The communications have been got from the Ring of 5 Group; the Republican Centre of Radiation and Environment Monitoring in Minsk, Belarus; the Pysikalish Technische Bundesanstalt in Braunschweig, Germany; the Federal Office of Public Health, Division of Radiation Protection in Fribourg, Switzerland; the "Fodor József" Public Health Center, "Frederic Joliot-Curie" National Research Institute for Radiobiology and Radiohygiene in Budapest, Hungary; the Ministry for Environment and Natural Resources in Kiev, Ukraine, and also the Radiation and Nuclear Safety Authority [1] in Helsinki, Finland. The obtained data have revealed that ^{131}I in the air in Europe in 1998–1999 have been detected at least in 94 measurements. The lowest concentration of 0.2(±20%) μBq/m^3 was measured after a 7-day sampling in Lublin (Poland), the highest value of 38.5(±9%) μBq/m^3 after a 2-day sampling in Budapest.

Table 1 shows that the annual mean concentration of ^{137}Cs in 1998 was a little bit higher (statistically not significant) than in 1999. The reason was not only the higher – of unknown origin – maximum concentration of 31.0(±9%) μBq/m^3, but also higher levels ranging from 12.7(±3%) μBq/m^3 to 22.5(±4%) μBq/m^3 measured in the first week of June 1998 at four stations situated in southern Poland. According to the saved communications from the Ring of 5 Group the source of the latter levels was an accidental release of ^{137}Cs from a steel plant in Algeciras near to Gibraltar at the end of May 1998.

The annual mean concentrations of the natural radionuclides were very similar. Only the ^{226}Ra data exhibited a lower value in 1999. According to the two-sided t-test, the difference was statistically significant at $\alpha = 0.01$. This difference was mainly caused by the measurements done at the station in Katowice (see Table 1). The annual mean concentration of ^{226}Ra at this station dropped from 22.3±1.4 μBq/m^3 in 1998 to 11.6±1.9 μBq/m^3 in 1999 at constant annual mean dustiness (55.7±3.2 μg/m^3 in 1998 and 65.2±3.2 μg/m^3 in 1999). On the other hand, the drop coincided with the installation – in May 1999 – of a more sensitive HPGe detector and a modern, automatic and accurate computer software for peak identification and calculations of activities and the lower limits of detection (LLD). Thus it cannot be excluded, that the drop was of methodological origin.

The above mentioned communications on air contamination in Europe were also very helpful in evaluation of our own measurement results. Table 2 contains the minimum and maximum values of concentrations, which were measured at the particular sites. It can be seen that the results of measurements performed within the Polish network are consistent with the result of other countries. The detailed information on ground-level air radioactivity in Poland and some European countries can be found in Ref. [2].

Conclusion

Continuous monitoring of radioactivity in the air gives not only the information on the abnormal radiological situations caused by releases of the artificial radioactivity from the nuclear industry, but also delivers valuable data on the natural radioactive background in Poland.

Table 1. Concentration of ^{137}Cs, ^{131}I, ^{7}Be, ^{40}K, ^{210}Pb, ^{226}Ra and ^{228}Ra in ground-level air, Poland, 1998–1999.

Radionuclide	Year	Concentration, μBq/m^3 Annual Mean	Min.	Max.	Number of samples	Sampling site and the week with the highest concentration
^{137}Cs	1998	1.8±0.1	<0.1	31.0	507	Świder, 6.04 - 14.04, 1998
	1999	1.6±0.1	<0.1	16.3	525	Świder, 14.06 - 21.06, 1999
^{131}I	1998	0.6±0.01	<0.1	<3.5	507	Sanok, 23.11 - 30.11
	1999	0.6±0.02	<0.06	7.5	525	Świder, 11.01 - 18.01
^{7}Be	1998	2800±50	470	6020	507	Wrocław, 4.05 - 11.05
	1999	2910±60	500	9380	525	Katowice, 17.05 - 24.05
^{40}K	1998	18.4±0.6	<2.3	111.2	507	Wrocław, 17.08 - 24.08
	1999	18.7±0.5	<2.5	86.2	525	Sanok, 29.03 - 5.04
^{210}Pb	1998	399±15	46	1935	316	Sanok, 30.11 - 7.12
	1999	398±12	71	1189	317	Sanok, 22.11 - 29.11
^{226}Ra	1998	9.0±0.4	<1.3	64.8	507	Katowice, 26.01 - 2.02
		7.5±0.3	*<1.3*	*46.5*	*455*	*Lublin, 21.09 - 28.09*
	1999	7.4±0.3	<1.4	69.0	525	Świder, 23.08 - 30.08
		7.0±0.3	*<1.8*	*69.0*	*472*	*Świder, 23.08 - 30.08*
^{228}Ra	1998	1.8±0.06	<0.3	9.5	507	Sanok, 17.08 - 24.08
	1999	2.1±0.08	<0.3	15.6	525	Katowice, 19.04 -26.04

Italics: Without the ^{226}Ra data from the station in Katowice.

Table 2. Comparison of ranges of concentrations of ^{137}Cs, ^{7}Be, ^{40}K, ^{210}Pb and ^{131}I in air, $\mu Bq/m^3$, obtained in Poland and in some European countries, 1998 and 1999.

Site	Year	^{137}Cs	^{7}Be	^{40}K	^{210}Pb	^{131}I
Finland [1]	1998	0.2-17.2 n=293	600-7500 n=293	–	–	<0.2-5.9 n=293
	1999	0.12-21.6 n=255	380-5840 n=255	–	–	<0.2-<5.8 n=255
Belarus, Pinsk	1998	4.2-32.8 n=32	670-5220 n=32	<0.2-54.3 n=32	129-1966 n=32	–
	1999	1.6-41.5 n=33	260-3470 n=33	18.4-76.2 n=33	193-1361 n=33	–
Ukraine, Rivne	1998	*8.6*	*2810*	*55.7*	–	*2.5*
	1999	3.6-6.7 n=8	990-2780 n=8	–	–	<1.2-3.4 n=8
Germany, Braunschweig	1998	0.1-4.3 n=52	1500-6300 n=52	3.4-12.4 n=52	81-879 n=52	–
	1999	0.1-2.3 n=53	1280-8420 n=53	3.0-45.9 n=53	79-1261 n=53	–
Hungary, Budapest	1998	0.3-34.5 n=51	1200-5220 n=51	–	170-1370 n=51	<0.5-32.0 n=51
	1999	0.1-2.5 n=52	1000-5640 n=52	–	130-1370 n=52	<0.3-38.5 n=52
Switzerland	1998	0.4-150 4 stations	1010-4720 4 stations	–	–	–
	1999	0.07-2.7 n=156	660-5720 n=156	–	82-1500 n=156	<0.3-11.0 n=156
Poland	1998	<0.1-31.0 n=507	470-6020 n=507	<2.3-111.2 n=507	46-1935 n=316	<0.06-<3.5 n=507
	1999	<0.1-16.3 n=525	500-9380 n=525	<2.5-86.2 n=525	71-1189 n=317	<0.06-7.5 n=525

n – number of the sampling sites

The Finland, Switzerland and Poland data refer to more than one sampling site. The Finnish data refer to different sets of sampling sites in the 2 years. For some sampling sites in Finland, and for Pinsk and Rivne not every week in the years is represented. The 1998 data for Ukraine are annual mean values.

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