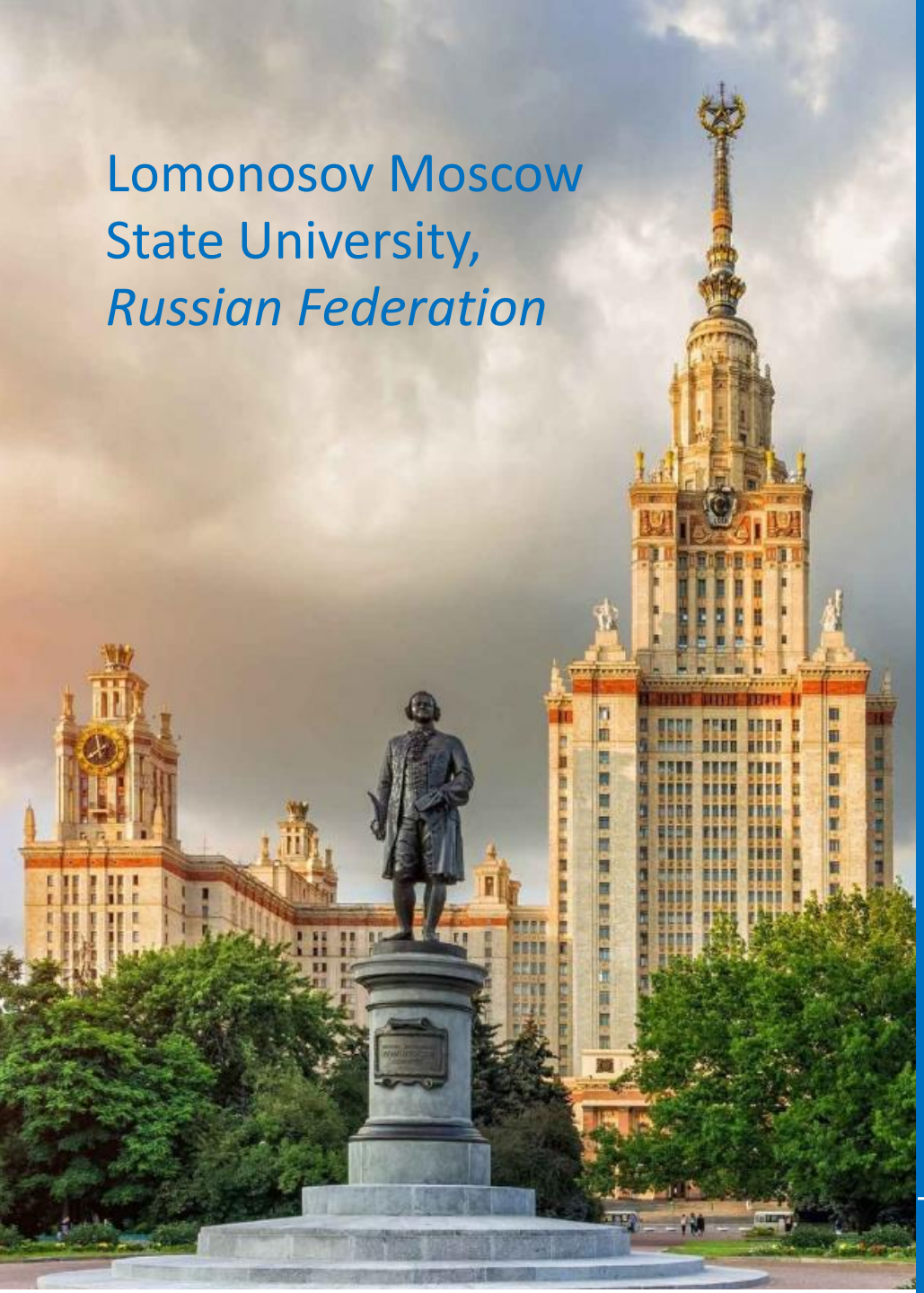

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Study of fallouts in the bottom sediments of Chernobyl Nuclear Power Plant cooling pond

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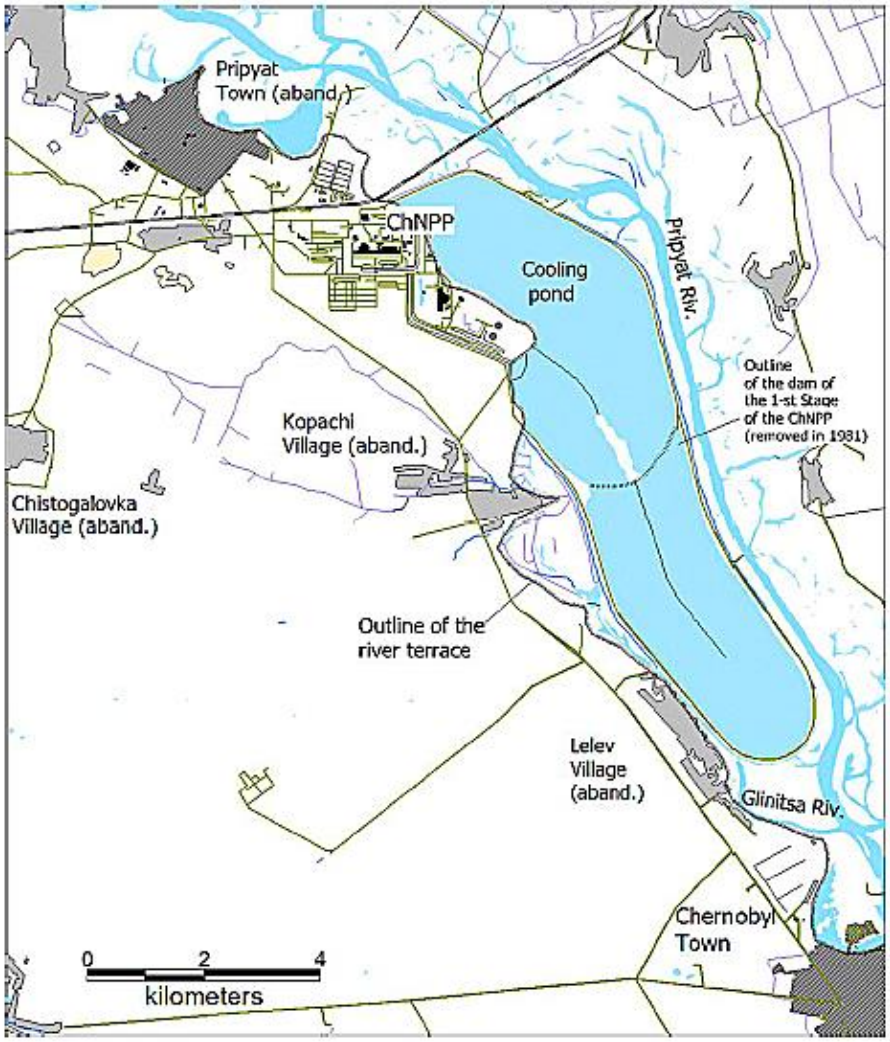
Background

The cooling pond of the Chernobyl Nuclear Power Plant (ChNPP) represents an artificial reservoir, which was constructed on the floodplain of the Pripyat River to the southeast from the power plant. When ChNPP Units 3 and 4 where put into operation, the area of the pond constituted ~22km^2.

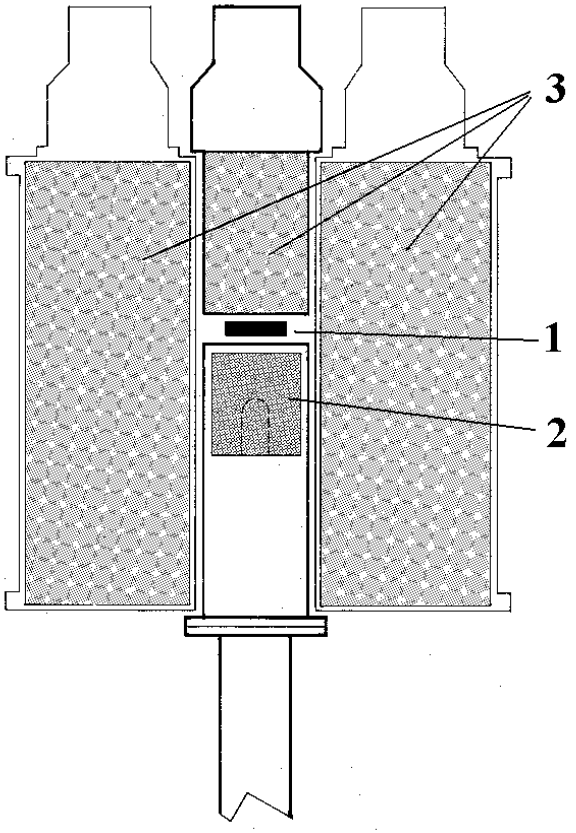
The operational water level in the pond was by 7 m higher than in the adjacent Pripyat River. The dam and sandy bottom of the pond was not isolated at time of construction by any low permeability lining. This engineering design resulted in large seepage losses from the pond of an order of ~100×10^6 m^3/year. The water level in the pond was maintained by constantly pumping water from the Pripyat River.



Materials and Methods

Samples were taken from different points of the cooling pond in the form of cores to a depth of 30 cm:

- two layers of 2 cm,
- two layers of 3 cm, and
- four layers of 5 cm each.



Measurements with Anti-Compton spectrometer:

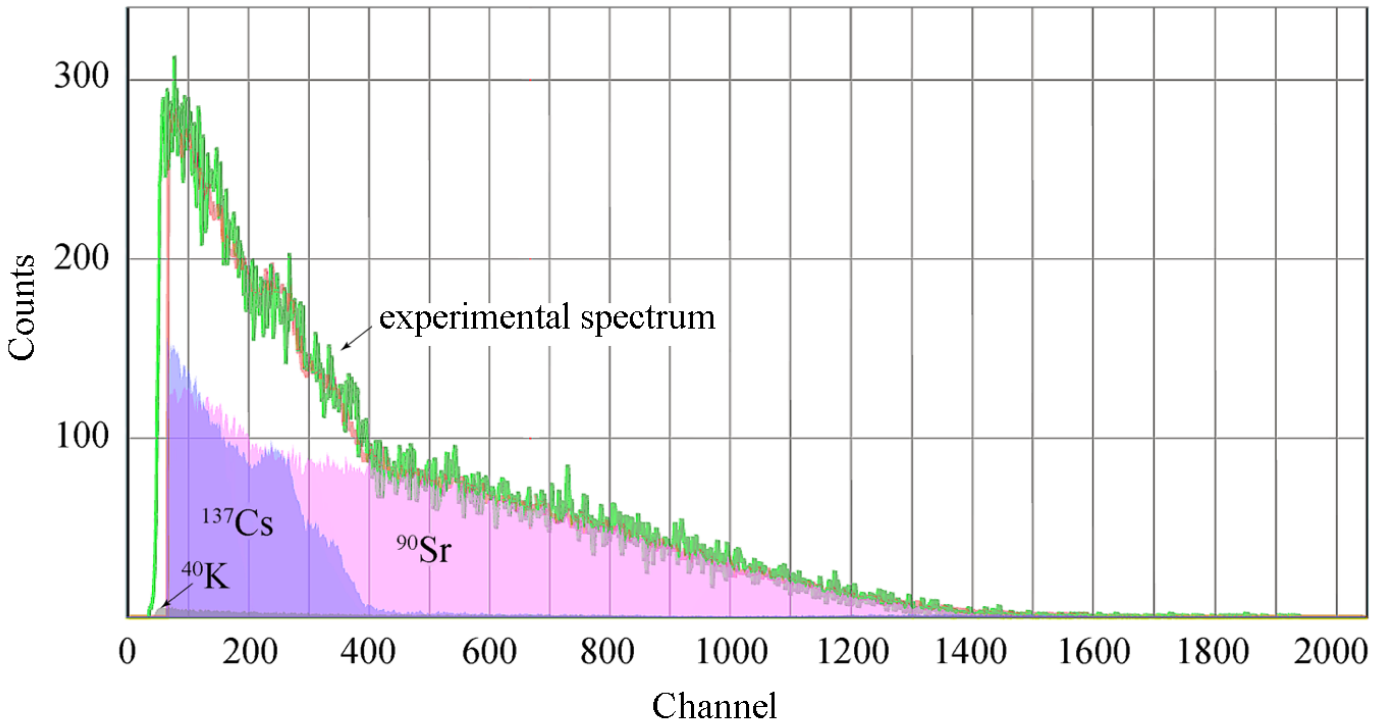
1 - measured sample,

2 - HPGe-detector,

3 - NaI (Tl)-detectors of active protection

Materials and Methods

The Strontium-90 specific activity in the samples was determined with a SEB-50 beta-spectrometer.



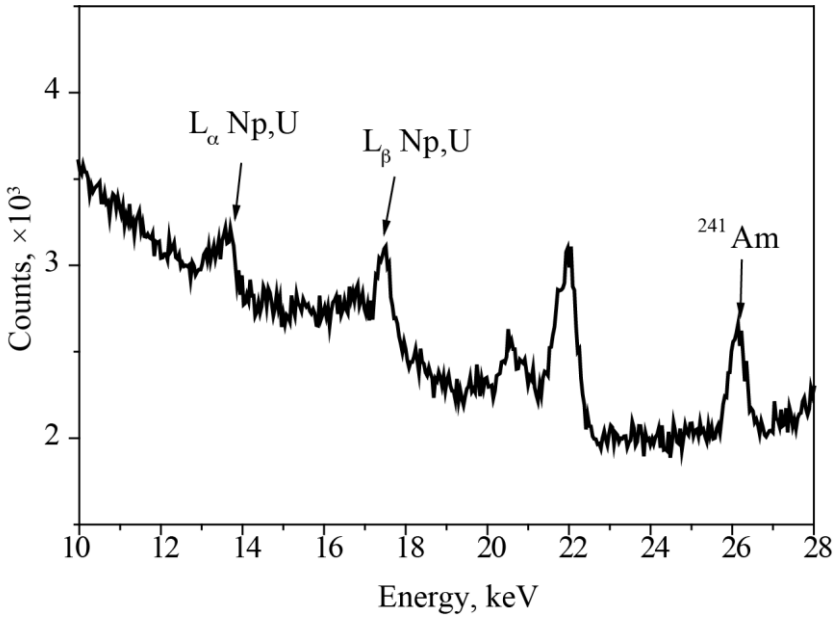
V. A. Zheltonozhsky, M. V. Zheltonozhskaya, M. D. Bondarkov, E. B. Farfán Spectroscopy of radiostrontium in fuel materials retrieved from the Chernobyl nuclear power plant. Health Physics. 2021. Vol. 120, no. 4. P. 378–386.

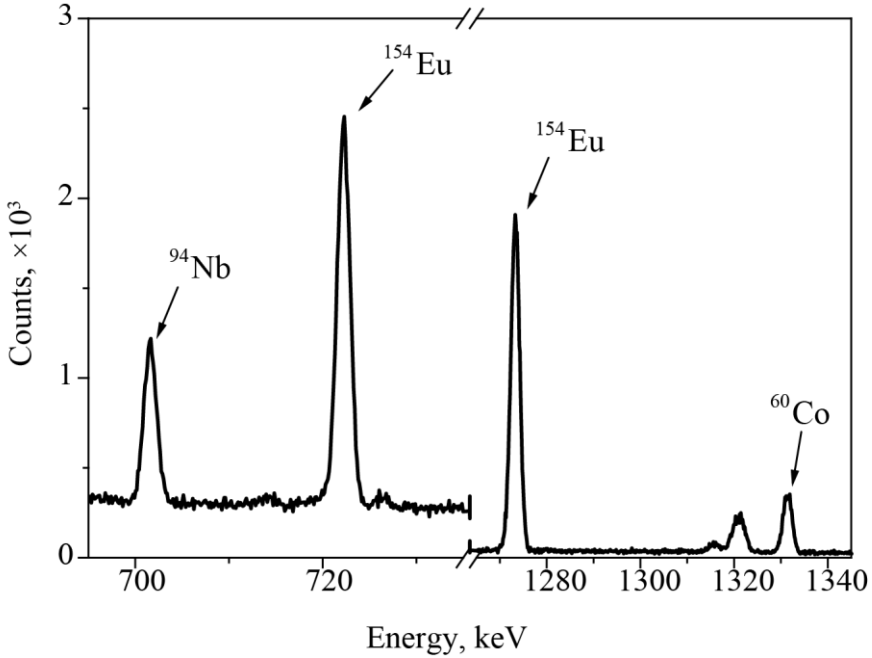
Results and discussion

Fragments of gamma-spectrum of bottom sediments of the cooling pond sampled at a depth of 10-15 cm:

(a) for the energy range of 0-120 keV,

(b) (b) for the energy range of 690-740 keV and 1270-1340 keV.





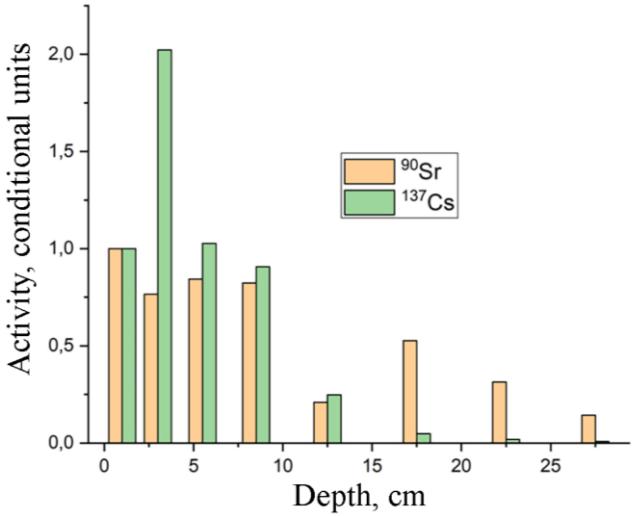
Results and discussion

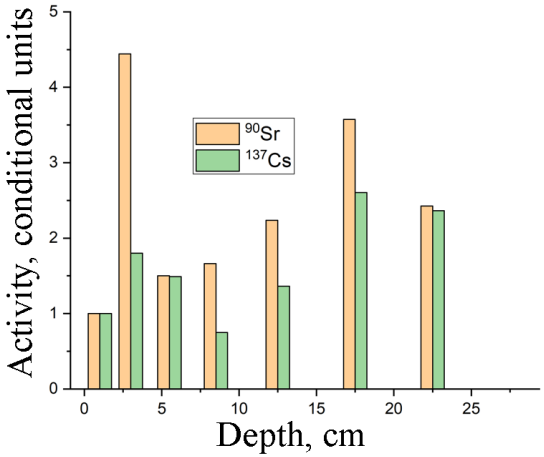
Depth distribution of ^{90}Sr and ^{137}Cs in the studied samples of the cooling pond sediments

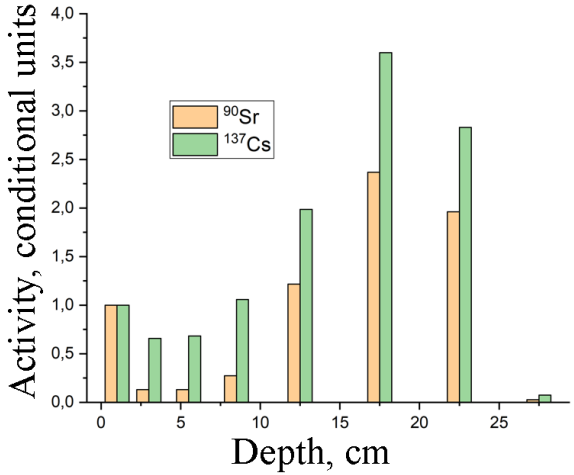
Depth, cm	Samples from the shoreline of the cooling pond		Cooling pond bottom sediments			
	^{90}Sr	^{137}Cs	^{90}Sr	^{137}Cs	^{90}Sr	^{137}Cs
1	765	3760	1520	2050	680	2750
3	586	7600	200	1350	3020	4950
5.5	645	3860	200	1400	1020	4100
8.5	630	3410	415	2170	1130	2060
12.5	160	930	1850	4070	1520	3750
17.5	403	180	3600	7380	2430	7160
22.5	240	70	2980	5800	1650	6500
27.5	110	30	40	150	0	0

Results and discussion

^{90}Sr and ^{137}Cs distribution in ChNPP cooling pond samples to a depth of 30 cm (from left to right: 1- sediments from the coastline zone; 2-3 - bottom sediments).







Results and discussion

Activities of gamma-emitting radionuclides in the 15–20 cm layer of the bottom sediments of the cooling pond

Radionuclide	Activity (Bq/g) as of 05.2021 (×10²)	Recalculated activity (Bq/g) as of 04/26/1986 (×10²)
^{60}Co	0.92(8)	92
^{94}Nb	0.75(6)	0.75
^{134}Cs	0.057(7)	7300
^{137}Cs	6680(300)	15000
^{154}Eu	10.0(5)	168
^{155}Eu	1.68(9)	275
^{241}Am	246(12)	-
^{243}Am	0.51(5)	0.51
^{243}Cm	0.28(5)	0.64

Results and discussion

Results of radiochemical studies of bottom sediment samples from the 15-20 cm depth

Radionuclide	Activity (Bq/g) ($\times 10^2$)
^{137}Cs	3200
^{234}U	0.20(2)
^{236}U	0.032(6)
^{238}U	0.08(2)
^{238}Pu	26(4)
$^{239+240}Pu$	56(8)
^{242}Pu	0.10(3)
^{241}Am	107(4)
^{243}Am	0.20(4)
^{242}Cm	2.1(5)
$^{243+244}Cm$	0.12(2)

Conclusion

- Studies of the radionuclide composition and vertical distribution in the bottom sediments of the cooling pond are ongoing.
- Sediment cross-sections were found with the deposited primary activity at a depth of 10-20 cm. Analysis of the radionuclides ratios shows that these fallouts are associated with the first explosion of the 4th power unit of the Chernobyl nuclear power plant.
- In contrast, precipitation at a 0-10 cm depth is mainly associated with aerosol fallout deposition in subsequent years.
- Obtained as a result of alpha-spectroscopic studies, isotopic ratios of transuranium nuclides in bottom sediment samples are close to isotopic ratios in fuel materials from the ChNPP 4th power unit.