^{129}I Measurements for a Reconstruction of the ^{131}I Releases in Mayak ◇

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Large amounts of fission products were released in the plutonium production facility Mayak (Russia) during the first decade of operation. Of these, ^{131}I ($T_{1/2}$= 8.02 d) is supposed to be the major radionuclide released to the atmosphere [1]. As a result, among the population of Ozyorsk, the city where most of the Mayak workers lived with their families, an elevated incidence of thyroid cancer was observed [2].

The long-lived ^{129}I ($T_{1/2}$= 15.7 Myr) can be used for a reconstruction of the ^{131}I emissions in Mayak. For the early years of operation the ^{129}I/^{131}I isotopic ratio at time of emission was calculated [5].

Because of a further rise in ^{129}I releases and a simultanous decrease in ^{131}I releases in the subsequent years without radiological significance, a time resoluted measurement of ^{129}I depositions is necessary to reconstruct the ^{131}I releases in Mayak. Glacier ice was used to obtain the necessary time information.

Measurements

^{129}I concentrations in an ice core from Belukha glacier (Sibirian Altai) [3] were analyzed by AMS. The samples covered the time range between 1941 and 2001. The chemical treatment of the samples and the AMS measurement are described elsewhere [7].

The ^{129}I deposited at Belukha glacier was released in the former Soviet reprocessing plants, in the European reprocessing plants and in the nuclear bomb tests.

An atmospheric transport model was used to separate the contribution of other reprocessing facilities from the ^{129}I deposition originating in Mayak. The obtained contributions to the ^{129}I deposition fluence at Belukha glacier from Mayak, Tomsk-7, Krasnoyarsk-26 and the european reprocessing facilities (Windscale/Sellafield, Marcoule and La Hague) are presented in Tab.1.

	Eur.	Mayak	Tomsk	Krasn.
start of operation	1951	1948	1956	1964
est. ^{129}I rel. [GBq]	2400	890	120	150
contr. [%]	8	42	34	16
contr. [10^{12} $\frac{at}{m^2}$]	2,7	14,7	11,7	5,6

Table 1: Reprocessing facilities contributing to the ^{129}I deposition fluence at Belukha glacier: start of operation and estimated total release of ^{129}I. Contributions to the ^{129}I deposition fluence at Belukha glacier: european reprocessing facilities, Mayak, Tomsk-7 and Krasnoyarsk-26.

Due to the big distance between Windscale and Belukha glacier and the late start of operation in Tomsk-7 and Krasnoyarsk-26, the Mayak B-plant is the only reprocessing plant with considerable deposition at Belukha glacier till 1952.

A further possible source of ^{129}I is fallout from nuclear explosions. An ice core from Fiescherhorn glacier (Switzerland) showed only low ^{129}I input from global fallout [9]. The same ^{129}I deposition fluence from global fallout was assumed for Belukha glacier.

^{137}Cs as another fission product can be used to estimate the ^{129}I deposition in the Altai region from local fallout. ^{137}Cs deposition fluences in the Altai region show a bimodal distribution [8]. The lower peak fits the global ^{137}Cs fallout, the higher one is attributed to the local fallout from nuclear explosions at the Semipalatinsk test site (Kazakhstan) [8]. 2 soil samples taken at Ak-kem closed to Mt. Belukha do not show an elevated ^{137}Cs content [4]. Hence a considerable ^{129}I deposition from local fallout at Belukha glacier can be excluded.

The ^{129}I deposition fluence at Belukha glacier was determined to be $(3{,}7\pm1{,}1)\cdot 10^{10}\ \frac{at}{m^2}$ until 1952. ^{129}I measurement of an ice core from Fiescherhorn glacier (Switzerland) showed a decline in ^{129}I concentration with increasing altitude [6]. Assuming the same factor for the altitude gradient for Belukha glacier gives an ^{129}I deposition fluence at Belukha glacier of $(22\pm7)\cdot 10^{10}\ \frac{at}{m^2}$ till 1952.

Results

An ^{129}I release of 13 GBq can be deduced from the ^{129}I measurements at Belukha glacier for the early years of operation in Mayak. Corresponding to this, about 150 PBq of ^{131}I were released in the Mayak B-plant till 1952. This result exceeds present estimations [1] by about one order of magnitude. The current dose reconstruction for the Mayak-Children-Cohort (MCC) in Ozyorsk possibly underestimates the thyroid doses occured in the MCC.

References

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