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THE MONTE CARLO METHOD APPLIED TO COMPUTE THE ORGANISM IRRADIATION OF A GEOTHERMAL WATER OF AIN-FRANIN, ALGERIA

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Summary : The AIN-FRANIN geothermal source, located on the sea side near ORAN, west of Algeria, has been investigated for the organism irradiation by applying the Monte Carlo method. It has been concluded, the doses concerning the gamma irradiation are under the limits of the Safety Standards for Radiation Protection (1).

Introduction. The geothermal source of AIN-FRANIN has been investigated for gamma-radionuclides making use of a Ge(Li) detector coupled to a multichannel analyzer(1). Because some people take bath in this water, empirically for medicinal purposes, it was interesting to investigate the irradiation of the organism when the body is totaly immersed in this water.

Material and Methods. 60 liters of A-FR water by colloidal MnO_2 was treated in view to extract rapidly some natural radionuclides (2). The yield varied between 70-80% of the total radioactivity. After drying the MnO_2 precipitate at $65^{\circ}C$, it has been counted by means of a Ge(Li) detector coupled to a multichannel analyzer. The counting time was 16 hours.

For computer simulation by Monte Carlo method of the organism gamma irradiation, a cylindrical reservoir filled with water was modelled. In the center of the reservoir was placed a phantom which the composition is that of a tissue with density $\rho \sim 1\ g/cm^3$. The cylindrical reservoir has the height equal to 3 m and the radius 1 m. The water contains the natural radioactive series of Thorium-232 and of Uranium-238 respectively.

For each member of the radioactive series the gamma radiation emission was simulated according to the decay scheme. The generation of gamma radiation trajectory and their interaction with water and tissue was simulated with adequate algorithms(3,4).For eacn gamma radiation, the energy transferred to the tissue through one or more Compton scatterings and through absorption were summed.Whenever a gamma radiation leaves the reservoir or is absorbed,its history is over and another gamma radiation is generated.

Let E_{tr} be the transferred energy to the tissue; the report between the energy E_{tr} and the mass m of the tissue is equal to the absorbed dose D (5) :

$$D = E_{tr}/m$$

From the desintegration number of Th-232 or U-238 one can know the activity used for computer simulation. With the help of reservoir volume one determine the radioactive concentration of water; thus the constants for determination of organism gamma irradiation was obtained:

$^{232}Th \quad 0.81\times10^{-4}\ \frac{mrad/h}{pCi/l} \qquad ^{238}U \quad 1.2\times10^{-4}\ \frac{mrad/h}{pCi/l}$

Results and Discussion. With the found values of radioactive concentration for ^{232}Th (3.5 ± 0.2)pCi/l and ^{238}U $(2.3\pm1)\mu g/l$, one obtains for gamma irradiation of the organism :

$^{232}Th \quad 2.8\times10^{-4}$ mrad/h $\qquad ^{238}U \quad 0.52\times10^{-4}$ mrad/h

Conclusions. The values obtained are much below the admissible level (1). We think that alpha and beta irradiation can be neglected. The Standards of the Agency (1) give the maximum admissible concentration for a man during a year:

^{232}Th	200 Bq	i.e.	5 pCi/l		
^{238}U	2000 Bq		50 pCi/l	or	146 $\mu g/\ell$

in supposition that a man has a need of about 3 liters water per day (for drinking and cooking) i.e. about 1 m^3 water a year a man.

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