ABOUT USE OF A THERMOLUMINESCENT METHOD FOR INVESTIGATION OF DISTRIBUTION OF Pu^{238}, Pu^{239}, Pu^{240} RADIONUCLIDES IN GROUND NEAR TO RANGES OF KAZAKHSTAN

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Investigation of the environmental caused by activity of the people, and, mainly, pollution by radionuclides is one of the basic scientific-practical problems of mankind.

There are various methods of definition of the contents of radionuclides in natural objects. Direct methods of the microelement analysis of the radionuclides, based on the absorptive and radiating properties of substances are well developed at interaction with α, β-particles and the γ -radiation, irradiated by the radionuclides contained in objects of an environment: X-ray fluorescent, atom-emissive, EPR, NMR and NGR spectroscopy, radiochemical and other methods. At use of the listed methods the number of radiators and absorbents in a unit volume should be sufficient for direct registration by detectors of these devices. The above-stated methods of monitoring of radionuclides are applied basically on district where nuclear explosions were carried out.

The important question of radioecology is influence of consequences of nuclear explosions on alive organisms and the natural objects, which are taking place in tens and hundreds of kilometers from a place of explosion.

In works /1,2/ distribution of radionuclides in territory of Kazakhstan after accident of Chernobyl and explosions on range Lop Nor (China) was shown. Concentration of radionuclides in ground, stubs of trees, horns of animals, dental enamel of the person is much less than in zones of explosion. For revealing radionuclides in these objects the above-stated methods are inapplicable, as sensitivity of detectors is limited. Methods of EPR dosimetry and autoradiography are applied to definition of an absorbed doze and thermoluminescent dosimetry.

Advantage of these methods consists that under action of α-, β - particles and the γ - radiations, irradiated by radionuclides in dosimetric crystals for a long time, collect radiating defects. Concentration of defects should be not less than extreme registered size of detectors of devices. For example, in a method of autoradiography the tracks of the α - particles that have been saved up in express films are studied. For studying tracks by a microscope the films should adjoin to natural objects some months. And for definition of an absorbed doze in crystals by EPR method saved up radiating defects should be paramagnetic.

In a thermoluminescent (TL) method offered by us the radiation arising as a result of recombination of saved up defects is registered. The TL method is one of

the basic methods of research of a nature of the trapping centers in the irradiated crystals.

The essence of a method consists that in dosimetric crystals LiF-U, Al_2O_3 and $CaSO_4$-Dy, irradiated with the ionizing radiation at fixed temperature, are created the complementary electronic and hole trapping centers, i.e. defects. After end of an irradiation there are stable defects in a crystal. Concentration of stable defects is always proportional to intensity of external initiation (α-, β - particles and γ - radiation). Then the irradiated crystal heats up with constant speed. At fixed temperature electrons or holes relocate from the trapping centers and recombine with the hole and electronic trapping centers, accordingly. For example, as a result of recombination a relocated electron with the hole-trapping center the light quantum is irradiated. Intensity of optical radiation is always proportional to number of the saved up trapping centers.

On intensity of a thermoluminescence or on lightsum in TL band the size of an absorbed doze or concentration of external initiation (α-, β - particles) is estimated. Crystals such as LiF, Al_2O_3, $CaSO_4$, CaF_2 and others were for many years used as highly sensitive and bio equivalent TL dosimeters of the ionizing radiations (α-, β - particles, γ-, X-, UV-radiations). For example, the minimum registered doze of a dosimeter on the basis of crystal LiF-Mg, Cu, P makes $5 \cdot 10^{-7}$ Gr /3/. According to authors /4/ in irradiated x-ray and γ - beams in crystal LiF-U at room temperature the basic dosimetric peak is at 100-110 ˚C. Occurrence of TL peaks at 100-110 ˚C under the assumption of authors /4/ it is connected to electron trap on impurities U^{6+} and localization of holes as V_k the center near impurities U^{6+}.

For an estimation of an absorbed doze by natural objects we used highly sensitive TL method. Dosimetric crystal LiF-U is brought up in Institute of physics (Kyrgyzstan).

Dosimetric crystal LiF-U was irradiated with an isotope ^{239}Pu at room temperature. Then the crystal heated up in a vacuum cryostat with constant speed 0,15 - 0,2 deg/s. The recombination radiation arising at heating of a crystal was registered by a photoelectric method.

From figure 1 (the curve 1) it is visible, that in irradiated with an isotope ^{239}Pu crystal LiF-U at room temperature there are TL peaks with maxima at 90-100 ℃ and 180-200 ℃. Research has shown, that with increase of exposure time the basic dosimetric peak becomes TL peak with a maximum at 180- 200 ℃. At an irradiation by x-ray and γ - beams the TL peak precipitates out at 100-110 ℃, and in crystals LiF-U under influence of α - particles there is follow-up intensive peak with a maximum at 180-200 ℃. It speaks that under action of α - particles in crystal LiF-U there are other relaxation processes. New researches of defect formation in crystal LiF-U under action of - particles are required.

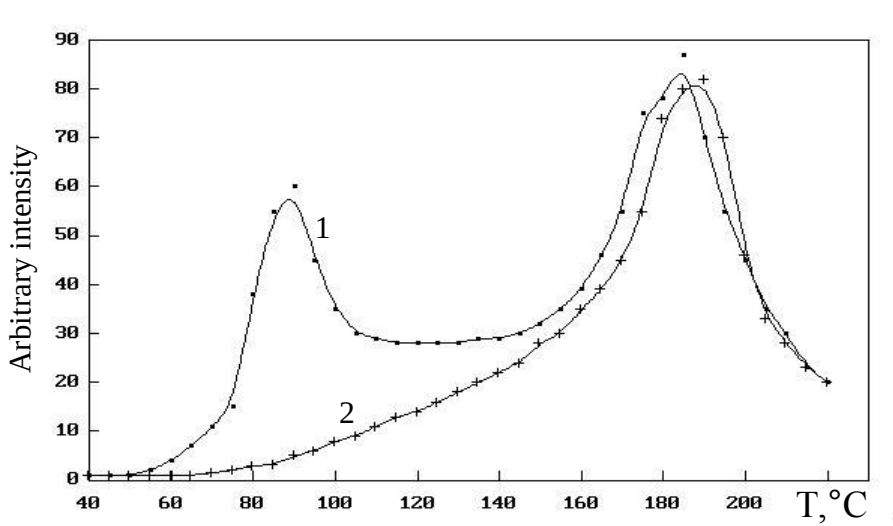

Figure 1. TL curves of irradiated crystal LiF-U at 300 K:
1-irradiated with α- particles (^{239}Pu) within 10 minutes;
2-irradiated with radionuclides saved up in annual rings stub of tree during three days.

For definition of an absorbed doze in annual rings of the tree brought from the West-Kazakhstan area, dosimetric crystal LiF-U was fixed on a surface of stub. It is known, that in annual rings of a tree radionuclides collect. In three day the crystal seats in a cryostat and TL is measured.

From figure 1 (the curve 2) it is visible, what there is one wide peak with a maximum 190-200 ˚C. Results of experiment have shown, that annual rings of trees irradiate α- particles and other accompanying radiations. Under action of these radiations in a crystal there are defects. On intensity of TL or on lightsum under TL curve it is possible to estimate size of an absorbed doze of trees or other natural objects.

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