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ADVANCED RADIOGRAPHY WITH ETCHED TRACK DETECTORS

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A brief review of the advanced radiographic techniques based on utilisation of etched track detectors will be presented. Recently a new technique of selective enhancement and evaluation of radiographic images in etched track detectors was developed. It is based on the image processing of individual image element units – etched tracks by a track analysis system. A selective radiograph is obtained on the basis of the assessment of the size and optical properties of individual tracks. The computer–generated image, in addition to its selectivity, which enables for instance, multi-elemental analysis from an autoradiograph, also offers a contrast enhancement for better visual observation and/or evaluation. The spatial resolution of a digital radiograph amounts to about 200 μm.

A method called radonography (radon autoradiography), based on difference of adsorption and diffusion coefficients of radon for different solids was developed. The specimen to be imaged is first exposed to a radon atmosphere for a few days to collect radon in the near surface layer. The specimen is then left in a radon free atmosphere for some hours to allow decay of the radon daughters plated out on the specimen surface during the exposure. Finally the specimen is placed in tight contact with a track etch detectors for some days to register alpha particles in the specimen. It was found that image contrast associated with the interfacial region of two materials characterised by adsorption coefficients k_a and k_b was estimated by a simple model to be proportional to $1-k_b/k_a$. The spatial resolution of the technique is about 30μm.

A high sensitive autoradiographic technique which enables detection of deposited radon decay products of 100 atoms /cm^2 with position precision of deposited radon decay product of $\mp$ 2 μm was developed and applied to understand the basic phenomena of the interaction of radon adsorption and deposition of its decay products with solid surfaces.

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INVESTIGATION OF RADIO-ECOLOGICAL SITUATION AT THE FORMER SEMIPALATINSK NUCLEAR TEST SITE BY NUCLEAR-PHYSICAL METHODS OF ANALYSIS

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In the report results of research of element and radionuclides composition environmental objects from different locations of the SNTS are presented. As method of

determination of elemental composition there were used neutron activation analysis (NAA), roentgen-fluorescent analysis (RFA), PIXE. Radionuclides composition was determined by both gamma-spectrometer and radiochemical methods. The main object of researches was soil, in which there were determined radionuclides ^{60}Co, ^{90}Sr, ^{137}Cs, ^{152}Eu, ^{154}Eu, $^{239+240}Pu$, ^{241}Am and others. For study of distribution of radionuclides on granulometrical fractions a radiochemical technique of determination of ^{90}Sr, plutonium isotopes and ^{241}Am in one sample was developed.

The technique of preparation of soil sample and radiochemical separation is described in [1,2]. The determination (of γ-radiating of radionuclides (^{60}Co, ^{137}Cs, $^{152,154}Eu$, ^{241}Am and etc.) in soil samples was carried out on γ-spectrometers with high resolution solid state Ge-detectors (ORTEC model GEM-2018 and CANBERRA GX-1520). The energy resolution of the spectrometers was 1.8 keV for the1332.2keV peak of ^{60}Co. In many samples there was carried out the instrumental determination of Pu with the detector CANBERRA GL-1010 with the resolution 230keV for 5.9 keV peak of 55Fe. For X-ray fluorescent analysis there was used the spectrometer with the detector ORTEC SLP-10180, with energy resolution 180 eV for the peak 5.9 keV of 55Fe and sources of ^{109}Cd. Measurements of α-spectra of plutonium samples after radiochemical separation were carried out on α-spectrometer "CANBERRA" model 7401. The energy resolution was 20keV for 5.3 MeV of ^{210}Po.

The soil samples of weight 0.2 -0.5 g were irradiated in channels of the reactor "WWR-K" during 3 hours by a flow of neutrons of $2 \cdot 10^{13} \cdot n \cdot cm^{-2} \cdot sec^{-1}$. Measurements of irradiated samples was carried out on the same gamma-spectrometers after 3 days of cooling.

Results and discussion

The results of distribution of concentration of radionuclides in surface layers of soil of the S-E plum of the SNTS are presented in Fig. 1.

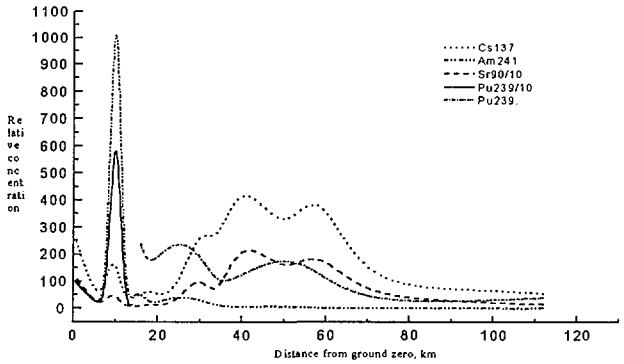

Fig.1. Distribution of radionuclides along S-E plum SNTS

It is seen that the course of change of concentration of ^{90}Sr and ^{137}Cs are differed from distributions of Pu and Am. It is possible, that the radionuclides of soil composition of this location of the S-E plum was generated not only in result of explosions, carried out in the centre, but also nuclear tests carried out near to this place. This specifies the increased

concentrations of ^{60}Co and $^{152,154}Eu$. A research of radionuclides distribution on granulometrical fractions has shown, that for the most contaminated places the main activity of ^{137}Cs is in rather large fractions (< 0.3mm), and contents of ^{137}Cs in a fine faction (< 0.05mm - "clay") in all investigated samples is about constant (~ 70 Bq/kg), i.e. this district is not a significant secondary contamination by ^{137}Cs owing to a wind erosion. The more difficult picture is observed for distribution of Am and Pu. In many cases the their main part is in fine fractions (< 0.1mm), however in rather large number of samples an activity of Am and Pu in large fractions (> 0.3mm) is (70-90) % of all activity of a sample. An inspection of large fractions in microscope has shown, that finer "hot" particles of the spherical form are introduced into large particles of soil minerals (quartz, granite and etc.). As was shown earlier [3] a leachebility of Pu, even from the finest fractions, is insignificant (~ 0.3 %), however the significant contents of Am and Pu in the fine fractions increases a risk of its redistribution owing to wind transferring.

The determination of elemental composition of soil samples of the S-E plum by methods of INAA and RFA has not shown large difference from usual composition of sedimentary rocks except sharp (10-20 times) increase of concentrations of As and Sb in region of 30 km from the Centre.

The distribution of radionuclides on the territory in the place of realization excavational explosion "Balapan" is investigated rather in detail. For this places there is characteristic a fast reduction of concentration of radionuclides in accordance with distance from the ridge of inrush. The characteristic feature is a presence of large concentration of ^{60}Co and $^{152,154}Eu$, formed due to activation. A study of distribution of radionuclides concentration on granulometrical fractions has shown, that as against of the majority of places of the territory of the "Opytnoe pole" the main part of radionuclides is in fine (< 0.3mm) fractions. The radiochemical determination of Pu in these samples has shown a large value of the activity ratio of $^{238}Pu/^{239}Pu \sim 0.5$, while for the majority samples, selected in other places of the SNTS territory this value has a few percents.

The study of radionuclides composition along beds of grooves at the mountain massif "Degelen", where the tests were carried out in tunnels, has shown a significant migration mobility of radionuclides. In Fig.2 distribution of concentration of radionuclides along the bed of groove depending on distance from tunnel portal is shown.

It is seen, what even at the significant distances (~2km) a concentration of radionuclides is rather large. A study of distribution of radionuclides at different distance from one source shows, that by migration capacity radionuclides are stacked in a set; Sr > Cs > Pu. A study of elemental composition of samples of bottom deposits has shown, that there is the certain difference in elemental composition of bottom deposits and soil samples at the "Opytnoe pole".

The conclusion

Results of work show, that the species of radionuclides and composition of soil samples from various locations of the SNTS strongly are differed. It is shown that the risk from the wind transfer of ^{137}Cs from the contamination of the (S-E) plum is small. This conclusion under relation of Am and Pu is less probable. The determination of elemental composition has not revealed significant deviations from composition of bottom rocks. There is noted a large migration capacity of radionuclides in the region "Degelen".

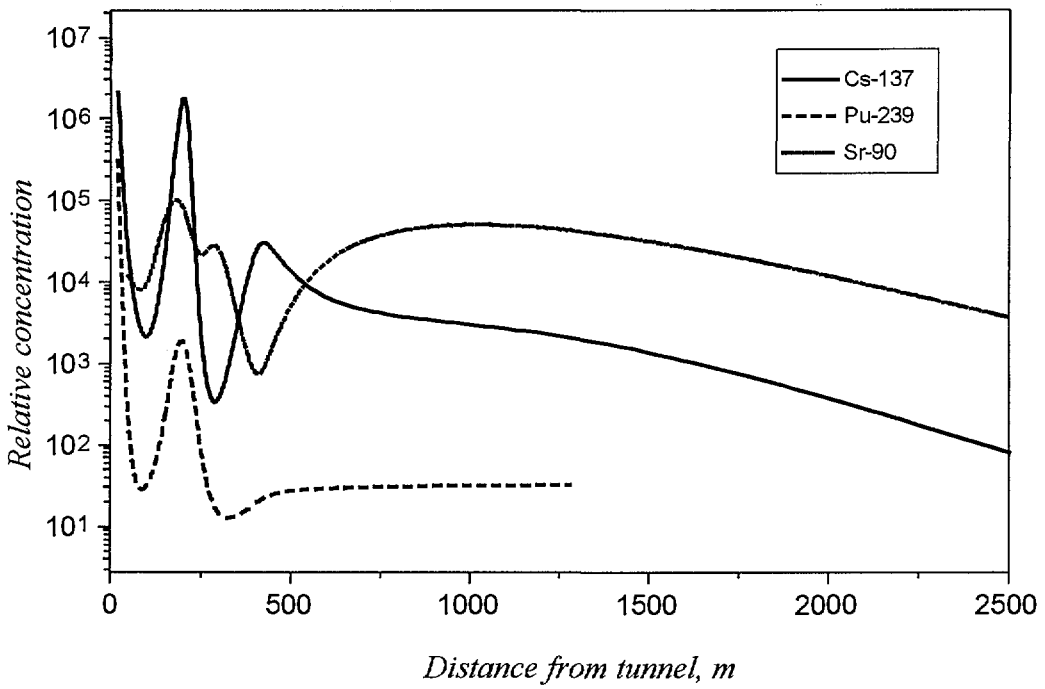

Fig.2. Distribution of the radionuclides along the botton of groove, flowing out of tunnel at the Degelen

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CHARACTERIZATION OF RADIONUCLIDE CONTAMINATION OF THE SEMIPALATINSK NUCLEAR TEST SITE

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After prohibition of nuclear tests at the SNTS before a scientific public of Kazakhstan with the special sharpness there were questions about study of a radioecological situation both at the Test Site and at territories adjoining to it, as well as about liquidation of negative consequences of this activity. Taking into account the huge area (18500 km^2) of the SNTS