ARTIFICIAL RADIONUCLIDES IN OILS FROM THE UNDERGROUND NUCLEAR TEST SITE (PERM REGION, RUSSIA)

S. N. KALMYKOV, YU. A. SAPOZHNIKOV
Division of Radiochemistry, Chemical Department, Lomonosov Moscow State University, 119899, Moscow, Russia.

B. N. GOLOUBOV
Scientific Council on Biosphere Problems, Russian Academy of Science, Moscow, Russia

The results of radionuclide determination in oil samples from the Gezh oil deposit (Perm region, Russia) where five underground nuclear explosions took place are presented. High $^3$H and $^{14}$C concentrations were found in oil from the wells where the explosions were made as well as from distant wells. This contradicts the assumption that the holes after the explosion are hermetic and the radionuclide leakage is negligible.

1 Introduction

Since 1952 from altogether more than 2500 nuclear tests about 1550 were carried out in the underground test sides in 90 regions of various parts of the globe. 129 so-called peaceful underground nuclear tests (UNTs) were conducted in the former Soviet Union and 27 of them in the U. S. Most of them were carried out for the purposes of the oil and gas mining.

It was assumed that the holes of the UNTs are hermetic since they are covered with glazed crust of solidified molten rocks that prevents the radionuclides to migrate out of them. But 8-15 years after the explosions at some of the sites where industrial UNTs were performed (near Osa, Irkutsk, Orenburg, Astrakhan', in Republic Sakha Yakutia, and others) the leakage of radionuclides from the holes was observed. Very few data on radionuclide contamination of underground water, soil, rocks and other natural complexes at the UNT sites are available.

8 oil samples were collected at the Gezh oil deposit where several UNTs were performed. Oil samples (of the volume of about 0.5 L) were collected at the heads of the wells. In this work the concentration of $^3$H and $^{14}$C in these samples was determined by liquid scintillation counting (LSC). An attempt to measure other artificial radionuclides ($^{90}$Sr, $^{134,137}$Cs, $^{60}$Co) as well as radionuclides from the uranium and thorium families had been done by different spectrometric techniques (non destructive semiconductor $\gamma$-spectrometry and Cherenkov counting) but their activities were below the lower limit of detectability (LLD). Alpha emitting radionuclides were determined by LSC (TRI-CARB-2500, Canberra-Packard Company), but their activities were also below LLD.

Gezh oil deposit is located at the northern part of Perm region 18 km south-east of the town of Krasnovishersk. The oil is located on four stratigraphic levels of Paleozoic age. The largest layer is confined to limestone of late Devonian – early Carbonian at the depth of 1700-2000 m. Before the exploration of the deposit the underground bottom waters of this layer were located at the depth of 2010 m. The thickness of the productive layer is about 232 m with the productivity varying from 10 to 743 tones per day.
The explosions at Gezh site were performed in five wells – one UNT in 1981, two in 1984 and two in 1987, each with the yield of 3.2 kT. The main purpose of the explosions was to intensify the output of the deposit but this was not done completely for some reasons. After the explosions the decrease of the pressure in the layer was observed that led to the rising of bottom waters and hole flooding. This could create the conditions for leakage of radionuclides and environmental contamination. The map, showing the UNTs location in Gezh oil-gas deposit, is presented in Fig. 1.

**2 Experimental**

After the non-destructive γ-spectrometric measurements 200 mL of each oil sample was taken for fractional distillation. The standard distillation apparatus consisting of round-bottomed flask, dephlegmator, thermometer and coiled condenser connected with several T-tubes was used for the collection of individual fractions. The apparatus was heated by an electric hot plate. For each oil sample some (6-12) low boiling fractions were collected sequentially. Their respective boiling points ranged from about 30 to 200 °C.

After measuring the volume each fraction was placed into the standard 20-mL vial for liquid scintillation counting (LSC). Routine \( ^3 \)H and \( ^{14} \)C determinations were made using the liquid scintillation spectrometer (RackBeta-1216). 2-10 mL of each fraction were taken and the toluene-based liquid scintillator was added. The \( ^3 \)H and \( ^{14} \)C