Toward the solution of radiation dose assessment to the residents living around the former USSR’s nuclear test site: laying stress on Sarzhal and Karaul settlements in the southern area

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Over a period of 40 years from 1949-1989, the former Union of Soviet Socialistic Republics (USSR) conducted more than 450 nuclear explosions at the Semipalatinsk Nuclear Test Site (SNTS), Kazakhstan. It has been said that several hundred thousand peoples who were living in settlements around the SNTS have been impacted by long-term low-dose radiation from the close-in fallout. Considerable efforts have been devoted to investigate the consequences of radiation exposures to the residents living in the area, particularly in villages contaminated heavily by fallout of the radioactive clouds. Since 1994, we have also investigated the radiological situation in and around the SNTS, and measured long-lived radionuclides such as ^{137}Cs and plutonium (Pu) isotopes, mainly for soil samples from various areas.

From the detailed soil sampling around Dolon village affected directly by the radioactive plume associated with the 29 August 1949 nuclear test, it has been gradually clarified that residents of Dolon received a radiation dose in air around 0.5 Gy.

In this paper, to obtain a more reliable estimation of radiation dose to residents of Sarzhal and Karaul villages contaminated mainly by the USSR's first hydrogen bomb in 1953, many soil samples up to a depth of 30 cm were collected along a line perpendicular to the supposed center-axis of the plume in 1953 and their Pu isotopes and ^{137}Cs were measured. Based on the measurements, we discuss the spatial distribution of the close-in fallout from the 1953 test. Furthermore, we present information on the neutron-induced radionuclides ^{152}Eu and ^{60}Co which were detected in some soil samples.

The distributions of ^{137}Cs inventories are respectively plotted in Fig. 2 for Sarzhal and Karaul as a function of distance from the supposed center axis of the radioactive plume from the 12 August 1953 hydrogen bomb test. All data are as of the date of measurements (2007-2008).

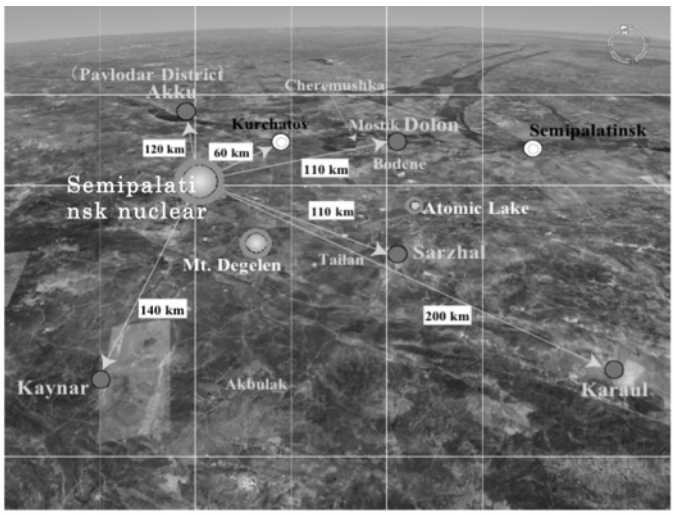

Fig.1 Locations of settlements in the Semipalatinsk historical cohort

Positive and negative values on the abscissa correspond to the distances from the trace center-axis toward the directions.

In Sarzhal village, although the inventories of these nuclides vary largely, overall, peak-like distributions similar to Gaussian function seem to be observed for both ^{137}Cs and ^{239,240}Pu. Their maxima are near the supposed center-axis. It is probable that the ^{137}Cs and ^{239,240}Pu inventories at the center-axis are around 10,000 and 2,000 Bq/m^2, respectively, and in the village where were located at about 5 km away from the center-axis, their inventories are, respectively, approximately 5,000 and 500-1,000 Bq/m^2.

On the other hand, in Karaul village, although nearly the same distribution pattern as the ^{137}Cs and ^{239,240}Pu inventories found in Sarzhal was observed, their levels seem lower for each maximum. It is probable that the real center-axis where the plume passed is near the village several km away from the supposed centerline. The ^{137}Cs and ^{239,240}Pu inventories in the vicinity of the village are 5,000-7,700 and 200-400 Bq/m^2, respectively. The ^{239,240}Pu/^{137}Cs activity ratios in Sarzhal and Karaul vary in a wide range from 0.1-0.6 and 0.1-0.3, respectively.

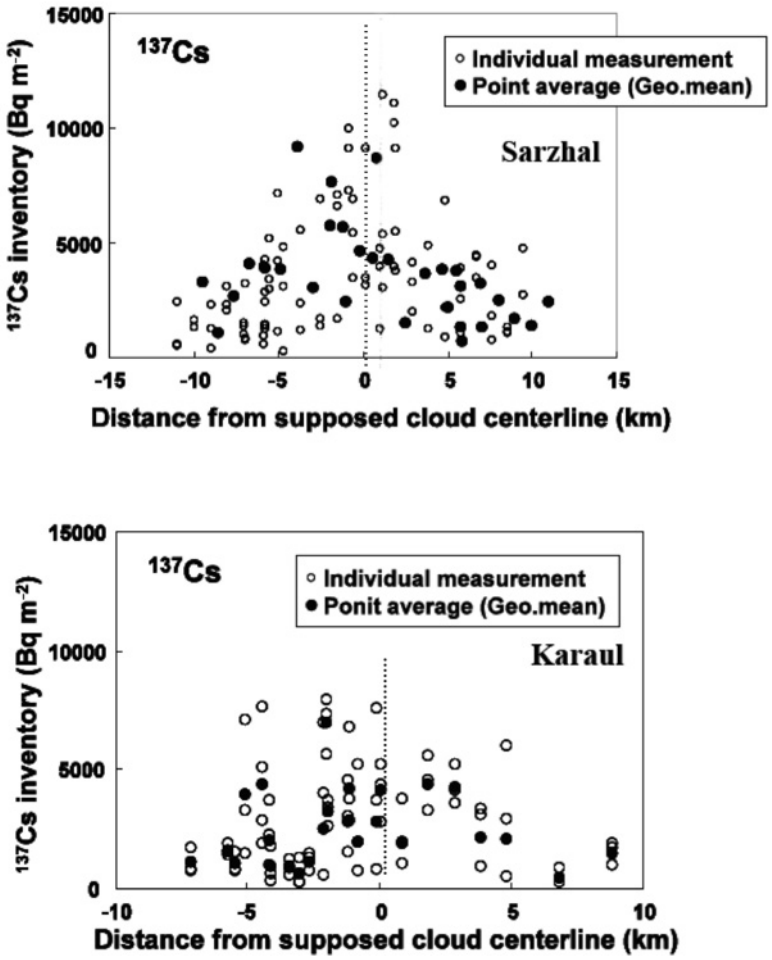

Fig. 2 Spatial distribution of ^{137}Cs inventories for soil samples collected from 38 locations around Sarzhal and Karaul villages. Average values (solid circles) are plotted as geometric mean.

Neutron-induced radionuclides ^{152}Eu and ^{60}Co were detected successfully by using extremely low-background Ge detector installed at the Ogoya underground laboratory after simple chemical separation. The ^{152}Eu contents do not vary so largely, ranging from 120-184 Bq/m^2, while ^{60}Co contents change in a wide range from 268 Bq/m^2 in Tailan to 23 Bq/m^2 in Karaul, with increasing distance from hypocenter. It seems likely that the ^{60}Co found is attributable to Co which is contained in materials used for the hydrogen atomic bomb, the iron tower and so on. These data will provide useful information on the efforts to estimate radiation dose to the residents living in Sarzhal and Karaul villages.