Application of 90Sr and 137Cs as tracers for the study of aeolian dust transport

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We have been monitored monthly depositions of 90Sr and 137Cs at the Meteorological Research Institute (MRI), Japan (36o03'N, 140o08'E) since 1957. After the Chernobyl accident, neither atmospheric nuclear test has been conducted nor the severe nuclear accident has occurred, which resulted in no additional severe contamination in the atmosphere. Accordingly, the present global atmospheric 90Sr and 137Cs concentration levels became extremely low. Nevertheless, these radionuclides have been still detected in the atmospheric deposition samples at the MRI. The decrease of the radioactivity deposition at the MRI no longer exhibits the stratospheric half residence time of aerosols, and it is slower. It becomes obvious that these radionuclides are supplied from other reservoir than the stratosphere. There are only two major reservoirs of the anthropogenic radionuclides on the earth; one is the land surface and the other is the ocean. We could know the contribution from the ocean is negligible from the sea salt deposition and contents of the radionuclides in the surface seawater. We could have reasonably assumed, therefore, that those anthropogenic radionuclides were resuspended with surface soils, and which is the major component in the radioactivity deposition. In other words, suspension of soil dust (surface soil particles) is the source of such anthropogenic radionuclides in ambient air. We have suggested a noble hypothesis, regarding the issue, that the recent depositions of anthropogenic radionuclides observed in Japan are not mainly due to the local resuspension (originating from neighboring farming fields, etc.) but the long-range transport of Asian dusts (Igarashi et al., 1996; 2001). There may be still opposed arguments over our hypothesis.

In order to solve the question of the origin of the resuspension, 137Cs/90Sr activity ratios in the atmospheric depositions were firstly compared with surface soil data. It was found that the average activity ratio of 137Cs/90Sr in the deposition samples at the MRI in the 1990s (average: 2.0 n=92) was not close to that of the surface paddy and field soils taken in neighborhood (median: 6.8, n=8), which had been considered as the primary source. Additionally, road and roof dusts, likely sources, showed no low activity ratio such as 2 to 3. The frequency distribution of the 137Cs/90Sr activity ratio in the deposition samples was narrow, while that of the surface soils was stretched out to the higher ratios. This was further confirmed for more extensive data set of the Japanese surface soils collected during the 1990s (median: 5.3, n=584), from the Ministry of Education, Culture, Sports, Science and Technology database for environmental radioactivity. It seems that 90Sr and 137Cs deposited and adsorbed on the soil particles during the 1960s to 1970s (original activity ratio of 137Cs/90Sr has been claimed as 1.6 (Krey and Krajewsky, 1970)) have been gradually fractionated through the leaching processes in the soil column in Japan. These findings indicate that there are remote sources other than Japanese local sources for the resuspension. From the viewpoint of the carrier, as is mentioned above, the resuspension is the dust suspension. It is, therefore, natural to consider large-scale meteorological dust events (the Kosa phenomena; Asian dust) as likely remote sources. It is known that the Asian dust transport is active in spring and autumn in the Eastern Asia. However, weak events (Iwasaka et al., 1988) also seem to contribute to some extent even in summer. The Kosa events are, in fact, severe dust storms, one of the serious natural disasters, when they occurred over the Asian continent.

It seems that, based on the above-mentioned noble findings and related knowledge on the aeolian dust transport, we can study more about the aeolian dust transport in the Eastern Asia.