Radiocesium Fixation on Soil Minerals

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Cesium-137 (^{137}Cs) is the most important long-term contributor to the environmental contamination of all the radionuclides released by the accident at the Fukushima Dai-ichi nuclear power plant, because of its high release rate and long half-life. Fate of ^{137}Cs in the terrestrial environments had been surveyed after the Chernobyl accident in 1986. Previous surveys revealed that most of ^{137}Cs deposited on land remains at soil surface over decades, and that ^{137}Cs is hardly exchanged with other cations. Immobilization of ^{137}Cs on land surface is mostly ascribed to selective adsorption on clay minerals, particularly micaceous minerals. Micaceous minerals, more or less included in soils, have a layered structure with negative charges between each layer which is neutralized by non-hydrated cations, mainly K^+, in the interlayer site. Cesium-137 is irreversibly retained at the fringe of the layered structure of illitic minerals, called as frayed edge site (FES), with much higher selectivity than other cations. Radiocesium Interception Potential (RIP) is accepted as a quantitative index of the FES in soils. Although the RIP is found to be a useful index to compare the ability of soils and soil clays to retain ^{137}Cs, relationship between RIP value and composition of clay minerals (e.g. amount of micaceous minerals) has not been clarified for soils in Japan and humid Asia. I determined RIP values for soils and soil clays of which composition of clay minerals was thoroughly investigated. I found that the RIP is largely dependent on not only the amount of micaceous minerals, but also their degree of weathering, and degree of hydroxy-Al interlayering. In case of paddy soils in Fukushima, we found that higher ability to retain ^{137}Cs was shown for soils containing larger amount of micaceous minerals in clay fraction. Origin of micaceous minerals may partly be those involved in the historical deposition of kosa dust (eolian dust), which caused a significant effect to increase the ability of volcanic ash soils to retain ^{137}Cs. This idea was obtained from the following results: 1) oxygen isotope ratio of fine-grained quartz isolated from representative volcanic ash soils (Andosols) in Japan was clearly different from those in volcanic materials, but quite similar to those of Gobi-desert soils, and 2) there were a proportional relationship between fine-grained mica and quartz content in the Andosols.

These findings provide basic information of radiocesium dynamics in soils and its diversity depending on soil formation processes such as type of parent materials and climatic conditions.

References

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