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Origin of mica in Allophanic Andosols in Japan and its role as a radiocesium fixing material

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The accident at the Fukushima Daiichi Nuclear Power Plant in March 2011 has turned attention to the fate of radiocesium (RCs) in soils in Japan. Allophanic Andosols are common soils in Japan, which generally have clay mineralogy rich in low crystalline minerals such as allophane and imogolite. Since RCs is not adsorbed strongly on these minerals, Allophanic Andosols are assumed to have very low RCs retention ability. The objective of this study is to elucidate the relationship between RCs retention ability and mineralogical properties of Allophanic Andosols in Japan. We hypothesized that trace amount of micas are deposited as a loess component even in Allophanic Andosols, which control the RCs retention ability.

Twenty-three soil samples were collected from a plow layer (0-15 cm) of either paddy or upland fields distributing at alluvial plains in Hokkaido, Tohoku, Kanto, and Kyusyu districts, representative areas of Allophanic Andosols. Particles with a size of 2-20 μm and $<$2.0 μm were fractionated from the soils by sedimentation method. RCs retention ability for each particle was represented by the Radiocesium intereception potential (RIP). Quartz content was estimated by random powder X-ray diffraction analysis for 2-20 μm particles with adding α-Al_2O_3 as an internal standard. Mica content in 2-20 μm particles was estimated by the amount of potassium extracted by fusion with $NaHSO_4$, whereas that in $<$2.0 μm particles was estimated by K extracted by digestion with HF-$HClO_4$. Quartz was isolated from 2-20 μm particles by the selective dissolution with H_2SiF_6, and then $\delta^{18}O$ value for the isolated quartz was determined to estimate the origin.

The RIP value for 2-20 μm and $<$2 μm fractions was 1.7$\pm$0.8 mol kg^{-1} and 2.6$\pm$1.3 mol kg^{-1}, respectively. Mica-K content in the respective fractions was 3.2$\pm$1.3 g kg^{-1} and 3.4$\pm$1.7 g kg^{-1}. These values are considerably small compared with those for fine particles in non-volcanic soils. The RIP positively correlated with mica-K content for each fraction, indicating that RCs retention ability is mainly controlled by the amount of micas, in spite of its minority as a mineral component. The mica-K content is proportional to the quartz content, suggesting that the origin of these minerals would be the same. Furthermore, $\delta^{18}O$ value for the isolated quartz was +14.8 ‰ on average with a range of +10.8 to +16.1 ‰, which is clearly higher than those of volcanic materials while similar to those of Chinese loess. Thus, this study strongly indicated that the RCs retention ability of Allophanic Andosols is largely controlled by loess-derived micas.

Keywords: loess, oxygen isotopic analysis, Radiocesium Interception Potential, Allophanic Andosol, mica