Experimental study to show the rapid incorporation of Asian dust to the terrestrial biogeochemical cycle

Atsushi Nagamine[1]; Tasuku Akagi[2]

[1] Earth and Planetaly Sci., Graduate School of Sci., Kyushu Univ; [2] Kyushu Univ.

A great amount of Asian dust reaches Japan from the Asian continent every year. Observation of radiogenic nuclei in soil in northern Kyushu (Osaki et al., 2007) implies that considerable amounts of the nuclei in the soil originate from the Asian continent. Most of Asian dust transferred to the ocean surface was considered to settle onto the sea floor without being dissolved. The fate of the dust fallen on the land was poorly known. It is known that terrestrial plants may actively weather silicate minerals. The dust may be less resistant to the weathering reaction, if its relatively great surface area is considered. We have the hypothesis that the presence of plants accelerates the transfer of inorganic elements in Asian dust to the terrestrial biogeochemical cycle. Our aim was to prove the hypothesis with pot experiments.

Commercially-available leaf mold was dried and pulverized, and loess from Dunhuang in China was sieved. They were mixed with different ratios to prepare experimental soils in pots. Parallel experiments were performed with and without plants, and we watered all the soils with identical amount of pure water in the experiments. The plant species used in the experiment was Ipomoea aquatica (water spinach). The soils in the pots after the experiment were sampled, and were treated with the sequential extraction following the BCR protocols with minor modification. The protocols was developed to separate and quantify elements in different chemical forms, using extra-pure water, acetic acid, hydroxylamine hydrochloride, hydrogen peroxide, mixed acid (nitric acid and perchloric acid). The resultant fractions were analyzed with ICP-AES. The two materials, leaf mold and loess, were separately treated with the BCR protocols. The sums of the first five fractions were named ‘digestible divisions’, and the residues were named ‘hardly-digestible divisions’.

Differences in the amounts of elements in each of the five fractions were observed between the pair of experiments with and without plants. Compared with the amounts of elements in the digestible divisions and that estimated by summing the corresponding divisions of the two soil materials, differences in extracted amounts were seen even in the experiment without plants. The differences can be interpreted that some elements in the hardly-digestible divisions moved to the digestible divisions by the action of water. In the presence of plants, higher amounts of elements were extracted as the digestible fractions than in the absence of plants. The differences might be underestimated, because the amounts of elements in plants were not considered. The higher the proportion of loess mixed was, the greater the differences became in the presence of plants. We, therefore, concluded that the plants significantly accelerated the transformation of elements in the hardly-digestible divisions in loess to those in digestible divisions. The rate of the transformation of Al in the hardly-digestible divisions was estimated from ‘the difference’. If loess in the experimental pots keeps the transformation at the same rate as the observed in experimental period, all elements in loess will become digestible in one or two years by the presence of plants and, thus, maybe incorporated readily to the biogeochemical cycles.