Long-term movement of elements in Andosols

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（火山灰土壌中における元素の長期的移動）

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論　文　内　容　の　要　旨

Andosols are important agriculture soils in Japan and frequently characterized by thick humic horizons accumulating large amount of soil organic carbon (SOC). However, the genesis and accumulation processes of the SOC in Andosols are still unclear, and the information on the movement of the SOC would be a key to understand them. In Andosols, the movement of the other elements in the soil profiles should also be clarified, because the repeated application of agricultural materials including plant nutrients for agricultural production has caused environmental issues such as eutrophication due to discharge of these elements to surrounding areas. A soil profile with well-preserved horizons would provide a very good opportunity to study the long-term movement of such elements in soils, and a buried humic horizon under thick tephra deposits would be suitable for investigating movement of C with ^{14}C dating technique with high accuracy since those covering tephra deposits have preserved past conditions from recent anthropogenic influences and external input of modern C. In the present study, the movement of C and other elements including Ca^{2+}, Mg^{2+}, Na^{+}, and P were clarified by investigating ^{14}C age of SOC fractions and depth profile of those elements in Andosols.

To clarify the mobility of SOC, a well-preserved buried humic horizon of an Andosol was collected from the depth between 147 and 187 cm at 5 cm-interval (total 8 sub-horizon samples), and SOC fractions were prepared from each sub-horizon sample by extraction and precipitation procedures, resulting in humin, humic acid, and four fulvic acid fractions. The average rate of vertical translocation of each SOC fraction determined by the ^{14}C dating technique was very low ($\leq$ 4 mm per century), implying that the vertical translocation of SOC would not be the main mechanisms for forming the thick humic horizons in Andosols. In addition, stable isotopic ratio of C and N revealed that most of the SOC fractions have not been well-metabolized, indicating that they have been fixed *in situ* right after photosynthesis by plants at the early stage of soil formation and chemically stabilized at the soil surface, by fire events to form charred materials, etc. Thus, in Andosols, high content of SOC found at deeper position than several cm depth from the soil surface would not be supplied through overlaying layers by infiltration but formed *in situ* on soil surface, and successive up-building accumulation of soil particles containing SOC would have contributed to the formation of the thick humic horizons.

To clarify the movement of the other elements, the depth profiles of available Ca^{2+}, Mg^{2+}, Na^{+}, and P were investigated in Andosols, and they were compared between a secondary forest

soil and an adjacent reclaimed grassland soil which has received fertilizers for a half century. The comparison revealed that the Ca and Mg applied as fertilizer ingredients have reached at least 100 cm depth as exchangeable Ca^{2+} and Mg^{2+} in the fertilized grassland soil during a half century. Similar trend was observed for exchangeable Na^{+}. Soil available P (Bray II P) was also observed to be increased at 80 to 100 cm depth in the fertilized grassland soil although the mobility was lower than those of the exchangeable Ca^{2+}, Mg^{2+}, and Na^{+}.

Overall, the present study clarified the very low mobility of SOC in Andosols, together with higher mobility for available P and the highest for exchangeable Ca^{2+}, Mg^{2+}, and Na^{+}. The findings in the present study would contribute to understand the mechanisms of SOC accumulation and adequate management of plant nutrients in Andosols for sustainable use.