Acidification in forest soils: a consequence of acid deposition on soil derived from granite and loam soil

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As a consequence of atmospheric pollution and related strong acid deposition, soil acidification has been considered to be a major environmental problem in the forest regions adjacent to densely populated cities. In this study, we assess acid neutralization potential of two types of soil; soils derived from granite parent material (tonalitic soils) and soils derived from volcanic ash (loam soils), in Tanzawa mountain area. The Tanzawa Mountains is located near Tokyo and has received significant amounts of pollutants through atmospheric deposition. In addition, this area has received considerably amounts of SO2 emitted from Mt. Miyake volcano since August 2000.

The study area is located in the southern part of Oomuroyama watershed (~25 km2) and covered by mixed hardwood forest. The bedrock of the study area is Miocene granitic (tonalitic) rock with minor amounts of gabbro. The area is partly blanketed by the Kanto loam. We conducted the fieldwork (from Apr 2003 to Nov 2004), and collected tonalitic soil and loam soil samples (Ao, A, AB, BC, C, and R horizon; 30 to 300 cm total thicknesses) from 72 sampling points. We analyzed 1) water content in the samples oven-dried at 105 degree C, 2) major and trace element abundance with XRF, 3) N and C contents with NC analyzer, 4) mineral compositions with XRD, and 5) pH in soil solution in the air-dried soil samples.

Average pH in the soil solutions in the A horizon is 5.96 in the tonalitic soils and 5.04 in the loam soils. The loam soils have lower pH values compared with the tonalitic soil. In the B-horizon, the soil solutions of loam soil exhibit a wide range of pH variation ranging from 5.61 to 7.39 (average 6.57). The tonalitic soils show a wide range of chemical variation from C to Ao horizon. From bottom to up, SiO2, Al2O3, CaO, K2O, Na2O systematically decrease, while TiO2, P2O5, total C (TC) and total N (TN) markedly increase. The concentrations of analyzed elements are normalized to the Ti content in the same sample to evaluate quantity of elemental lost during weathering. The data suggest that the tonalitic soils have need extensively weathered and considerable mounts of elements leached out from the parent material. The present results indicate that 25wt.% SiO2 in the parental material has leached out. The present observation suggests that chemical changes in the soil are associated with chemical weathering of plagioclase, hornblende and biotite, and formation of clay minerals. No correlation is noted between the soil chemistry and topographic data of sample location. The loam soils exhibit narrow stratigraphic variation. These show comparable composition from the top to the bottom horizon. The present data indicate that the loam soils were not extensively modified by weathering and have higher potential in acid neutralization than the tonalitic soil.

The average value of pH of the soil solution is 4.72 in the A horizon of tonalitic soil, and 3.99 in the Ao horizon of the loam soil. Chemical profiles of the tonalitic soil indicate that considerable amounts of Al have been lost from the tonalitic soil. P2O5, K2O, TC and TN concentrations in the tonalitic soil and the loam soil show highest value in the Ao horizon, and these gradually decrease toward lower horizon. Negative correlation is noted between TC and TN. TC and TN correlate inversely with elevation and slope angle. This negative correlation implies that higher run off rate of organic elements at site with higher and steeper topography.