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The increase in groundwater chemical components along water flow in a forested watershed

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Introduction

To understand soil acidification due to atmospheric deposition, it is important to know a formation process of water quality in a forested watershed. Forest watershed is a place for water quality transformation. Groundwater is the water positioned in between rainwater (=input) and stream water (=output). Rainwater undergoes various reactions under the ground. The examples are weathering, mineralization of soil organic matters, nitrification and ion exchange, which determine the groundwater quality. Thus it is very important to observe the changes in groundwater quality to understand a formation process of water quality in the forested watershed.

In this study, we studied water chemistry of groundwater using wells installed in a forested watershed and analyzed their changes along the course of groundwater flow with a special reference to weathering reaction.

Methods

We sampled groundwater from wells (piezometer) in a watershed covered with deciduous forest in Hachioji in Tokyo. The wells of different depths were installed at different sites; 7 wells at a ridge site (altitude 176m) and 18 wells at 7 sites along a slope (altitude 160m-181m). We measured EC, pH, water temperature, well water level, alkalinity and the major cation and anion concentrations.

Results and Discussion

The concentrations of SiO2-Si, HCO3-, Ca2+ and Na+ of the well-water increased along the slope. In the wells having different depths at a ridge site, vertical changes of the concentration was observed, where the concentrations of these components also increased along the course of infiltration. These changes correspond with the course of the groundwater movement which was shown by hydraulic potential. Therefore, the concentrations of the above components were shown to increase along groundwater flow.

Correlations were found between the concentration of SiO2-Si and that of HCO3-, Na+ and Ca2+, except some exceptional wells. These components correspond to products of weathering reactions, and then are expected to increase in its concentration as weathering is developed. Therefore, it was suggested that the observed increase in SiO2-Si, HCO3-, Na+ and Ca2+ concentrations was caused by a weathering reaction along the groundwater flow. Accordingly, it was clear that weathering was in progress accompanied with groundwater movement in deep underground.

We calculated a stoichiometrical relationship due to weathering from the gradients of concentration of HCO3-, Ca2+ or Na+ versus that of SiO2-Si. From the calculation, it was found that the proportion of SiO2-Si : HCO3- : Ca2+ : Na+ was 1: 0.85 : 0.12 : 0.13 for the change observed along the slope and was 1 : 1.0 : 0.44 : 0.47 for that in the vertical difference.

However, the relationships between the above components were characteristically different, where higher concentrations of HCO3-, Ca2+ and Na+ were observed. From these observations, we can suggest that groundwater flow in these wells is given different weathering reactions.