Characterization of Netiyagama Soil (Sri Lanka) for the Fate of Fluoride in Groundwater

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Abstract

Inhabitants from the dry zone of Sri Lanka are vulnerable to serious health problems due to a lack of safe drinking water because of high fluoride and salinity. Major parameters that control the fluoride fixation are pH, soil organic matter, soil salinity, clay content, and the presence of Al, Ca, Fe, and P. We aimed at determining the geochemical provenance of fluoride in dry zone groundwater. Soil samples from Netiyagama ("8.328764N, 80.587615E") were collected to study the relationship between soil properties and fluoride geochemistry of three main soil horizons; Horizon A (0-30 cm), Horizon B (30-80 cm), and Horizon C (80-110 cm). Soil pH values of the horizons were 6.96, 6.27, and 6.94, where Horizon B was influenced more by the acid-forming ions in soil than the other horizons. The electrical conductivity values 72.17 µS/cm, 20.63 µS/cm, and 25.30 µS/cm, respectively suggest the non-saline nature of all horizons as its less than 1000 µS/cm. Soil organic matter content (OMC) along horizon gradient from A to C were 2.94%, 0.98%, and 0.19%, respectively. Similarly, C, H, N content decreased along the horizon gradient correlating with the OMC. Fluoride in organic matter and soil can decrease the growth and activity of microorganisms. According to the surface titration study carried out at three ionic strengths of NaCl (0.1, 0.01, 0.001 M), it was observed that the net charge of the three horizons was negative in all pH. The net negative charge results in a high CEC than anion exchange capacity with large buffering capacity. The soil cation exchange capacity values determined by the ammonium acetate method were 13.5 $cmol^{+}kg^{-1}$, 17.4 $cmol^{+}kg^{-1}$ and 14.1 $cmol^{+}kg^{-1}$ respectively. The pH variation results were obtained within 4-9 range in $NaNO_3$ (0.1, 0.01, 0.001 M). Horizon B showed the highest fluoride adsorption of 59.3%, 47.9%, and 56.2%, respectively. The pH in water is the master variable that controls the fluoride uptake by the soil surface. The pH increased after fluoride adsorption in an acidic medium and vice versa. It can be concluded that fluoride adsorption onto soil occurs by ligand exchange with hydroxyl present on surface sites. The results presented will pave the essential first step in proposing new water purification methods for community water supplies.

Keywords: *Horizons, fluoride, netiyagama, soil*

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