Simulation of Br concentration in soil columns by HYDRUS-ID model

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Abstract
Water and contaminants moving through the vadose zone are often subject to a large number of simultaneous physical and chemical nonequilibrium processes. Modification of the transport of one component is difficult, time consuming and expensive, therefore it is important to develop methods to simulate this movement. In the present study our purpose was to investigate bromide concentrations in soil columns, Br simulations by the HYDRUS-ID model and study the efficiency of this model in estimating concentrations of Br. For this, we used sandy loam and loamy sand textures, 3 Br doses (10, 20 and 30 mg/kg soil) were added to columns under saturated conditions. After leaching, samples were taken at every 2 cm from 0-12 cm depth; at every 4 cm from 12-20 cm depth; and at every 5 cm from 20-25 cm depth. Br concentration was measured using a Br selective electrode. The result showed that this model proved a suitable estimation of Br concentration with depth and thus can be use for prediction of Br diffusion in these soils.

Key Words
Nonequilibrium, concentration profile, model, bromide, simulation

Introduction
Amount of leaching is related to the velocity of water movement at soil and conservation potential of solutes by soil. The most important things that affect solute movement include: texture, structure and capillary conductivity that are influenced by management and tillage (Agus *et al.* 1992; Cary *et al.* 1967). Soil anions have a particular importance and this is because of their importance for salinity, productivity and groundwater pollution. Most anions are inactive and do not adsorb at adsorption sites, thus they can be leached from the soil profile and pollute groundwater. Often, Br is used as a tracer because of its low concentration in most soils, and its low chemical activity in adsorption reactions. This ion does not react chemically with with the kinds of compounds normally found in soil solution and is not attracted to clay or organic matter surfaces. Thus, it may act as a tracer of the water flow pathways.

Material and methods
Soil columns 10.17 cm in diameters and 25cm in were filled with soils having sandy loam and loamy sand textures. We kept the bulk density of the soil in the column similar to that in the field. The ends of the columns were closed with 5cm of sand washed with acid to inhibit soil loss and closed by aluminum nets. Experiments were laid out in by 18 columns with 3 replications to each texture. Three different doses of Br (10, 20 and 30 mg/kg soil) were dissolved in 250 ml distilled water, after solute pulse treatments applied to columns, leaching them in saturated conditions with 5cm constant head. After leaching, samples were taken at every 2 cm from 0-12 cm depths; at every 4 cm from 12-20 cm depths; and at every 5cm from 20-25 cm depths. Then we measured the Br concentration with a Br selective electrode. Bulk density was determined by the core method (Klute 1986), saturated hydraulic conductivity determination was made by a constant head method (Klute 1986), texture with a pipette method (Klute 1986). Electric conductivity was determined from soil extracts and cation exchangeable capacity ammonium acetate extraction.

Results
After measurements of Br concentration, all necessary data for modeling were collected from columns and were compared with leachate concentrations predicted by the model. In all level of treatments Br concentration was less measured less than detection of ion selective electrode. As we can see in the diagram below,the ion selective electrode is too sensitive to measure the estimated concentrations and can be concluded that the model has good prediction of the concentration. According to estimated concentrations, Br concentrations in all 3 levels of treatments for the sandy loam were more than for loamy sand textures, because the finer-textured soil contains smaller pores, thus increasing the portion of immobile water and thus decreasing leaching of Br. For both textures maximum concentration within the profile occurred at 23-25 cm depth because Br is an anion that is not well adsorbed by the soil, and is thus easily leached and transmitted to of the bottom of the soil columns.

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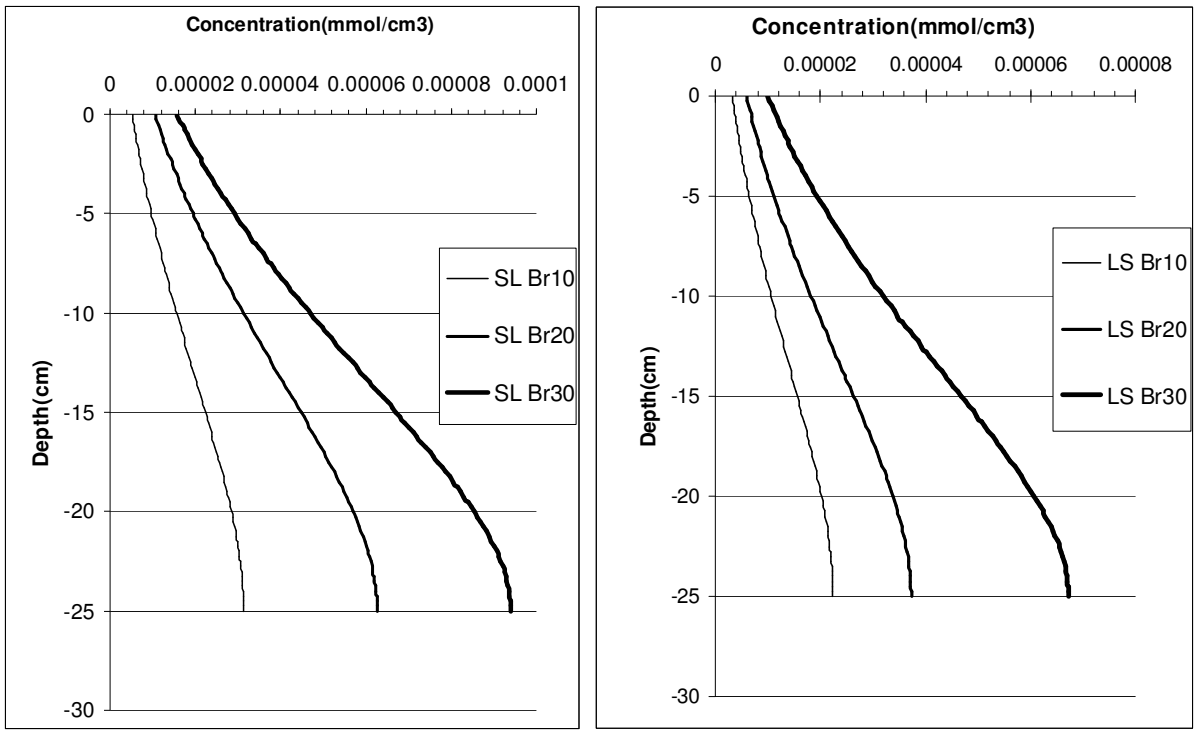

Figure 1. Chart of Br Concentration profile for sandy loam and loamy sand soils.

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