ABSTRACT

Knowledge of processes in the unsatured zone is important for understanding the behaviour of pollutants in the soil; this is the case of saline contamination or sulphide oxidation. In both cases, evaporation causes high ionic strength solutions, which affects the activity of water and, hence, phase changes. Moreover, under very dry conditions, water vapour fluxes become the main water flux mechanism. These phenomena have been studied in the past using closed columns, which represent poorly the actual field conditions. Therefore, the objective of this work is to study solute transport under evaporation condition using open columns, so as to understand the role of ionic strength and vapour fluxes.

We have built the open soil columns using two different materials: sand and silt. High ionic strength has been simulated using two different salts: halite (ClNa, initial concentrations of 7g/kg and 20g/kg) to simulate the processes that can occur in the saline soils and epsomite ($MgSO_4 \cdot 7H_2O$, 14g/kg and 40g/kg), to simulate the sulphated soils. The columns were initially saturated with these solutions.

Evaporation was generated using an infrared lamp and proceeded until the overall saturation arrived at 0.32.

The resulting evaporation rates and processes depend on the material, sand or silt, on the salt and the solution initial concentration. Evaporation is fastest for silt, halite solution and low initial concentration. At the end of the experiment, water content of silt columns increases slightly downwards. Concentration decreases sharply from brine values at the top to values below initial concentration at the lower half of the column. In contrast, sand columns display more complex patterns. Sand is virtually dry at the top portion. An evaporation front, characterized by a sharp increase to field capacity water content, is observed beneath. Further down, water content increases slowly with a shape similar to the retention curve. As in the silt columns, concentration in sand columns reaches brine values at the top and markedly smaller values than the initial concentration at the bottom. However, concentration now displays a minimum just beneath the evaporation front.

These results point to the qualitative importance of water vapour flux not only upwards above the evaporation front, but also downwards beneath this front. It is the subsequent condensation, especially near the front in the case of sand columns, what causes dilution of the solution below initial values.