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Monitoring of colloidal mobilization using the pressure induced field-flow fraction (PFFF) system

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1. Introduction

The concentration of the colloids has excessively variable in the soil porewater during the transient flow such as the rainfall events, snowmelting, and irrigation. The colloids usually include mineral fragments, microbes, and plant decay debris whose size range is about 10nm to 10㎛. Colloidal mobilization demonstrates a transport process of adsorbed contaminants, heavy metals, pesticides, and radionuclide in the soils. The colloidal mobilization in the soil is controlled by chemical composition of soil solution as well as water movement through the soil. The lysimeter experiments reported high concentration of colloids on the limbs of the water flux from the initial infiltration experiment. It is explained that air-water interface is likely to sorb irreversibly hydrophilic and hydrophobic particles in a porous media.

Field-flow fractionation is recognized as a relatively new technique that can sample the colloids in soil solution. Then, in this study, the pressure induced field-flow fractionation (PFFF) system is designed by accompanying the measurement system of soil water pressure, and seems to be more versatile and effective for quantitatively describing the extraction of soil colloids. The measurement of soil colloids in soil solution can predict colloid mobilization in transient flow regime. For this purpose, PFFF system was used to measure the soil water pressure together with the extraction of soil colloids. The PFFF system consists of a porous ceramic cup connected to capillary tube. It makes to sample soil colloids in two domains of the saturated and unsaturated condition. The objective of the present study was to investigate the relationship between the soil water pressure and colloidal concentration for the colloidal mobilization in sand column.

2. Results and discussion

The concentration of colloids was monitored with respect to soil water pressure in the sand packed column using the PFFF system. The PFFF system was consisted of soil solution sampler together with soil water pressure sensor, and connected with peristaltic pump. The sand column was prepared with saturated condition, and the soil

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colloids in the sand column were extracted with PFFF system.

The PFFF system extracted soil colloids from the sand column and measured soil water pressure by inducing the extraction pressure. As the induced extraction pressure was increased from -33 to -90 kPa, both soil water pressure and concentration of extracted soil colloids increased.

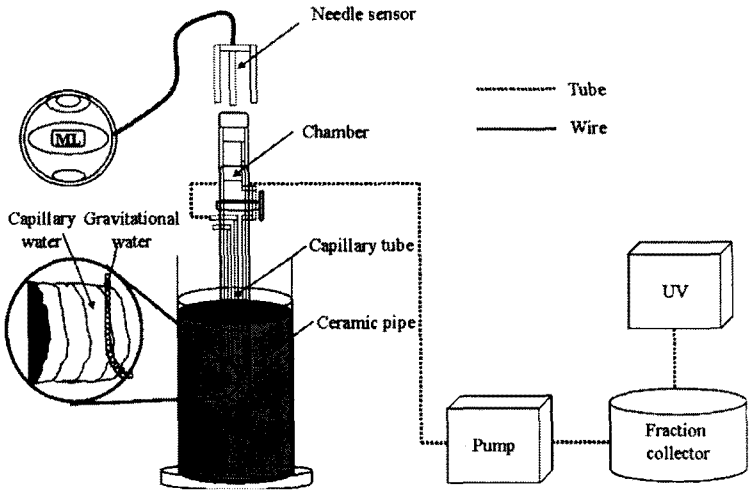

Fig. 1. PFFF system for the study of colloidal mobilization in transient flow condition

Under an constant induced extraction pressure, the concentration of extracted soil colloids was increased at the points increasing soil water pressure. The instant change in soil water pressure is related to colloidal mobilization. The colloidal mobilization results from generating shear force between pores in the saturated zone. However, high soil water pressure may restrain the increase in colloidal concentration in the unsaturated zone. The zeta potential seem to be reached to both negative and positive charge affected by the surface charge of silicate mineral colloids. The zeta potentials of extracted soil colloids depend on only the pore solution chemistry of each pH and ionic strength. Large-sized colloids were released during the initial extraction time under a constant induced extraction pressure. The size of colloids largely increased with increase of the induced extraction pressure. Then it implies that the higher induced pressure are exerted, the larger sized colloids are mobilized. This result is related to the shear force by water flow dominantly in saturated zone.

3. Conclusion

The PFFF system can be used for monitoring colloidal mobilization in the geochemical environment. Under a constant induced extraction pressure, the concentration of soil colloids increased at the points increasing soil water pressure. The large-sized colloids was released by the shear force of the water flow. Therefore, the colloidal mobilization may be affected by shear force of water flow in the transient flow regime. Further we will test the physical and chemical perturbation in a real system using PFFF.

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