

## Effect of soil environment on arsenic release in groundwater

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Geochemical cycling of arsenic (As) in the water ecosystems is increasing gradually, which provokes anxiety because of its severe toxicity effect for the human body. Long term exposure to low concentrations of As has been reported to cause cancer of bladder, skin and other internal organs. The mobilization of As from soil to groundwater and groundwater to soil is dependent on soil-water interaction in the subsoil environment. Although the geogenic source of the As in the groundwater is generally accepted, the primary source and the release mechanism of As in the groundwater are still not well understood. However, the redox potential of soil is an important parameter affecting As transformation. The redox conditions can affect the degradation and solubility of such organic material those are living in soil and then influence the release of As in groundwater. In the present study, a column experiment was carried out to observe the release of As in water from soil, collected from a area of Munakata city, Fukuoka under reducing environment, as well as its removal at the aerobic condition.

The chemical species arsenate (As(V)) and arsenite (As(III)) of As controlling its chemistry and toxicity in soils. Under oxidizing conditions, in aerobic environments, As(V) are the stable species and are strongly adsorbed onto iron and manganese oxides/hydroxides, clays and organic matters. The concentration of total As and arsenate As(V) measured in soil was same and it was  $9.4 \text{ mg kg}^{-1}$  that indicated As remained primarily as As(V) in soil. The total concentrations of Fe, Mn and total organic carbon (TOC) were measured in soil and which were  $39400 \text{ mg kg}^{-1}$ ,  $1130 \text{ mg kg}^{-1}$  and 1.95%, respectively.

A column was packed with experimental soil and water flow was continuous from feeding tank to overflow tank to create an anaerobic environment in the soil column. The temperature was also controlled at  $23^\circ\text{C}$ . The concentrations of As, Fe, Mn, Mg, Ca and  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$  were determined by the inductively coupled plasma and mass spectrometry (ICP-MS) and ion chromatography, respectively in effluents of soil column, and also physical properties were measured during the experiment to find out their interrelationships. It was observed that As concentration increased with decreasing oxidation-reduction potential (ORP). Electrical conductivity values correlate well those of As concentrations. Arsenic concentrations demonstrated negative co-variation with the concentrations of  $\text{NO}_3^-$  and  $\text{SO}_4^{2-}$  but strongly correlated with Fe concentrations. These relationships suggest that As may mobilized from soil to water by reductive dissolution of Fe oxyhydroxide or microbial reduction of organic matter under anaerobic environment.

The effluent of soil column was passed through the oxidation column filed with glass beads used as a filtration media. The physical parameters and the concentrations of As, Fe and Mn were measured in effluent of oxidation column by ICP-MS. During the oxidation period, the removal of Fe and As increased gradually and reached over 95% and 80%, respectively. From this, one can conclude that Fe(II) was firstly oxidized to Fe(III), which was precipitated and could act as the adsorbent for the subsequent removal of As(V). As(III) which may also be present in the effluent of soil column, could be also oxidized to As(V) and subsequently sorbed onto the iron oxides.

Keywords: Arsenic mobilization, Reducing environment, ICP-MS, Fe oxyhydroxide and Microbial reduction