

Dissertation Abstract

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Dissertation title	Leaching behavior of some metals and metalloids in the Quaternary sediment of Kanto plain, Japan (関東平野の第四紀堆積物に含まれる金属および半金属の溶出挙動に関する研究)		
Abstract			
<p>Leaching behavior of trace element and heavy metal strongly depends on the physicochemical form termed as chemical speciation in soil and sediment. So that, sediment and soil act as scavenger to transfer naturally or anthropogenically occurring element to subsurface environment with changing environmental conditions. Metals are usually very toxic at very low concentration and poses health risk. So, that it is required to understand their release mechanism or leaching behavior from sediment. Leaching behavior of some selected metals and metalloids were investigated in terms of potentially mobile speciation in sediment of different depositional environment. Metalloids are arsenic (As), and Selenium (Se). Metals are lead (Pb), Cadmium (Cd), Copper (Cu), Nickel (Ni), Zinc (Zn), Cobalt (Co), Chromium (Cr), Iron (Fe) and Manganese (Mn). In this research, total 25 boring core sediment samples were investigated at 1 m interval from lowland valley of Yono area, Saitama in Kanto Plain. Samples were kept in near natural or not oxidized condition applying special preservation technique so that samples were assumed to be under natural subsurface condition. Boring core consist of surface clayey silt, peat, organic rich silt and clay, tuffaceous clay and medium to coarse sand with gravel layer of nonmarine sediment up to 17 m depth, where as from depth of 17 to 20 m transitional sediment are underlain by marine sediment up to 26 m. On the other hand, total 20 samples were investigated for from a pre-existing boring core of Oto area, Saitama in central Kanto plain which are already air dried/ oxidized. Two bore hole distance is 1.6 km. Same lithology with sediment of same depositional environment exist in two borehole location. A four steps sequential extraction method was adopted to determine chemical speciation as well as potential mobile fractions. Total metal concentration, mineral content and chemical speciation concentration were determined by using X-ray Florescence(XRF), X-ray diffractometer (XRD), Inductively coupled plasma mass spectrometer (ICP-MS) and Inductively coupled plasma atomic emission spectrometer (ICP-AES) respectively. Clay minerals distributions were determined specially after application of heat and ethylene glycol treatment and XRD peak analysis. Pore water were collected from each samples and element concentration were measured by ICP-MS and ICP-AES. Under natural condition, pH of the leachate from sediment are not significantly different in nonmarine and marine environment which are ranged from pH 6.55 to 8.04. However, the electrical conductivity (EC) concentration range 53.9 to 72.1 $\mu\text{S}/\text{cm}$ in marine and</p>			

77.9 to 104.7 $\mu\text{S}/\text{cm}$ in surface silty clay sediment, that is quite higher than (7.83 to 25.4 $\mu\text{S}/\text{cm}$) of nonmarine fluvial, peat and tuffaceous clay. In airdried sediment, Peat and marine sediment showed pH ranges from 3 to 4.6 which is lower than other sediment. Electrical conductivity of peat and marine sediment is high which are 14.04 m S / cm and 4.85 to 9.91 m S / cm respectively. Total S concentration is relatively high in peat, surface and marine sediment which is ranges from weight percent of 2 to 5 %.

Transitional clayey silt between aquifer and marine sediment at 13 m depth showed high Fe and Mn concentration which are 15 % weight percent and 262 mg / kg.

The geochemical analysis showed the order of leaching trends to be As > Pb > Cd > Se for all steps. Chemical speciation trend for As in nonmarine fluvial sediment is Fe-Mn oxide bound > Carbonate bound > Ion-exchangeable bound > water soluble. The potential mobile fractions of all metals are less than 95-98 % where main fractions are residual indicates their occurrence are of natural origin. The leaching of As in fluvial environment is due to the organic matter-mediated, reductive dissolution of Fe-Mn oxide bound, where Mn is the scavenger. The amount of total content of As and sulfur (S) in transitional sediment reflects an elevated level of leachate in pore water, which is controlled by S reduction.

For Cu, Cr, Pb and Fe, reductive dissolution is the main mechanism before and after oxidation in both marine and non-marine fluvial environment. However, for Se, Co, Ni and Cd showed changing behavior after oxidation and become more mobile in marine, peat and alluvial sediment. There were no pollution risk from the leaching of these metals except Cd showed low pollution risk in marine sediment. Desorption is the main mechanism for Cd which is controlled by pH. In pore water also, the concentration trend is As > Se > Cd > Pb. However, only As conc. in pore water exceeds several times from environmental standard (10 $\mu\text{g}/\text{l}$) of WHO and Japan in leachate and drinking water of both non marine and marine sediment. Pore water concentration of Pb, Cd and Se have not exceeded the environmental standard of leachate and drinking water quality. Leaching behavior of metals and metalloids showed variable characteristics with sediments of different depositional environment along with variable pH, salinity, organic matter content and oxidation state. Results of non-airdried sediment can be considered as base reference for further investigation on metal pollution. Some metals like Cd, Se, Co, Ni and Mn become more bioavailable after oxidation /aeration with the influence of pH. Thus proper management is required for dredged sediment from the lowland of Kanto plain to protect metal pollution in surrounding environment.