Speciation and Distribution of Arsenic in Contaminated Soils in Guandu, Taipei

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Arsenic (As) is one of the priority contaminants of major concern in the environment because it is highly carcinogenic after long–term or high-dose exposure. Recently, elevated levels of arsenic (< 500 mg kg^{-1}) were found in the soils in Guan-duh plain, Beitou, Taipei. At this moment, the potential sources of the contamination have not been identified. Because we have found rocks containing As-bearing minerals in the nearby hot-spring area, we hypothesized that As in the soils may come from the weathering products of As-bearing minerals in the parent materials of the soils. Understanding the distribution and speciation of As-bearing phases in these soils will be essential for clarifying the major reactions and processes governing the transformation and bioavailability of As in soils.

In soils, pH and redox potential are two of the major factors determining the solubility and transformation of As-bearing species. To investigate the influence of soil redox conditions on the transformation and transport of As species, soil samples were collected at different depths of a As-contaminated paddy land and an adjacent dry land (Figure 1). Since the flooding of the paddy soil during rice growing seasons impedes the penetration of air to the soil, the resulting depth-dependent redox gradient is expected to strongly affect the distribution of As species in rice-paddy soils as compared with their counterparts in the dry land.

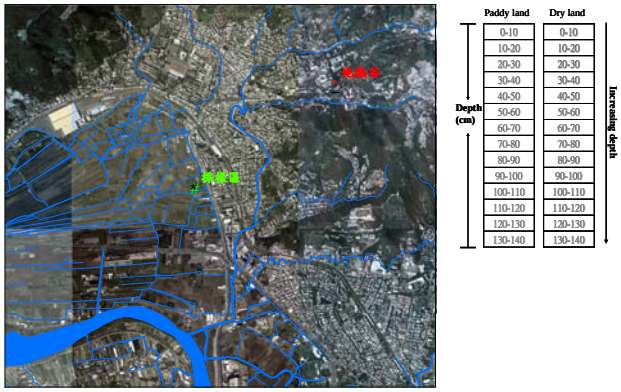

Figure 1. The soil sampling sites in Guan-du plain, Beitou, Taipei

To determine soluble As species in soils, de-ionized water was added into each soil sample (water:soil = 1:1) and equilibrated. The suspensions were subsequently filtered and the concentration of As species were determined using LC-ICP-MS. Meanwhile, soil samples were separated into sand, silt and clay particle-size fractions. Particle mineralogy in these fractions were investigated using X-ray diffraction, X-ray absorption spectroscopy and TEM. Specifically, As K-edge XANES and EXAFS analyses were used to determine (1) the oxidation states of As and (2) bonding configuration of As with respect to mineralogical association. The results of these analyses were used to identify the sources of As in soils and to determine As species and their spatial distribution along the soil profiles.

Due to high Fe content (>10%) in the Guan-duh soils, As may be associated with Fe(III) oxides (e.g., hematite) and oxyhydroxides (e.g., goethite and lepidocrocite) through adsorption or coprecipitation of As from water. To investigate the influence of reductive dissolution of Fe(III) (oxyhydr)oxides on As mobility and transformation, surface soils were collected and incubated in water at room temperature for up to 2 years. A set of samples will be collected every 4 months. Following aging, different size fractions of the soils will be collected from the samples for mineralogical characterization and As speciation.

The preliminary results showed that As(V) is the predominant species present in the soils of the As-contaminated rice-paddy and dry lands in Guan-du plain (Figure 2). A major fraction of As(V) was associated with Fe (oxyhydr)oxides under oxic condition and were released into water when reductive dissolution of Fe (oxyhydr)oxides occurred under anoxic condition. Thus, the mobility of arsenic is higher in the paddy soil. Our further efforts will be to differentiate the origins of As and the transformation of different As phases in soils. The information acquired in this work will assist in assessing the potential threat of As to ecosystems and publich health and improving strategies of managing these As-containing soils.

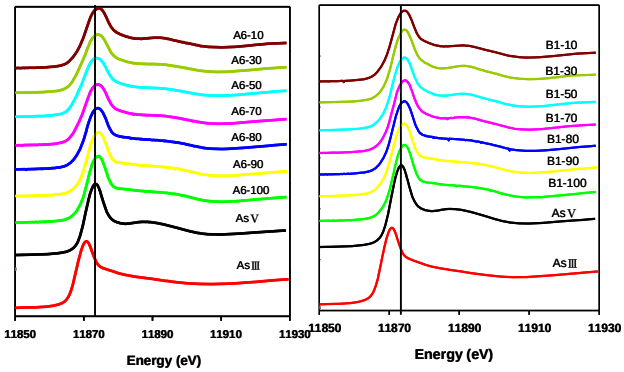

Figure 2. As *k*-edge XANES for the soil from the profiles of the As contaminated rice paddy (a) and dry (b) lands in Guan-du plain, Beitou, Taipei.