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Distribution and characteristics of arsenic in the geochemical environment of Chianan plain in Taiwan

S. W. Wang (1), C. W. Liu (1), C. C. Lai (1), and K. H. Lin (2)

(1) Department of Bioenvironmental Systems Engineering, National Taiwan University, Taipei 106, Taiwan, ROC, (2) Research Center for Environment and Resources Management, National Chen Kung University, Tainan, 701, Taiwan, ROC

Blackfoot disease associated with the direct ingestion of high As content groundwater was first reported in the Chianan plain of southwestern Taiwan. However, both the geochemistry of high As groundwater and the possible As release mechanisms in this area are still poorly defined. The objectives of the study are to characterizes the As-affected groundwater of the Chianan plain by multivariate statistical method and geochemical model, PHREEQC, and to identify the source of As and possible geochemical reactions by chemical, spectroscopic, and microscopic approaches of solid phases. A conceptual geochemical cycling in the Chianan plain will be proposed. The controlling factors of this groundwater quality determined by factor analysis are salinization factor and the As enrichment factor. The latter is based on well correlation between As, reductive potential, organic and inorganic carbon. Si, Al and Fe are the main components of sediment materials. Arsenic concentrations correlate well with S and Fe contents in sediment. The primary Fe minerals are Fe oxy-hydroxides and iron disulfide. According to the results of sequential extraction, >90% of As contents is related to coprecipitation with iron sulfides, amorphous and crystalline Fe oxy-hydroxides, and adsorption of bicarbonate. Two most possible geochemical process of As release to groundwater are reductive dissolution of As-rich Fe oxy-hydroxides and microbial-mediated oxidation of As-bearing Fe sulfide minerals. Under reductive condition, low Eh causes the dissolution of Fe oxy-hydroxides and reduction of sulfate to sulfide. Over-pumping introduces excess dissolved oxygen to first oxidize As-bearing sulfide minerals, release As and then gradually re-precipitated as As-coated Fe minerals. The result provides valuable information for utilization and management of As-affected groundwater resources.