Groundwater contamination with U and Th in Cox’s Bazar paleo-beach aquifers, South-Eastern Bangladesh: Focusing on characteristics and fate in the environment

Ashraf Ali Seddique 1, Harue Masuda 2, Teruyuki Maruoka 3, Shaibur Rahman Molla 4, Nur Alam 5, Moklesur Rahman 1, Matin Ahmed 6, Ashraful Hoque 7

1 Dept. of Petroleum & Mining Engineering, Jessore Science & Technology University (JSTU), Jessore, asheddiq@yahoo.com; 2 Dept. of Geosciences, Osaka City Univ., Japan; 3 Graduate School of Life and Environmental Sciences, Univ. of Tsukuba, Japan; 4 Dept. of Environmental Science & Technology, JSTU; 5 Dept. of Chemical Engineering, JSTU; 6 Dept. of Geology, Univ. of Dhaka, Dhaka; 7 Marine Fisheries & Technology Station, Cox’s Bazar

ABSTRACT: Cox’s Bazar town is a rapidly growing densely populated area and famous for tourism. Thereafter, the Cox’s Bazar paleo-beach area is composed by unconsolidated sedimentary formations of fine to medium size sands to form the groundwater aquifers. The beach sand deposits are enriched with more than 60 wt% heavy minerals includes magnetite, ilmenite, garnet, zircon, rutile, kyanite, leucoxene and monazite. Ninety eight drinking groundwater samples collected from different depths of Cox’s Bazar paleo-beach and the hills behind the beach were analyzed using ICPcMS for contents of U and Th together with minor and major chemical components. Physico-chemical parameters (i.e., pH, Eh, dissolved O₂, EC, alkalinity) were also measured in situ. Results show clearly that the highly U and Th contaminated groundwater are spatially limited in paleo-beach area. Concentrations of U ranged <0.01 - 3.40 µg/l, and 4% of studied shallow tubewells (<30m in depth) contained excess U from the WHO (1998) drinking water guideline, 2.0 ug/l, which were mainly found at paleo-beach sites. Th and Ce concentrations ranged <0.01 - 1.60 ug/l and 0.01 - 9.89 ug/l respectively, both of which do not have the WHO guideline values. However, those occurrences are strongly correlated to each other. U and Th rich groundwater mostly occurred in the high Eh (0.35- 0.5V). Compared to the U and Th concentrations, U rich groundwaters were found in pH ranged from 6.6 to 7.5, while Th was found in pH ranged from 8.0 to 8.5 conditions. It implies that U and Th mobility in water-rock system taking place in oxidizing conditions, U and Th solution-mineral equilibrium and sorption reactions. The correlation analysis for U and Th showed that only U gives a positive correlation between its concentration to EC (ranged 220 - 3655 µS/cm) and alkalinity values (ranged 1.24 - 13.12 meq/l), indicating solubility of U-bearing minerals by carbonate complexation in association with the biodegradation of organic matter. U and Th concentrations showed an inverse relationship with Pb concentrations. It is predicted that the successive recoils of U and Th and release of Ra, Rn and Pb isotopes in the same decay chain and the enrichments by adsorption in a zone of water-rock interaction. The study area has been extensively utilizing pumped water from the underlying aquifers to meet the demand for thousands of tourists along with domestic, aquaculture, and agricultural purposes. Dissolved U and Th concentrations in groundwater were first examined and it is great concern for the environments. Release of U and Th via weathering of placer deposits of heavy minerals and measurement of radioactivity should be the focus of further research to better understand the formation and mobilization processes of U and Th in Paleo-beach aquifers.

Key words: Paleo-beach; Groundwater; U and Th; Mobilization, Weathering.