

## Seasonal change of the major and trace elements of Red river water, northern Vietnam.

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Red River, originated in Yunnan, China, is running through Vietnam along Red River Fault, and forms Red River Delta in its downstream. In Vietnam territory, there are big towns along the Red River such as Lao Cai at the border with China, Bao Ha, Yen Bai, Capital Ha Noi, and Nam Dinh. It has been clear that arsenic contaminated ground waters have spread in and around the Red River Delta since 2000's. The arsenic must be carried to the aquifer through the river, although the transportation process is not well understood. In order to trace the process, we analyzed major and minor dissolved components including arsenic concentration and the oxygen and hydrogen isotopes of river water samples; 29 in rainy season (2013.7.26-2013.8.4) and 45 in dry season (2014.4.11-2014.4.21).

Range of total arsenic concentration of riverwaters from the main channel are 1.4-9.1  $\mu\text{g/L}$  in the rainy season and 2.2-92.9  $\mu\text{g/L}$  in the dry season. Total arsenic concentrations were 9.2  $\mu\text{g/L}$  in the rainy season and 33.9  $\mu\text{g/L}$  in the dry season near Lao Cai. Although arsenic concentration is less than the WHO standard (10  $\mu\text{g/L}$ ) in the rainy season, the concentration in the dry season was much higher than the standard. Arsenic concentration decrease toward downstream from Lao Cai. Around Ha Noi, located in about 300km downstream, total arsenic concentration was 1.4  $\mu\text{g/L}$  in the rainy season and 3.8  $\mu\text{g/L}$  in the dry season. In both seasons, range of total arsenic concentrations of branches are lower than those of the main channel. 40% of arsenic was dissolved near Lao Cai, and the ratio of dissolved arsenic increase toward downstream. Finally, most of arsenic was dissolved near Ha Noi.

The oxygen and hydrogen isotope ratios of riverwaters were plotted on the GMWL ( $\delta^2\text{H}=8*\delta^{18}\text{O}+10$ ). Most of the  $\delta^{18}\text{O}$  of branch waters were lower than those of main channel in the rainy season, while higher in the dry season. Inflow from the branches influenced the isotope compositions of main channel waters through the year, especially in the rainy season when precipitation was abundant.

Total arsenic concentration of main channel water decreased due to the inflow of diluted branch waters. Also, the arsenic would be removed from the riverwater in association with sedimented particles on the riverbed.

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