Geochemistry of U-Th series radionuclides in groundwater of the Hetao basin, inner Mongolia (China)

WEIGUANG ZHAO [1,2], HUAMING GUO[1,2,*]

[1]School of Water Resources and Environment, China University of Geosciences (Beijing), Beijing 100083, P.R. China (*correspondence:hmguo@cugb.edu.cn)

[2]State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Beijing 100083, PR China (weiguang_zhao@qq.com)

The health risk of groundwater radionuclides (uranium, radium and radon) has received much concern, due to their digestion as drinking water by human. However, few data are available for groundwater radionuclides in the Hetao basin, P.R. China. Therefore, it is necessary to investigate the distribution and migration characteristics of nature radionuclides in groundwater from the Hetao basin.

From alluvial fans, via transition area, to flat plain in the Hetao basin, 111 groundwater samples were taken from irrigation and drinking wells, and 16 sediment samples from two boreholes and 5 bedrock samples with different lithology in the langshan mountain were also collected. Radionuclides and major components and trace elements were analyzed in the lab.

Results showed that 40.3% of investigated samples had uranium concentrations greater than 30 μg/L (WHO drinking water standards). High U groundwater was mainly found in alluvial fans and transition area. Of analysed samples, 52 groundwater samples had radon activity > 11.1 Bq/L (EPA drinking water standards), which was mostly observed in alluvial fans.

Groundwater in alluvial fans is mainly recharged from fracture water in mountain areas, which was present under oxidizing conditions. Uranium existed in the form of U(VI), and mainly occurred as complexes with carbonate in groundwater, which was related to high mobility of U in this region.

The Ra isotope in groundwater derived from alpha recoil process of the parent nucleus in the aquifer rocks and on the surface coatings of clay minerals and Fe/Mn oxides. Ra was readily adsorbed on the clay minerals neighbouring aquifers, and Fe/Mn oxides, which were the sinks of groundwater Ra. The U and Th contents in primary minerals and secondary minerals in aquifer solids were major factors controlling groundwater radium isotope. Reduction of Fe/Mn oxides led to release of Ra into groundwater. Besides, cation exchange also resulted in desorption of Ra. Total dissolved solids and redox condition affected radium isotope in groundwater.

Adsorbed Ra produces Rn into groundwater by α- recoil process. The major source of Rn in groundwater was the sediment Ra in aquifers. In alluvial fans, groundwater had low TDS values and high Eh, where sediment Ra may be relatively higher. This was the reason for high activity of Rn in groundwater of alluvial fans.

Keywords: groundwater; radionuclides; geochemistry