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Radioactivity in rocks and soil and interaction with groundwater in an arid region

Dalal Alshamsi (1), Ahmed Murad (2), Ala Aldahan (3), Xiaolin Hou (4), and Ayman El Saiy (5)

(1) UAE University, Department of Geology, United Arab Emirates (dalal.shamsi@uaeu.ac.ae), (2) UAE University, Department of Geology, United Arab Emirates (ahmed.urad@uaeu.ac.ae), (3) UAE University, Department of Geology, United Arab Emirates and Department of Earth Sciences, Uppsala University, Uppsala, Sweden (aaldahan@uaeu.ac.ae), (4) Center for Nuclear Technologies, Technical University of Denmark, Roskilde, Denmark and Xi'an AMS Centre and SKLLQG, Institute of Earth Environment, CAS, Xi'an, China (xiho@dtu.dk), (5) Department of Geology, United Arab Emirates University (aymane@uaeu.ac.ae)

Interaction of groundwater with soil and rocks changes the chemical composition of the water both spatially and temporally. In arid regions, surficial recharge of groundwater is generally limited to sporadic rainfall events which may cause rapid interaction between the recharge water and the aquifers materials. Among the elements that commonly increase in concentration as groundwater interact with the aquifer materials are the radioactive elements such as uranium and thorium and their decay chain products. Here, we present data on ^{235}U, ^{238}U, ^{232}Th as well as ^{137}Cs in some sediments and rock aquifers located in the United Arab Emirates (UAE) in southeastern Arabian Peninsula. The Quaternary sediments are composed of silt, sand and gravel with varying proportions of quartz, carbonates, feldspars, evaporites, while the carbonates are mainly limestones, dolomitic limestones, dolomite and calcareous mudstones. These carbonate rocks cover ages extending from 10-230 Myr. After complete digestion using fluoric and nitric acids and chemical separation, the isotopes were measured using ICP-MS. The ^{235}U, ^{238}U and ^{232}Th concentrations ranges are 2.66-32.5 ng/g, 354.7-4453 ng/g and 13.2-1367 ng/g respectively in the carbonate rocks. In the sediments the concentrations are 4.6-17.5 ng/g for ^{235}U, 631.7-2406 ng/g for ^{238}U and 25.6-799.6 ng/g for ^{232}Th. Although it is difficult to quantify the amounts of uranium isotopes that enter the hydrological system from the aquifers, it seems that in the presence of carboxyl ions, uranium forms highly soluble complexes which can be transported to large distances in groundwater. The variations in ^{232}Th concentrations are probably controlled by the availability of sulfate salt rocks (like gypsum) interacting with thorium and forming soluble thorium compounds which can also explain the highly variable concentrations in groundwater.