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Distribution of uranium and thorium in groundwater of arid climate region

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Uranium, thorium and their decay products are the most common radionuclides in groundwater in addition to potassium-40. Once groundwater is used for drinking, domestic and irrigation purposes, the radionuclides will then pose environmental and health related hazard originating from radioactivity and toxicity. In the investigation presented here, assessment of ^{238}U, ^{235}U and ^{232}Th concentrations in groundwater across of the United Arab Emirates (UAE) is evaluated in terms of quality and sources. The region is dominated by arid climate conditions and radioactivity assessment of groundwater is essential for safe use of groundwater. Furthermore, the results were linked to data from other arid regions and worldwide. Groundwater samples (total dissolved solids,TDS, 142.5 mg L^{-1} to 12770 mg L^{-1}) from 67 different wells were collected across geomorphologically different areas and most of the wells are actively used for agriculture. The aquifers are recent sand dunes, Quaternary (3 million years to present) sediments, and older carbonate rocks (230-10 million years). The ^{235}U, ^{238}U and ^{232}Th measurements were carried out using ICP-MS system equipped with an Xt-skimmer cone and a concentric nebulizer under hot plasma conditions. Concentrations of ^{235}U, ^{238}U and ^{232}Th range at (0.125–508.4) ng L^{-1}, (25.81–69237) ng L^{-1} and (0.236–2529) ng L^{-1}, respectively. Apparently, most ^{235}U, ^{238}U, ^{232}Th concentrations in the sampled groundwater are below the WHO proposed permissible level of 60000 ng/L for total uranium (1 Bq L^{-1} for ^{235}U and 10 Bq L^{-1} for ^{238}U) and 5000 ng L^{-1} (1Bq L^{-1}) for ^{232}Th. A few samples show high concentrations of uranium that are associated with high TDS values and occur within interbedded limestones and shales aquifer. Comparison with worldwide groundwater data suggests that ^{238}U concentration is highest in the arid regions groundwater where the recharge to aquifers is relatively low. The situation for ^{232}Th concentrations seems less affected by climatic conditions, most likely is related to its less solubility in water compared to uranium. We calculated the accumulated ^{T}U and ^{232}Th concentration in the irrigation water annually to estimate the cumulative concentrations after twenty years on specific agricultural areas. The ^{T}U and ^{232}Th are expected not to reach more than 1.14 x 10^{-3} g (1.14 mg) and 4.32 x 10^{-6} g (4.32 μg) respectively after twenty years if the daily irrigation is at its maximum amount (10 m^3). Despite these obtained values of concentrations in irrigation water, the transfer of uranium and thorium into crop is not readily and it is expected that only a tiny fraction of the element end into the body. However, further research is needed to quantify the dietary exposures in the UAE with detailed data from crops and consumers.