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A survey of thorium (Th) and uranium (U) in the groundwater of NW Portugal

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INTRODUCTION:

Thorium (Th) and uranium (U)are both radioactive and chemical toxins and the role that radiation vs chemical effects play in its toxicology remains mysterious. In the last years, a great interest on the environmental toxicity of Th and U has been raised by two recent developments: (i) the global drive toward low-carbon energy which enhances the interest towards nuclear power, and (ii) its growing use as depleted uranium (DU) in military munitions [1]. A third important factor from an exposure perspective, and maybe the one receiving the least attention, is the increasing worldwide consumption of groundwater. Recent evidence points to the fact that groundwater in many parts of the world is contaminated with Th and U from natural and industrial sources [2]. Exposure to Th and U from drinking water is growing rapidly as more people increasingly rely on groundwater as their primary source of water [3].

OBJECTIVES:

The aim of the present work was to assess the Th and U contamination of groundwater used for irrigation and human consumption during 3 months.

MATERIALS AND METHODS:

The study involved a monitoring program in NW Portugal, in a region between Esposende and Vila do Conde. Groundwater samples were collected from 4 sites (S1, S2, S3 and S4) every 2 weeks during 3 months in a total of 6 sampling times. Groundwater physicochemical characteristics (pH, EC, salinity and TDS) and radioactives (Th and U) were determined according to standard methods. Water pH, EC, TDS and salinity were measured *in situ* by a portable pH/conductivity meter. Th and U were determined by ICP-MS.

RESULTS AND DISCUSSION:

With the exception of S4, Th and U were detected in all groundwaters. Groundwater from S1 had the highest mean values of Th (0.23 ± 0.02 µg/L) and U (11.5 ± 1.1 µg/L) compared with the other groundwaters. In the case of Th, groundwater from S1 was 7- and 12-times higher than groundwater from S2 (0.033± 0.004µg/L) and S3 (0.019± 0.003µg/L), respectively. In the same way, U concentrations in groundwater from S1 were 4- and 100-times higher compared to water from S2 and S3, respectively. Regarding the temporal variation, no significant differences ($p< 0.05$) were observed for Th and U concentrations along the studied period. The mean U concentration of all the studied groundwaters was below the threshold of 30 µg/L imposed by WHO. Currently, the WHO does not have a drinking water guideline for Th [4]. Despite the fact that U concentrations were always below the WHO guidelines and Th concentrations seem relatively small when expressed in µg/L, several trillions of Th and U atoms are present per liter of water. These trillions of Th and U atoms per liter of drinking water over a lifetime of exposure could pose a significant health risk, especially carcinogenic effects [5].

CONCLUSION:

These results highlight the urgent need for multiple metal testing of groundwater in NW Portugal and other areas where radioactive contamination is known to occur. To prevent the serious health effects of exposure to radioactive elements, remediation strategies must be considered in common water treatment facilities. In addition to the common elements monitored in drinking water, routine water testing must include analyses for other common groundwater contaminants such as Th and U.

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