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Radiation Dose Assessment and Mobiliy Studies of Thorium in Sediments from a High Level Natural Background Radiation Area in Sri Lanka

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Sri Lankan coastal areas are well-known for their high background radiation levels, mostly due to Th-bearing minerals, identified not more than a decade ago [1,2]. The radioactivity of Th-232 in Sri Lanka ranges between 9 and 1166 Bq kg-1 (average 138 Bq kg-1) [3] while global natural Th-232 content in sediments ranges between 11 and 64 Bq kg-1 (average 30 Bq kg-1) [4]. However, higher inland natural background radiation levels were discovered in 2015 in the Kawudupelella area (Matale district) while exploring the availability of natural radio-minerals under a collaborative project between the Sri Lanka Atomic Energy Board (SLAEB) and the Geological Survey and Mines Bureau (GSMB) of Sri Lanka [5]. The radioactivity data of this location raised concern related to the risk of public radiation exposure since the screened area comprised a school playground.

This study presents both on-site radioactivity measurements and results from leaching experiments using sediments from the school playground in order to better understand the environmental risk in the area. Gamma spectrometry from the sediment samples clearly showed the dominant contribution of Th-232 to total activity (ranging between 4000 and 7600 Bq kg-1). In-situ measurements carried out using a radiation survey meter equipped with a NaI scintillation detecor and built-in GM counter, yielded background radiation levels at one-meter height above the ground of 2.5 ± 1.2 μSv h-1 (max. 21.6 ± 10.9 mSv yr-1). The calculated absorbed dose rates in air, 3000 –4600 nGy h-1, exceed the world averages (18 –93 nGy h-1) and are similar to those registered in monazite-bearing sands in coastal areas of Kerala and Madras (200 - 4000 nGy h-1) [4]. The potential mobility (i.e. solubility and leaching behavior) of radioactive Th was extensively studied using appropriate selective extraction schemes (sequential and single batch extractions) and column experiments. Both sequential and single extractions showed comparable results (i.e., no losses of Th during sequential extractions) indicating that the maximum extractions (8 wt.% of total Th) occurred from carbonate, organic and amorphous iron/manganese (hydr)oxide fractions, i.e. not related to the major Th-containing mineral phases (oxide, phosphate and silicate phases). Batch extractions and column leaching experiments with simulated rainwater showed much lower leachability of Th compared to the chemical extractions. These results imply that >90 wt.% of the radioactive Th is mainly present in the residual fraction (assumed to be non-reactive) and that environmental processes may mobilize less than ~500 Bq kg-1 (still non-negligible). This study suggests important public, on-site exposure to radioactive Th-containing particles, marking the onset for future work concerning radioactive risk assessment in Sri Lanka.

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