Natural radioactivity and radiation exposure at the Minjingu phosphate mine in Tanzania

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Abstract

In this paper the results of studies on activity and ambient radiation background around the Minjingu phosphate mine in Tanzania are presented. The outdoor dose rate in air and the activity levels of samples from and outside the mine were determined by thermoluminiscent dosimeters and a gamma spectrometer system with a Hyper Pure germanium detector system respectively. The determination of activity was made for the 226Ra, 228Ra, 228Th and 40K radionuclides. High concentrations of radium-226 were observed in phosphate rock (5760+/-107 Bq kg(-1)), waste rock (4250+/-98 Bq kg(-1)), wild leaf vegetation (650+/-11 Bq kg(-1)), edible leaf vegetation (393+/-9 Bq kg(-1)), surface water (4.7+/-0.4 mBq l(-1)) and chicken feed (4+/-0.1 Bq kg(-1)) relative to selected control sites. These findings suggest a radiation health risk particularly when the samples are ingested, because the internal exposure may give rise to an effective dose exceeding 20 mSv which is the annual limit of intake of natural radionuclides recommended by the ICRP. On the other hand, the radiation dose from ambient air over five years at the phosphate mine ranges from 1375 to 1475 nGy h(-1) with an average of 1415 nGy h(-1). The average is about 28 times that of the global average background radiation from terrestrial sources, and about 12 times the allowed average dose limit for public exposure over five consecutive years. Future investigations on the occupancy factor, external dose rate and radon and radon progeny exposure in drinking water, buildings and activity content in the locally grown foodstuffs are proposed, for the realistic quantification of the overall exposure of workers and public at Minjingu, and remedial measures for future radiation safety.