

Monitoring anthropogenic airborne natural radionuclides in the vicinity of a TENORM industry using lichen as bio-indicator

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Abstract

It is well known that the operation of TENORM industries may affect the surrounding environment. The amount of natural radionuclides discharged to the atmosphere from a TENORM industry depends on a number of factors such as the composition of the raw material and final residue formed and the chemical process involved. The tin industry is a typical example of a TENORM industry, since the high temperatures used in the smelting and refining processes may lead to concentrations of natural radionuclides, mainly in the precipitated dust and in slag, which are stored in piles in open air. Pb-210 can also be released to the atmosphere during the combustion, depending on the efficiency of the emission control devices. This paper aims to study the viability of using *Canoparmelia texana* lichen species as bio-indicator of air pollution by natural radionuclides of the U and Th series (^{238}U , ^{226}Ra , ^{210}Pb , ^{210}Po , ^{232}Th and ^{228}Ra) in the surroundings of a tin and lead industry located in Pirapora do Bom Jesus city in the state of São Paulo, Brazil. This installation is responsible for the production of about 7 500 ton year⁻¹ of tin and 120 ton year⁻¹ of lead. The raw material used is cassiterite, which presents in its composition concentrations of U and Th up to 42 kBq kg⁻¹ and 60 kBq kg⁻¹, respectively. The amount of waste stored is estimated to be about 54 000 ton annually. The radionuclides ^{226}Ra , ^{228}Ra and ^{210}Pb were determined by radiochemical separation followed by gross alpha and beta counting using a gas flow proportional counter. Po-210 was spontaneously plated on a silver disc and measured by alpha spectrometry. Uranium and thorium were determined by instrumental neutron activation analysis. Concentration values obtained for lichen samples varied from 19 Bq kg⁻¹ to 473 Bq kg⁻¹ for ^{238}U , 21.4 Bq kg⁻¹ to 265 Bq kg⁻¹ for ^{226}Ra , 401 Bq kg⁻¹ to 1083 Bq kg⁻¹ for ^{210}Pb , 16 Bq kg⁻¹ to 574 Bq kg⁻¹ for ^{232}Th , from 175 Bq kg⁻¹ to 389 Bq kg⁻¹ for ^{228}Ra and from 115 ± 4 Bq kg⁻¹ to 1318 ± 30 Bq kg⁻¹ for ^{210}Po . It was also observed that the lichens more exposed to atmospheric deposition and for a longer period of time presented a higher accumulation of these elements.

KEYWORDS: *Natural radionuclides; lichens; TENORM industry; bio-indicator.*

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