

# Assessment of atmospheric pollution in the vicinity of a tin and lead industry using lichen *Canoparmelia texana*

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## Abstract

The tin and lead industry located in Pirapora do Bom Jesus in the state of São Paulo, Brazil, is responsible for the production of about 7500 ton year<sup>-1</sup> of tin and 120 ton year<sup>-1</sup> of lead. The raw material used in this facility is cassiterite, which presents in its composition concentrations of natural radionuclides from the uranium and thorium series up to 42 kBq kg<sup>-1</sup> and 60 kBq kg<sup>-1</sup>, respectively. The high temperatures used in the smelting and refining processes may lead to concentrations of these radionuclides, mainly in the precipitated dust and in slag. In the operational process, intermediate refining and final slag are obtained and are stored in piles in open air. It is estimated that the amount of waste stored is about 54000 ton annually. Although in the raw material the radionuclides from the uranium and thorium series are almost in equilibrium, during the processing this equilibrium is disrupted and the radionuclides migrate according to their chemical properties. Concentrations up to 63 kBq kg<sup>-1</sup> for <sup>238</sup>U, 69 kBq kg<sup>-1</sup> for <sup>226</sup>Ra, 2.5 kBq kg<sup>-1</sup> for <sup>210</sup>Pb, 127 kBq kg<sup>-1</sup> for <sup>232</sup>Th and 120 kBq kg<sup>-1</sup> for <sup>228</sup>Ra were obtained in the slag. It was observed that REEs can also be found in the slag in concentrations higher than in the feedstock. Since this facility has been in operation for more than 20 years, it is expected an environmental impact due to re-suspension of the residue, atmospheric dispersion and deposition in the soil by rain washout. This paper aims to study the viability of using lichen *Canoparmelia texana* as bioindicator of air pollution by radionuclides and REEs. The lichen and soil samples were analyzed for uranium, thorium and REEs determination by instrumental neutron activation analysis. The radionuclides <sup>226</sup>Ra, <sup>228</sup>Ra and <sup>210</sup>Pb in soil samples were determined by gamma spectrometry; and in the lichens samples by radiochemical separation and gross alpha and beta counting in a gas flow proportional counter. Concentration values obtained for lichen samples varied from 19 Bq kg<sup>-1</sup> to 473 Bq kg<sup>-1</sup> for <sup>238</sup>U, 21.4 Bq kg<sup>-1</sup> to 265 Bq kg<sup>-1</sup> for <sup>226</sup>Ra, 401 Bq kg<sup>-1</sup> to 1083 Bq kg<sup>-1</sup> for <sup>210</sup>Pb, 15.9 Bq kg<sup>-1</sup> to 574 Bq kg<sup>-1</sup> for <sup>232</sup>Th and from 175 Bq kg<sup>-1</sup> to 389 Bq kg<sup>-1</sup> for <sup>228</sup>Ra. The results obtained show that the lichen *Canoparmelia texana* concentrate radionuclides and REEs and therefore can be used as bioindicator of atmospheric pollution.