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The Application of Radiochemical and Isotopic Studies to Inform on the Impact of Acidic Effluent Discharges from the Caldas Uranium Mine into Neighboring Surface Waters

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Located in the Poços de Caldas Plateau, in the southeast of Brazil, the Caldas Uranium Mine is undergoing a decommissioning process. The uranium ore consists of uranium oxides, sulfide and zirconium minerals, fluorite, rare earth phases and molybdenum-bearing minerals. The main environmental problem in the site is the generation of acid mine drainage (AMD) due to the presence of sulfide minerals in the ore and in the host rocks. Acidic effluents flow from a tailings dam, from the open pit and from waste rock piles. The study evaluates the influence of these effluents on the surrounding surface water courses. Twelve sampling stations were established in order to carry out the investigation. Two of them were located inside two effluent retention ponds: the tailings pond that collects the effluents percolating from the major waste rock pile at the site, and the settling pond immediately downstream from the tailings dam. The remaining stations were located downstream and upstream of the mine. Sampling was performed in the rainy and dry seasons in 2010 and 2011. Electrical conductivity and pH were measured in situ; uranium and sulfate concentrations were determined by ICP-MS and by liquid chromatography, respectively. Radiochemical procedures were used to measure the 226Ra, 228Ra and 210Pb activity concentrations. 18O and 2H isotopes were determined by isotope ratio mass spectrometry. 238U was estimated to be 12.3 Bq per mg of uranium mass. Samples from the ponds exhibited high median values of SO42- (1301 mg/L), electric conductivity (1788 µS/cm), 238U (≈109 Bq/L), 226Ra (0.49 Bq/L), 228Ra (0.47 Bq/L), 210Pb (0.70 Bq/L), and low pH (3.6). The effluents from the tailings dam pond presented a more enriched isotopic composition (δ18O = -2.6‰ and δ2H = -18‰) than the other sampling stations, while the opposite was noticed in the pond collecting the waste pile effluent (δ18O = -7.1‰ and δ2H = -44‰). The results also indicated that acidic effluents from the ponds were entering the surrounding downstream watercourses, causing a significant increase in the acidity, electric conductivity, sulfate concentration, and 238U, 226Ra and 228Ra activity concentrations. The variation of δ18O and δ2H values along the watercourses suggests that: waste pile effluent discharges caused a depletion of 2H and 18O in the waters downstream; tailings dam effluents have enriched the stable isotope composition of the waters downstream. These results can be relevant to the stakeholders and to the authorities responsible for the site remediation. The authors will continue to carry out studies on the site, emphasizing the identification of acidic effluent underground leakage points. In future work, tracers, radiotracers and isotopes will be used, contributing to the dissemination of these techniques as important tools for solving environmental problems, with focus on those arising from the mining industry.

Country/Organization invited to participate

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