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Study of the Transport of ^{226}Ra Colloidal in Mining Context Using a Multi-Disciplinary Approach

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Abstract : ^{226}Ra is one of the radionuclides resulting from the disintegration of ^{238}U. Due to its half-life (1600 y) and its high specific activity (3.7 x 1010 Bq/g), ^{226}Ra is found at the ultra-trace level in the natural environment (usually below 1 Bq/L, i.e. 10-13 mol/L). Because of its decay in ^{222}Rn, a radioactive gas with a shorter half-life (3.8 days) which is difficult to control and dangerous for humans when inhaled, ^{226}Ra is subject to a dedicated monitoring in surface waters especially in the context of uranium mining. In natural waters, radionuclides occur in dissolved, colloidal or particular forms. Due to the size of colloids, generally ranging between 1 nm and 1 µm and their high specific surface areas, the colloidal fraction could be involved in the transport of trace elements, including radionuclides in the environment. The colloidal fraction is not always easy to determine and few existing studies focus on ^{226}Ra. In the present study, a complete multidisciplinary approach is proposed to assess the colloidal transport of ^{226}Ra. It includes water sampling by conventional filtration (0.2µm) and the innovative Diffusive Gradient in Thin Films technique to measure the dissolved fraction (<10nm), from which the colloidal fraction could be estimated. Suspended matter in these waters were also sampled and characterized mineralogically by X-Ray Diffraction, infrared spectroscopy and scanning electron microscopy. All of these data, which were acquired on a rehabilitated former uranium mine, allowed to build a geochemical model using the geochemical calculation code PhreeqC to describe, as accurately as possible, the colloidal transport of ^{226}Ra. Colloidal transport of ^{226}Ra was found, for some of the sampling points, to account for up to 95% of the total ^{226}Ra measured in water. Mineralogical characterization and associated geochemical modelling highlight the role of barite, a barium sulfate mineral well known to trap ^{226}Ra into its structure. Barite was shown to be responsible for the colloidal ^{226}Ra fraction despite the presence of kaolinite and ferrihydrite, which are also known to retain ^{226}Ra by sorption.

Keywords : colloids, mining context, radium, transport
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