



XVI Congresso de Geoquímica dos Países de Língua Portuguesa

Universidade de Aveiro
28 julho > 2 de Agosto 2024

Contributos da Geoquímica para um Futuro Sustentável

Livro de Resumos · *Abstract Book*

título	XVI Congresso de Geoquímica dos Países de Língua Portuguesa - Contributos da Geoquímica para um Futuro Sustentável: Livro de resumos
editores	Eduardo Ferreira da Silva, Carla Patinha, Nuno Durães, Carla Candeias
organizações	Universidade de Aveiro, Unidade de Investigação GeoBioTec, Sociedade Geológica de Portugal e Sociedade Brasileira de Geoquímica
apoio	Sociedade Geologica de Portugal / Sociedade Brasileira de Geoquímica
editora	UA Editora, Universidade de Aveiro 1ª edição, julho 2024
ISBN	ISBN 978-972-789-934-0
DOI	https://doi.org/10.48528/kdqa-r788

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Este trabalho foi financiado pela Fundação para a Ciência e Tecnologia (FCT), através de fundos nacionais, pelos projectos UIDB/04035/2020 - GeoBioTec- GeoBiciências, GeoTecnologias e GeoEngenharias, financiado pela FCT, fundos FEDER através do Programa Operacional Factores de Competitividade-COMPETE.



Investigating contamination indexes and mobility processes in mine-stream sediments systems (Central Portugal)

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Abstract

The mining industry plays a crucial role in today's society due to the growing demand for strategic materials. Nevertheless, it is essential to acknowledge the significant threats posed to the environment by mining operations. Striking a delicate balance between resource needs and environmental protection is imperative.

Long-term detrimental environmental impacts have been identified by old uranium and thorium mining exploitations, that took place in central Portugal, between 1908 and 2001. Those impacts were caused by the lack of a proper mine closure plan. The mine dumps left exposed on the surface are the main cause of environmental contamination by potentially toxic elements in these old mining areas. Additionally, ore treatments, and mine drainage leaching from open pits and underground mines going towards streams, stream sediments, and soils may also cause significant pollution and several risks to ecosystems and human health. Stream sediments are usually used as a tool for contamination evaluation in these old mining areas.

The old uranium mine of Ribeira de Bôco is located about 2.5 km SW from Arcozelo village (Gouveia, Central Portugal). The ore deposit is mainly of supergenic nature with dominant mineralization in autunite and torbernite (U-bearing minerals). The mine is abandoned, and a total of ten stream sediments and fifteen tailings samples were collected, and potentially toxic elements were analyzed by ICP-MS, at the Department of Earth Sciences, University of Coimbra (Portugal). Some contamination indexes were determined to assess the influence of old mine uranium mines on the mobilization of potentially toxic elements. Stream sediments contain higher As (up to 120.5 mg kg⁻¹), U (up to 156.4 mg kg⁻¹), Th (up to 332.5 mg kg⁻¹), and Mn (up to 550.9 mg kg⁻¹) contents. The stream sediments are moderately to heavily/extremely contaminated in Al, As, U, Th, and Zn. The contamination factor varies from low to very high for As, Cd, Cr, Pb, Th, U, and Zn. The degree of contamination is high. The contamination of stream sediments is mainly related to the erosion and leaching of the mine dumps located in the study area. Furthermore, the contaminant concentrations tend to decrease downstream of the source, due to hydrodynamic and chemical processes in fluvial systems influenced by the mine drainage.

Keywords: Geogenic contribution; Uranium mines; Contamination indexes; Stream sediments; Portugal