Geophysical characterization of diversion channel infiltration in a uranium waste rock pile

Matheus Mistrinel Pacine Feitoza do Nascimento*[1], César Augusto Moreira[1], [1] Universidade Estadual Paulista "Júlio de Mesquita Filho"

This paper was prepared for presentation during the 18th International Congress of the Brazilian Geophysical Society held in Rio de Janeiro, Brazil, 16-19 October 2023.

Abstract

Acid mine drainage (AMD) is a common issue in many mining operations where sulfide minerals, such as ore minerals or associated minerals, are present. This natural process arises from the oxidation of sulfide minerals, such as pyrite, followed by interaction with water, resulting in the generation of sulfate and sulfuric acid. In the mineral industry, this problem is exacerbated due to the accumulation and increased exposure of these reactive minerals to atmospheric agents. It is within this context that the Osamu Utsumi Mine (MOU) is situated, which is the first uranium mining and beneficiation operation in Brazil, managed by the Brazilian Nuclear Industries (INB). The mine is located in the Alkaline Massif of Poços de Caldas, in a geological setting characterized by alkaline rocks such as nepheline syenite, as well as uraniferous mineralization with high sulfide content. During its operation, millions of tons of waste were moved, with the final destination being the mine's waste rock piles (BF), where materials from stripping and low-grade uranium rocks were deposited. Currently, the mine is undergoing decommissioning, which encompasses the post-closure period during which environmental liabilities must be addressed. Acid mine drainage is the most complex of the environmental liabilities present in the area. The materials were deposited in the form of a landfill bridge, which resulted in the rearrangement of the grain-size fractions, with coarser particles at the bottom and finer particles at the top. This, combined with the heterogeneity of the deposited material, allows BF-04 to function as a hydrogeological system permeable to the flow of water and oxygen, both of which react with the existing sulfides. A complicating factor is the presence of the diversion channel for the old drainage that flowed through the old valley (Consulta stream), which was positioned on the NW side of BF-04 and excavated directly into soil and rock. Given the aforementioned factors, this research aims to assess the influence of water infiltration from the diversion channel and its contribution to the generation of acid mine drainage within BF-04. In this study, the geophysical methods of Electrical Resistivity (ER) and Induced Polarization (IP) were employed, obtained simultaneously through electrical tomography lines. The 2D inversion models highlight zones of low resistivity (~50 Ω.m), similar to results obtained in previous studies in areas with AMD flow. Furthermore, it was feasible to identify areas of high chargeability (~10mV/V) in regions of low resistivity adjacent to the diversion channel, implying the interaction of moisture-rich zones, potentially originating from the diversion channel, with sulfide minerals present in BF-04. These pieces of evidence indicate the effective contribution of the diversion channel to the generation of AMD within BF-04 and the need for its impermeabilization to reduce this environmental liability.