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Environmental impact assessment of leachate from mining tailings using electrical resistivity imaging

Mosaad Ali Hussein Ali[1]✉, Wei Qian[2], Ragab Rabeiy[1,3], Hussein A. Saleem[1,4], Ahmed S. Mohamed[5], Abdullahi Uwaisu Muhammad[6] & Ali Shebl[7,8]

The environmental difficulties from mining tailings arise mainly from legacy dump sites because these residues spread pollution through surrounding areas. Effective environmental management requires a comprehensive pre-assessment. An ERI, electrical resistivity imaging, system serves as the analytical tool to create models for leachate assessment prior to its measurement in abandoned mining tailing storage sites. A total of 16 2D ERI profiles produced both 2D and 3D models that monitored the El Mochito mine waste site in Honduras. Different geoelectric zones were identified in the electrical resistivity models of this site with high resistivity values ranging between 60 and 100 Ω m in the surface layer while the middle layer exhibited moderate resistivity between 30 and 60 Ω m and the lowest resistivity of 1–30 Ω m was observed in the active leaching zone that contained conductive materials and mineral-rich leachate. The 3D hydrogeological models provided clear visibility of leachate areas and flow paths. The leachate migration showed uniform movement towards the northern direction until it reached the southern region where concentrations decreased. Another level of spatial understanding and depth information on resistivity distribution was obtained from 3D ERI models. The complete assessment objectives of the research form the basis for future investigations while demonstrating the importance of integrating geochemical measurements. The study emphasizes the need for ERI to examine complicated mining tailings yet requests deeper scientific investigation to create effective environmental management techniques and remediation practices.

Keywords Mining tailings, Leachate pre-assessment, Electrical resistivity imaging, Legacy dump, Environmental management, Modelling

Tailings from mining operations contain large volumes of pulverized rock fragments together with process waste products[1–4]. The disposal practice of tailings occurs in designated containment areas or dumps causing critical environmental risks. One critical matter of concern involves leachate spreading through nearby locations because this substance contains dissolved minerals together with other materials. The difficulties associated with legacy dumps increase because they were created using older disposal approaches that fall below present-day requirements[5,6]. The study of leachate formation together with its migration behavior and containment procedures within mining tailings dumps demands highest priority. The improper management of tailings leads to severe to catastrophic environmental damage according to sources[7,8]. The monitoring of tailings leachate spreading needs to be consistently performed for immediate cleanup work and forthcoming mining venture design purposes. Achieving mapping and monitoring of mining tailings requires an effective tool because the continuous control of their environmental impact remains crucial[3,9–14].

The delineation and assessment of leachate migration effects from landfills on environments traditionally use standard testing methods like monitoring groundwater along with collecting surface water data and analyzing soil contents through monitoring wells installation around a pond/dump site[15–17]. Traditional methods deliver crucial hydrogeological and chemical information which requires long durations, extensive labor, and produces restricted small-scale results[18]. Invasive procedures involved in these methods cause damage to the subsurface

[1]Mining and Metallurgical Engineering Department, Assiut University, Assiut 71515, Egypt. [2]School of Earth Sciences and Engineering, Hohai University, Nanjing 211100, China. [3]Department of Civil Engineering, College of Engineering, Qassim University, Buraydah 51452, Saudi Arabia. [4]Mining Engineering Department, King Abdulaziz University, Jeddah 21589, Saudi Arabia. [5]Mining and Petroleum Department, Faculty of Engineering-Qena, Al-Azhar University, Qena 83513, Egypt. [6]Department of Computer Science, Federal University Dutse, Dutse 7156, Nigeria. [7]Department of Geology, Tanta University, Tanta 31527, Egypt. [8]Department of Mineralogy and Geology, University of Debrecen, Debrecen 4032, Hungary. ✉email: mossad_ali2000@aun.edu.eg