


Chapter 1


Valorization of Abandoned Lakhouat Mine Waste in Metakaolin–Based Geopolymers: Mechanical Properties and Immobilization of Toxic Elements

Samir Mefteh

 <https://orcid.org/0009-0002-1454-8520>


Laboratory of Spectroscopic Characterization and Optical Materials, Faculty of Sciences of Sfax, University of Sfax, Sfax, Tunisia

Hajer Haj Ali

 <https://orcid.org/0000-0002-6254-3778>

Laboratory of Spectroscopic Characterization and Optical Materials, Faculty of Sciences of Sfax, University of Sfax, Sfax, Tunisia

Yamina Romdhani

 <https://orcid.org/0009-0008-8382-4035>

Laboratory of Spectroscopic Characterization and Optical Materials, Faculty of Sciences of Sfax, University of Sfax, Sfax, Tunisia


Slavka Andrejkovicová

Department of Geosciences, University of Aveiro, Aveiro, Portugal

Rui M. Novais

Department of Materials and Ceramic Engineering, University of Aveiro, Portugal & Universitário de Santiago, Aveiro, Portugal

Khalil Lazaar

 <https://orcid.org/0000-0002-4230-8834>

Laboratory of Spectroscopic Characterization and Optical Materials, Faculty of Sciences of Sfax, University of Sfax, Sfax, Tunisia

DOI: 10.4018/979-8-3373-3506-3.ch001

João A. Al Labrincha

Department of Materials and Ceramic Engineering, University of Aveiro, Portugal & Universitário de Santiago, Aveiro, Portugal


Mounir Medhioub

Laboratory of Spectroscopic Characterization and Optical Materials, Faculty of Sciences, University of Sfax, Sfax, Tunisia

Abdelaziz Sebei

Department of Geology, Faculty of Sciences, University of Tunis El Manar, Tunisia

Fernando Rocha

 <https://orcid.org/0000-0002-3636-3933>
Department of Geosciences, University of Aveiro, Aveiro, Portugal

ABSTRACT

This study investigates the valorization of abandoned Lakhouat mine waste (LKH) through its incorporation into metakaolin-based geopolymers. The waste material, mainly composed of carbonates with minor amounts of metal-bearing minerals such as sphalerite (ZnS), galena (PbS), and marcasite (FeS₂), was blended with calcined kaolinitic clay and activated using sodium hydroxide (NaOH) solutions. The resulting geopolymers were characterized by XRD, XRF, compressive strength measurements, FTIR spectroscopy, and leaching tests to assess their chemical composition, structural development, and capacity for heavy metal immobilization. The influence of NaOH concentration (8, 10, and 12 M), mine waste content (0, 10, 20, 50, 80, and 100 wt.%), and curing duration (7, 14, 21, and 28 days) was systematically evaluated. The optimal formulation was achieved using 10 M NaOH and curing for 28 days, resulting in materials with high compressive strength, a dense and cohesive matrix, and efficient immobilization of potentially toxic elements (Pb, Zn, As, and Cd). These results highlight the potential of Lakhouat mine waste as a raw material for sustainable geopolymer production, offering an environmentally responsible approach to mine waste management and the development of eco-friendly construction materials.

1. INTRODUCTION

Tunisia possesses a rich geological and mining heritage, with mineral exploitation dating back to Antiquity and continuing into the present day (Mobbs, 2005). Mining activities have primarily targeted various ores, notably iron, lead, zinc, and barite, which are mainly concentrated in the northwestern region of the country (Jemmali et al. 2014; Ayari et al. 2025). While these activities provide valuable resources, they also generate substantial amounts of waste, posing significant environmental and socio-economic challenges. Former mining operations often leave large volumes of

22 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/valorization-of-abandoned-lakhouat-mine-waste-in-metakaolin-based-geopolymers/395936

Related Content

Investigation of Influence of Quenching and Annealing on the Plane Fracture Toughness and Brittle to Ductile Transition Temperature of the Zinc Coated Structural Steel Materials

M. Ramesh, Rajnish Gargand Garimella V. Subrahmanyam (2017). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 33-42). www.irma-international.org/article/investigation-of-influence-of-quenching-and-annealing-on-the-plane-fracture-toughness-and-brittle-to-ductile-transition-temperature-of-the-zinc-coated-structural-steel-materials/192113

Microstructural and Mechanical Characterization of HVOF-Sprayed Ni-Based Alloy Coating

Sunitha Kand Hitesh Vasudev (2022). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 1-9). www.irma-international.org/article/microstructural-and-mechanical-characterization-of-hvof-sprayed-ni-based-alloy-coating/298705

Wear Characteristics of Ni-WC Powder Deposited by Using a Microwave Route on Mild Steel: Microwave Cladding of Ni-WC

Hitesh Vasudev (2020). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 44-54). www.irma-international.org/article/wear-characteristics-of-ni-wc-powder-deposited-by-using-a-microwave-route-on-mild-steel/244158

Influence of Process Parameters on Microstructure of Friction Stir Processed Mg AZ31 Alloy

G. Venkateswarlu, M.J. Davidson, G.R.N. Tagoreand P. Sammaiah (2014). *International Journal of Surface Engineering and Interdisciplinary Materials Science* (pp. 47-58). www.irma-international.org/article/influence-of-process-parameters-on-microstructure-of-friction-stir-processed-mg-az31-alloy/113282

Analysis of Lipids Produced by Microalgae Isolated from the Area around Okinawa, Japan

Shinya Ikematsu, Ipputa Tadaand Yasuma Nagasaki (2017). *Applied Environmental Materials Science for Sustainability* (pp. 222-233).

www.irma-international.org/chapter/analysis-of-lipids-produced-by-microalgae-isolated-from-the-area-around-okinawa-japan/173860