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Mini Review

Contamination by Heavy Metals in Sulfide Deposits a Challenge for the Development of Environmental Management in Associated Ecosystems

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Abstract

The metallurgical mining development in sulfurous deposits facilitates the occurrence of processes that affect the contamination of ecosystems if the correct measures are not taken. The objective of the work is to assess the incidence of heavy metal contamination in the ecosystems associated with the exploitation of these deposits, using the Santa Lucía deposit in the Minas de Matahambre municipality, Pinar del Río, Cuba as a case study. The biotic and abiotic oxidation of sulfides was identified as the fundamental cause of contamination by heavy metals in the reservoir under study. Its negative impact on the deterioration of the ecosystems associated with the exploitation of these deposits was determined and, based on the identified impacts, alternatives were developed to mitigate negative impacts, such as a responsible management proposal for decision makers.

Introduction

In the mining regions, the origin of the deposits, the processing technology and the development of the environmental policies that are applied, are determinants for the mitigation of the environmental problems caused in the different ecosystems [1]. The mining-metallurgical activity in sulfurous deposits causes the devastation of ecosystems, causing environmental problems such as deforestation, loss of biodiversity, atmospheric pollution, in terrestrial and marine waters and soils due to geo-available elements [2]. In mining-metallurgical projects, the low rates of mitigation of impacts and the incorrect use of management instruments to diagnose and design recovery measures are essential elements to take into account to achieve favorable environmental results in these activities. The pollution generated is mainly due to the discharge of tailings containing sulfurous minerals, the use of chemical reagents and mining operations. Its negative effects have direct and indirect repercussions on the associated ecosystems [3]. The methods and techniques applied to achieve the proposed objectives were empirical, theoretical and individual. Used in the different stages of the research process, their use allowed obtaining the proposed results for the areas affected by the activity in the study region.

Mini Review

In the Santa Lucia deposit, the recovery carried out after exploitation was not effective, the quarry remains open and the recovery rates are low, therefore the oxidation processes of sulfides are exacerbated by weathering and the action of weathering agents. Heavy metals pass in the form of sulfates to ecosystems. Following the geological method of irregular itineraries in the field work, the sites most affected by contamination were identified in two periods, the dry and the rainy. The samples taken made it possible to compare the results with the specialized bibliography. It was found that the fundamental cause of contamination by heavy metals is caused by acid mine drainage, a process that is exacerbated by the influence of natural processes in the reservoir that is without effective recovery actions. The samples taken reflect acidic pH values which, is explained by the presence of H_3O^+ and S_2^- ions dissolved within the solid matrix, these when combined in aqueous solution and in the presence of air react giving rise to the formation of sulfuric acid , these are justified by the oxidation-dissolution reactions of the primary sulfides at acid pH, through the oxidation of pyrite with the formation of iron sulfate II and ferric hydroxide, as well as the oxidation of iron sulfate II to III, catalyzed by Acidithiobacillus Ferrooxidans and the reaction of ferric sulfate with pyrite. The sulfides rich in heavy metals iron, lead and zinc are characteristic of the ores (galena, pyrite and sphalerite) present in the case study deposit [4]. The surface waters show pH values (acids), in the currents that drain from the slag heaps, the sinkhole and the quarry into the waters of the Santa Lucía River. The results of chemical analysis of these waters from the reservoir throughout the basin, reflect the contamination of heavy metals that oscillate as follows: Fe (13-15mg/l) and Zn (5.0 -81mg/l) and Pb (62-65mg/l) respectively, values above the permissible limits established by Cuban Standard NC-27: 2012.

To carry out the neutralization of these acidic waters, the traditional method of chemical neutralization was used, calcium hydroxide (slaked lime) was used as neutralizing agents; $Ca(OH)_2$, calcium oxide CaO (quicklime); and calcium carbonate $CaCO_3$. The most effective was CaO since it allows with a smaller amount of product to reach the desired pH values for neutralization [5].

Conclusion

The fundamental cause of contamination by heavy metals in sulfurous deposits is due to oxidation processes, which is evidenced in the case under study [6]. Heavy metal contamination has a negative impact on the deterioration of ecosystems associated with the exploitation of sulfur deposits, it was shown that the most effective neutralizer for mitigating impacts is lime oxide, a proposal for the treatment of this problem environmental impact with direct impact on surface waters in the region.

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