Geophysical Research Abstracts
Vol. 21, EGU2019-13843, 2019
EGU General Assembly 2019

Biodissolution of amorphous and crystalline fayalite-bearing copper metallurgical slags

Anna Potysz and Jakub Kierczak

University of Wroclaw - Institute of Geological Sciences, Department of Experimental Petrology, Wrocław, Poland (jakub.kierczak@uwr.edu.pl)

Copper production is mainly accomplished by smelting processes, however, this industrial sector generates a considerable volume of waste slags. The slags are composed of various phases that occur as the result of melt quenching and contain residual content of metals unrecovered during smelting. At the present time, the slags are either considered as secondary metal resources or as useful materials for construction and engineering purposes. In contrast, in the past, the slags were considered as completely useless wastes that were disposed of at dumping sites without appropriate environmental oversight. A long-term disposal of formerly produced slags was associated with these wastes exposure to a variety of factors such as microbial activity, organic and inorganic acids and changes in pH jointly termed "bioweathering".

The aim of this study was: i) to decipher weathering sequence of slag components (phases) under exposure to biotic and abiotic conditions, ii) to evaluate the role of bacteria Acidithiobacillus thiooxidans in metal release and iii) to assess the slags potential to serve as secondary metal resources. Two types of historical copper slags were selected to study: i) amorphous glassy slag and ii) crystalline fayalite-bearing slag. Experiments were carried out using three weathering solutions that included: i) sterile ultrapure water (UPW), ii) sterile growth medium (GM) and iii) growth medium with bacteria A. thiooxidans (GM+B). Kinetic of elements release from the slags were monitored using Inductively Coupled Plasma Atomic Mass Spectrometry, whereas direct slag dissolution was assessed using a Scanning Electron Microscope.

The results of this study revealed that dissolution of both slags, crystalline and amorphous is the most intense in the presence of A. thiooxidans. Even up to 92% of Fe and 98.5 of Al were released within 21 days from amorphous and crystalline slags, respectively when wastes were incubated with bacteria (GM+B). A comparison made between these two slags in the context of metal release showed that up to 53% and 98% of Cu can be extracted from crystalline and amorphous slags, respectively. The slags immersion in abiotic GM solution resulted in the release of Cu in the amount not exceeding 32%. Furthermore, direct observation of weathered slags revealed that biodissolution of amorphous slag leads to the formation of metal-depleted residue, mostly in the form of gypsum and silica. Biodissolution of crystalline slag results in nearly complete disappearance of fayalite and important crystallization of silica. The element release profiles combined with direct observation of weathered slags demonstrated that biodissolution of amorphous slag components under studied conditions is ranked as follows: metallic phases>glass, whereas biodissolution of crystalline slag components proceeds as follows: fayalite>sulfides>glass. Based on gathered results, we conclude that bacteria A.thiooxidans considerably enhance dissolution of crystalline and amorphous slags as compared to dissolution under abiotic conditions. Therefore, application of bacteria to extract metals from these slags appears to be promising in the view of potential biohydrometallurgical processing.