Fluvial and windborne transport of arsenic-bearing mine tailings in semi-arid environments

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Gold and silver mining throughout the state of California has left an environmental legacy of exposed mine wastes (tailings) containing elevated levels of arsenic (As) and other potentially toxic trace elements. The uncontrolled movement of mine tailings by erosion and natural transport processes poses challenges to the long-term containment and remediation of these contaminated materials.

The typically fine-grained size distribution of mine tailings combined with decades of exposure and weathering of large tailings piles has resulted in the mobilization of As-bearing mine wastes by both fluvial means (rainwater runoff and streams) and by transport of windblown mine waste particles. While airborne mobilization of mine tailings is diffuse and covers large areas, in semi-arid mining areas with relatively low rainfall rates fluvial transport is both sporadic and much more localized down narrow semi-linear streambeds (washes), facilitating the movement of tailings across significant distances and into ephemeral lakes/playas.

We have conducted extensive geochemical, mineralogic, and spatial characterization of tailings throughout the Mojave Desert, CA to assess the degree of surface arsenic enrichment in soils surrounding tailings piles, identify arsenic concentration trends with distance in sediments located within different washes, and measure arsenic in surface water runoff from a tailings pile during a rare storm event. EXAFS spectroscopy was also applied to selected samples to determine arsenic speciation at various locations.

Intense precipitation events were determined to mobilize mine wastes as a series of discrete pulses down a wash, which could be effectively modeled as a series of overlapping pulses with power-law exponential decay characters. Similar exponential decay behavior was observed by windblown tailings and maximized in the direction of prevailing winds. In the majority of samples, arsenic was found to exist as As(V), either in the form of secondarily-mineralized iron arsenate phases or in a sorbed phase onto iron (hydr)oxide phases.

By examining fluvial and windborne transport of As-enriched tailings at various mines throughout the western Mojave Desert, we have developed a conceptual model for the transport of mine wastes within alluvial systems that provides a sound basis for formulating strategies for the effective remediation and monitoring of historic mine areas in semi-arid environments.
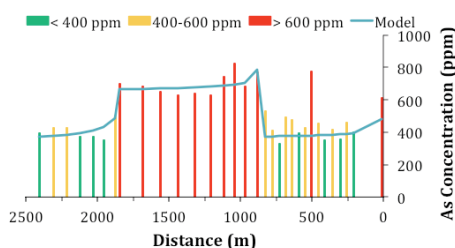

Figure 1: Arsenic concentration as a function of distance from mine point source, with exponential decay model overlying data.

Evaluation of Rice Wine Waste as Substrate for Use in Acid Mine Drainage Treatment

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Introduction

The spent mushroom compost(SMC) has been generally used as substrate for passive treatment systems, especially for SAPS in Korea. More effective substitutes to replace the SMC have always been a key concern. In this study, rice wine waste(RWW) was tested as substrates for use in acid mine drainage treatment.

Materials and methods

Batch tests were conducted to evaluate the material's efficacy in reducing sulfates and removing heavy metals within the artificial AMD. AMD was made from the standard solution for some heavy metals, mixed with distilled water and strong acid. During the test, limestone aggregates were added for increasing the pH of AMD. Batch test was continued for 27 days, and samples were taken every 3 days. The ORP, pH, and the sulfate concentration of each sample were recorded, and the concentration of heavy metals was measured with ICP.

Results and Conclusion

Test results showed that both SMC(#1) and RWW(#2) have similar efficiency in total sulfate reduction capacity(Fig. 1). However, the RWW has a little higher reducing rate, and the mixture of SMC and RWW(#3) showed the highest reducing rate. In terms of the heavy metal removal, including Fe, Al, and Cu, both materials showed similar results. Overall, the batch test results indicated that RWW has a good potential as a substrate for SAPS.
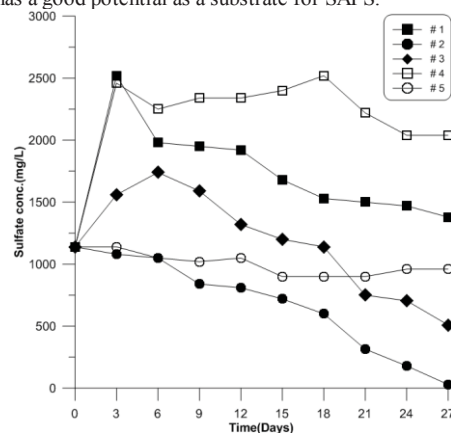

Fig. 1. Changes in sulfate