

Active treatment experiments including coprecipitation-adsorption of arsenic for mine drainages in Peru

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Abstract

Two metalliferous mine drainages from El Triunfo 1 (ET) and Santa Teresita (ST) mines in the Ancash region of Peru were selected to assess the feasibility of (semi-) active treatment methods, including the efficiency of As coprecipitation with Fe in inflows. Elevated concentrations of Al, Fe, Mn, and Zn at both mine drainages were reduced to target levels at pH 10. Additionally, the As concentration of 1.69 mg/L at the ET mine was reduced by approximately 93%, reaching 0.124 mg/L at pH 10, suggesting that coprecipitation and adsorption by Fe in the mine drainage played a substantial role in As removal.

Keywords: Active treatment, coprecipitation of arsenic, manganese, Peru, mine drainage

Introduction

Peru is the second largest producer of Cu and Zn in the world. Mining of porphyry copper ores and hydrothermal multimetal ores leads to the enrichment of various metals, often resulting in water contamination by Al, As, Cd, Fe, Mn, and Zn. Therefore, it is essential to assess the feasibility of conventional (semi-)active treatment methods, including the efficiency of As coprecipitation with Fe in inflows.

Methods

Two metalliferous mine drainages of El Triunfo 1 (ET) and Santa Teresita (ST) in the Ancash region were selected. ET adit drainage exhibited Al, As, Cd, Fe, Mn, and Zn concentrations of 13.5, 1.69, 0.084, 31.3, 7.73, and 21.0 mg/L, respectively, while ST adit drainage exhibited Al, Cu, Fe, Mn, and Zn concentrations of 15.1, 0.49, 11.4, 43.1, and 6.79 mg/L, respectively.

Hydrated lime was injected into ET and ST mine drainages in stepwise. At each step, pH, Eh, electrical conductivity (EC), and dissolved oxygen (DO) concentration were analyzed using Hach HQ 2200 multimeters immediately after sampling. Alkalinity was determined using Hach AL-DT digital titrator. Collected samples were filtered using 0.45 μ m syringe filter papers and samples for cation analysis were acidified to pH < 2 using concentrated nitric acid. Cations were analyzed using an inductively coupled plasma optical emission spectroscopy (ICP-OES) at the Certimin, Lima, Peru. Anions were analyzed using an ion chromatography (IC) at the Certimin, Lima, Peru. Relative standard deviations (RSD) were less than 5% for ICP-OES and IC analyses.

Results and discussion

Increasing pH to 9.0 resulted in reductions of Cd, Cu, Fe, and Zn concentrations to below 0.03, 0.02, 0.2, and 0.2 mg/L, respectively,



at both ET and ST mine drainages, meeting effluent standards. However, decreasing Mn concentrations to <1.3 mg/L required an increase in pH to 10.0 at both mines. While Al concentration increased slightly due to redissolution at these pH levels, they remained below 0.7 mg/L. In the ET drainage, As concentrations were reduced by approximately 93%, reaching 0.124 mg/L at pH 10, suggesting that coprecipitation and adsorption by Fe in the mine drainage played a substantial role. Further reduction of As concentrations to below 0.08 mg/L by adsorption is still necessary to meet effluent standards.

Conclusion

The Fe present in the mine drainage facilitated a reduction in As concentration by up to 93% through coprecipitation and adsorption. Given the diversity of contaminants in these mine drainages, this treatment approach could be applied to a wide range of mine sites where contamination by Al, As, Cd, Cu, Fe, Mn, and Zn is a concern.

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