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NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION RESEARCH

Treatment of Chromite Ore-Processing Solid Waste Using a Ferrous Iron-Based Reductant

Problem Definition

Chromite ore-processing solid waste generated from ferrochrome alloy production can act as a major source of hexavalent chromium (Cr[VI]) to ground water. A large volume of chromite ore-processing solid waste, consisting of slag, conditioning tower sludge, and electrostatic precipitator dust and measuring approximately 20 acre-feet in size, is present in the saturated zone at the Macalloy Corporation site in Charleston, South Carolina. Ground water Cr(VI) concentrations in the source area measure as high as 57 milligrams per liter and solid phase Cr(VI) concentrations as high as 550 milligrams per kilogram.

Background

In the presence of a strong reducing agent such as sodium hydrosulfite (dithionite), ferrous iron can be stabilized in solution for an extended period of time, even under elevated pH conditions. This could prevent premature precipitation of the iron during injection (which may otherwise lead to well and aquifer formation clogging) and allow for effective dissemination of ferrous iron over significant distances within the subsurface. Laboratory batch studies indicated that ferrous iron (as ferrous sulfate) in the presence of sodium hydrosulfite was highly effective in treating the chromite ore-processing solid waste sediments, while sodium hydrosulfite alone was ineffective. Based on these observations, an in situ field pilot study was initiated to evaluate the performance of a combined ferrous iron/sodium hydrosulfite reductant solution in treating the high pH chromite ore-processing solid waste sediments in the saturated zone at the Macalloy site.

Objectives

The objectives of the study were to determine whether ferrous iron in the presence of sodium hydrosulfite can be effectively disseminated within the Cr(VI) saturated zone/source area at the Macalloy Corporation site and thereby achieve effective treatment of dissolved and solid-phase Cr(VI).

Approach

Forty-five hundred gallons of a ferrous sulfate/sodium hydrosulfite solution were injected into the source zone through a single injection well screened over 7.5 feet. A series of monitoring wells were installed out-radially from the injection well to evaluate the performance of the injected reductant. Ground water samples were analyzed for multiple parameters, including cations, anions, oxygen-reduction potential, pH, conductivity, total sulfur, alkalinity, and ferrous iron.

Accomplishments to Date

The results of the field study showed that ferrous iron in the presence of sodium hydrosulfite can be disseminated a significant distance within the saturated zone containing the chromite ore-processing waste sediments and can effectively treat dissolved and solid-phase Cr(VI).

Near-Future Tasks

A preliminary evaluation of findings has been published:

Su, C. and R.D. Ludwig. (2005). "Treatment of Hexavalent Chromium in Chromite Ore Processing Solid Waste Using a Mixed Reductant Solution of Ferrous Sulfate and Sodium Dithionite." *Environ. Sci. Technol.*, 39: 6208–6216.

Additional publications describing the findings of the study are pending.

Investigators

Frank Beck
Patrick Clark
Kyle Jones
Ralph Ludwig
Chunming Su