Correlation of TDS Release Potentials with Field Leaching Behaviors for Appalachian Coal Mine Spoils and Coarse Refuse

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Project Description and Objectives

The major goals of this study were to characterize the elemental composition of leachate associated with coal spoil and refuse, to determine the temporal pattern of elemental release, and to compare the results obtained from column leaching trials with larger scale leaching methods and valley fill water quality data. Several static laboratory tests were evaluated as predictors for total dissolved solids (TDS) from spoils. Incorporating spoil and refuse TDS characterization into pre-mine planning and permitting procedures could potentially minimize TDS release to receiving streams.

Applicability to Mining and Reclamation

In recent years, concerns about elevated long-term emission of TDS from coal mine backfills and valley fills have emerged. Coal mining discharges could potentially be regulated for TDS in the future, requiring remedial action to maintain conductivity below defined levels. Understanding the TDS potential of diverse spoil and refuse materials may facilitate the development of pre-mine spoil testing protocols and spoil disposal fill designs that reduce TDS inputs to surface waters. This study is relevant to coal mining sites throughout the central Appalachians.

Methodology

Several coal spoil and refuse samples, mostly from Tennessee, were collected and analyzed by acid-base accounting and other relevant chemical characterization methods. These materials also were evaluated using laboratory leaching columns for 20 weeks. The columns were dosed/sampled twice a week, and the leachate was analyzed for pH, electrical conductivity (EC), and several ions of concern in order to characterize the quantity and temporal nature of TDS release. One spoil and two refuse samples were evaluated in a similar manner using larger field-scale leaching barrels and tanks to observe scaling effects on leachate/TDS. Data from the leaching columns were compared to field data from existing valley fills to determine similarities in TDS levels and release patterns. For spoils, the leaching column data also was compared to static laboratory test results to identify the predictive capabilities of these tests.

Highlights

Leaching columns: Mine spoil and coal refuse materials initially released significant amounts of TDS (as measured by EC). Leachate EC dropped quickly for all spoils, while

response over time for refuse was more variable. The refuse materials were more reactive than the spoils due to higher levels of sulfides and carbonates/neutralizers. Mass release of most major cations closely followed EC trends, while minor and trace elements varied among the materials.

Scaling effects: For the spoil material, leachate composition and temporal response was similar at all three scales evaluated, although a few differences were noted. In contrast, the two coal refuse materials studied at two scales produced more variable results over the leaching period.

Static test predictors (spoils): Both total-S and CCE were relatively strong predictors of EC levels. Saturated paste EC may be a reliable predictor for peak initial EC levels.

Valley fill study: Observed conductivity levels in the field were similar to peak and average EC levels observed for a wide range of spoils in our column studies. The time for EC decline in the field was significant, taking approximately 20 years to decline to < 500 µs/cm.

Results/Findings

While initial EC leachate levels from the mine spoils tested were higher than published aquatic effects thresholds, they dropped quickly to relatively low levels. Coal refuse materials generated much higher EC/TDS levels which were more variable among materials and over time.

Laboratory leaching columns can be used as a general predictor for spoil and refuse leaching potentials; however, the presence of highly reactive sulfides, more commonly found in refuse materials, can result in a much wider range of leaching responses over time. Static test methods may prove useful for predicting peak and/or long-term EC levels, but a much larger sample set must be analyzed to develop a predictive model.

Combined results from all three study components, particularly for the mine spoil materials, indicate that TDS elution is predictable and readily related to well documented spoil and refuse chemical weathering reactions. While the time required for TDS to decline from peak elution levels to lower 'semi-equilibrium' levels varies by material and testing scale, all results indicate that it will decline to relatively low levels over extended periods.

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Website Information:
The final project report can be found at
http://www.osmre.gov/programs/tdt/appliedscience/projects.shtm

Layout of Mesocosms and Leachate Barrels in field.

Mesocosm prior to filling with Harlan sandstone spoil.

Leachate Columns in Lab.