

The Effect of Dissolved Organic Matter and Mixing Energy on the Release of Trace Elements from Coal Ash in Natural Surface Waters

Abstract

The inadvertent release of coal ash from the Tennessee Valley Authority's Kingston Fossil Plant into the Emory River in eastern Tennessee in December, 2008, has raised concerns about threats to aquatic ecosystems and drinking water supplies. Around the country, disposal of coal ash is contaminated groundwater at sixty-three sites in twenty-six states. The Kingston coal ash spill has highlighted the need for better understanding of the environmental risks posed by coal ash disposal failures.

Past research has established that toxic trace element release depends primarily on the pH and temperature of the groundwater and that some of the trace element release can be described in terms of dissolution of mineral phases that make up coal ash. However, the past research does not account for the influence of dissolved organic matter in the release of trace elements even though dissolved organic matter plays an important role in the dissolution of many oxide, sulfide, and aluminosilicate minerals.

To address this lack of knowledge about the effect of dissolved organic matter on the release of trace elements from coal ash, we propose to conduct coal ash leaching experiments in aqueous solutions containing dissolved organic matter. The proposed research addresses Area 2 of the request for proposals, the area of *Environmental Studies*, and the sub-areas of *transport and fate of ash contaminants* and *ash transport and weathering in river sediments*. Three hypotheses will guide our research: (1) that the concentration and character of the dissolved organic matter will affect the amount and kinetics of trace element release from coal ash; (2) that the mixing energy of the overlying water will affect the colloidal distribution of trace element release from coal ash, and (3) that the extent of coal ash weathering with respect to trace element release will depend on the amount and nature of the dissolved organic matter to which it has been exposed to a greater extent than the time since its release into surface waters.

To test these hypotheses, we will collect and characterize coal ash and river water from the vicinity of the Kingston Fossil Plant. Along with other coal ash samples, the Kingston coal ash will be subjected to leaching experiments with different amounts and types of dissolved organic matter and different shear rates. The leaching experiments will focus on mercury, arsenic, and selenium because these trace elements present the greatest risk to aquatic life and drinking water. The presence of colloids on trace element release will be analyzed by filtration, field flow fractionation, and extended x-ray absorption fine structure spectroscopy. The weathering of the spilled Kingston coal ash will be analyzed by x-ray photoelectron spectroscopy depth profiling.

Our two-year research plan focuses on generating results for Kingston coal ash first and then reinforcing these results by examining trace element release from a range of coal ash samples and dissolved organic matter fractions. The research will be conducted as a collaboration between the principal investigator, Joseph Ryan, and a postdoctoral research associate at the University of Colorado at Boulder and the co-principal investigator, George Aiken at the U.S. Geological Survey in Boulder, Colorado.