A Twenty-Month Geochemical and Isotopic Investigation into the Environmental Impacts of the 2008 TVA Coal Ash Spill

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Almost two years after the largest coal ash spill in US history at the Tennessee Valley Authority (TVA) coal-fired power plant in Kingston, TN our investigation has revealed several conclusions about the clean up effort and the impact of coal combustion residues (CCRs) released into the environment. Our previous research indicates that CCRs could leach contaminants into the environment [1], where mobilization of leachable coal ash contaminants (LCACs) such as boron, arsenic, selenium, strontium, and barium depend on ash composition and environmental factors such as pH and redox conditions. Systematic sampling of the water and sediments in downstream segments of the Emory and Clinch Rivers near the spill revealed high levels of LCACs (e.g., As: 9- 95 μg/L) in surface water in areas of restricted water exchange, but remediation and removal of ash from this area combined with diversion of surface water has led to a reduction of the LCAC concentrations with time. The Clinch and Emory rivers downstream of the spill show low LCAC concentrations below the EPA maximum contaminant level (As=10 μg/L), but with levels (e.g., As ~4 μg/L) above the baseline of the upstream rivers. Dredging activities had little impact on the concentration of LCACs in the surface water, while reservoir level (dilution effect) played a much larger role in the concentration of LCACs measured [2]. Pore water extracted from bottom sediments of the downstream rivers has significantly higher LCAC levels (e.g., As 9-2010 μg/L), which are associated with some degree of anoxic conditions, which can play a major role in LCAC release from CCRs.
Field data and independent leaching experiments indicate that boron is a sensitive indicator for CCR leaching, with boron content up to 1518 μg/L in pore water relative to upstream river water (6 to 9 μg/L) and a distinctive isotope fingerprint that is significantly different from that of meteoric boron in the upstream rivers. Pore water and surface water (sampled downstream of the spill) revealed a $\delta_{11}B$ value of -11‰ and -12‰ respectively (relative to the NIST951), while most natural waters have a more positive $\delta_{11}B$ value. Leaching experiments performed on the spilled TVA coal ash have measured concentrations of B (415 μg/L avg.) and an isotopic $\delta_{11}B$ value of –11‰ (avg). Dilution has played a major role in reducing the LCAC concentration in surface water of the Emory and Clinch Rivers, but leaching continues to occur in buried CCRs within the river sediments resulting in substantial contamination of pore waters in the downstream spill area.

[1] Ruhl, et al. (2009) *Env. Sci. Tech* **43**, 6326–6333.
[2] Ruhl, et al. (2010) *Env. Sci. Tech* **44**, 9272–9278.