ENERGY AND WATER RESOURCES: UNDERSTANDING THE IMPACT OF COAL COMBUSTION RESIDUES ON THE ENVIRONMENT BY EVALUATING THE EFFECTS OF THE 2008 COAL ASH SPILL IN TENNESSEE, USA

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Coal is a major source of energy, providing 41% of the world's electricity, resulting in 125 million tons of coal combustion residues (CCRs) produced each year. CCRs are enriched in trace metals (e.g. Hg, As, Se, Sr), and while 30% of CCRs in the US are utilized in beneficial re-use applications, 70% are disposed of in ash impoundments and landfills. The environmental impact of CCRs is manifested by surface water and/or groundwater contamination, which can severely impact the water resources and thus the health of nearby populations. An investigation of the environmental impacts of the largest coal ash spill in the US history at the Tennessee Valley Authority (TVA) coal fired power plant in Kingston, TN has revealed that CCRs release contaminants into the environment and mobilization of the contaminants depends on the coal ash types, pH, and redox conditions of the ambient environment. Systematic monitoring of the quality of water and sediments in downstream segments of the Emory and Clinch Rivers near the TVA spill site has shown that the interaction of CCRs with natural river water mobilizes leachable coal ash contaminants (LCACs) such as boron, arsenic, selenium, strontium, and barium. Several distinctive patterns have also been revealed: (1) surface waters in areas of restricted water exchange show high LCAC levels (e.g., As: 9- 95 µg/L) (2) downstream diluted Emory and Clinch Rivers show low LCAC concentrations below the US EPA maximum contaminant level (As=10 µg/L), but with levels (e.g., As ~4 µg/L) above the baseline of the upstream rivers; and (3) porewater extracted from bottom sediments of the downstream Emory and Clinch Rivers with significantly high LCAC levels (e.g., As 9-285 µg/L). The high levels of LCACs measured in porewater could help explain the higher LCAC concentrations measured in the fish collected at the spill site. Our field and leaching experimental data show that boron is a sensitive indicator for CCR contaminant leaching, with boron content up to 1276 µg/L in pore water relative to the upstream river water (6 to 9 µg/L) and 11B values of -12‰ and -16‰ (relative to NIST951). This isotopic composition is significantly different from that of meteoric boron and provides a novel tool to trace the CCR leachate in the environment. The spill was an unexpected event, but provided an opportunity to understand the environmental impacts of coal combustion.

Keywords: coal combustion residue CCR, coal, coal ash