Tracing river contamination of toxic metalloids from coal-fired power plant ash ponds in the southeast US

PHILIP N. FROELICH*

Nicholas School of the Environment, Duke University, Durham, NC 27708 USA (*correspondence: pfroelich@comcast.net)

Goldschmidt in the Blast Furnace

Dissolved germanium (Ge), arsenic (As), selenium (Se) and antimony (Sb) have been measured for 30 years in receiving waters above and below coal-fired power plants (CFPP) in the southeastern U.S at USGS river gauging stations. These data permit calculations of fluxes from these plants. Metalloids are generally slightly enriched above the crust in coals (~3 ppm Ge, 10 ppm-As, 3 ppm-Se & 1 ppm-Sb), but are very enriched in coal flyashes, reflecting volatilization during high-temperature coal firing and condensation from stack gases onto flyash. Typical flyash values are 24 ppm-Ge, 75-89 ppm-As, and up to 36 ppm-Se.

A common mode of ash disposal in the southeastern U.S. is wet sluicing of hot ash from fireboxes and precipitators to ash retention ponds (CFPPs are rapidly being converted to dry ash disposal and to gas-firing). The initial pH of flyash sluice is acidic due to acid volatiles released during firing. Ash holding ponds are thus treated to increase pH above 7.5 to precipitate the dangerous metals Cd, Ni, Zn and Cu. Alkaline pH efficiently mobilizes metalloids from flyash to the aqueous phase. The effluents from these ash ponds with high dissolved metalloid concentrations are then discharged to adjaecnt receiving waters, cooling reservoirs, streams and rivers. As, Se and Sb enrichments appear to be quickly removed to fluvial particulates and settle downstream into river and reservoir sediments. Thus these three metalloids are enriched in river muds and carried downstream during flood events, making realistic assessment of ultimate transfer to reservoirs, coastal bays and estuaries very difficult (e.g., the Chattahoochee-Apalachicola River and Bay system in Georgia, Alabama and Florida). Contaminant Ge, which is the most enriched metalloid released from CFPP (orders of magnitude above natural) is easily characterized because the natural Ge/Si cycle is well characterized in aquatic systems. The CFPP-derived fluvial Ge flux in all rivers (escape factor ~0.1 mg Ge/kg-coal fired) can be used to scale long-term As, Se & Sb loads downstream. On an annual basis about 4.1 metric tons As, 1.7 MT Se and 0.9 MT Sb have been released from CFPPs to the Chatahoochee-Apalachicola river system over the past 30 years, and ultimately to Apalachicola Bay.