The geochemical and isotopic fingerprints of fossil fuels associated contaminants

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For decades, coal has been the primary source of fuel for electricity production in the United States. Yet, over a century of coal mining and combustion has created a legacy of water pollution: seepage of metal-rich acid mine drainage into watersheds, selenium and sulfate stream contamination from surface mountaintop mining [1], and leaking of effluents enriched in arsenic, boron, and other toxic metals from hundreds of coal ash ponds to associated water resources across the nation [2]. Conventional oil and gas and unconventional shale gas exploration has generated wastewater with high salinity, bromide, toxic elements, and radioactivity [3]. Tracing the impacts of fossil fuels contaminants in the environment is challenging given the presence of naturally occurring contaminants in the aquifers [4] and the legacy of old versus new developments such as shale gas and hydraulic fracturing. Here we present a diagnostic geochemical "tool-box" that enables us to delineate and monitor contaminants' sources originated from different fossil fuels productions. The integration of inorganic geochemistry and multiple isotopic tracers such as boron, strontium, lithium, sulfur, radium and inorganic carbon provides a novel methodology for identification of the specific contaminants' sources and reconstruct their pathways in the environment. Our studies are based on field and laboratory observations from sites of mountaintop mining in WV, acid mine drainage in PA, coal ash and effluents from NC and other sites across the US, wastewaters from conventional oil and gas operation in NY and PA, and wastewaters fro unconventional shale gas from PA and WV.

[1] Vengosh *et al* (2013) *ES&T* **47**, 10041-10048 [2] Ruhl *et al* (2012) *ES&T* **46**, 12226-12233 [3] Warner *et al* (2013) *ES&T* **47**, 11849-11857 [4] Warner *et al* (2012) *PNAS* **109**, 11961-11966