Incorporation of a Chemical Weathering Model in Sediment Source Apportionment Models

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Background/Objectives. Contaminated sediment sites often contain chemical contributions from multiple parties, with contributions that pre-date sediment sampling by years to decades. Typical contributions include urban runoff and petrogenic (e.g., fuel oil, diesel fuel) and pyrogenic (e.g., tar, creosote) materials in various states of freshness. Receptor and source apportionment models can account for mixing processes and source dilution and can be used to calculate potential contributions from different parties. Over time, however, chemical fingerprints in the sediment are altered due to weathering processes, e.g., water-washing and degradation. Receptor and source apportionment models assume that chemical fingerprints remain static and unchanged over time. Therefore, source apportionment and cost allocation calculations often neglect chemical weathering. The objective of this study was to construct a polycyclic aromatic hydrocarbon (PAH) weathering model appropriate for historical sediment sites and to incorporate this weathering model into existing source apportionment and receptor models.

Approach/Activities. This project involved the analysis of sampling data from a PAH sediment site with more than 100 years of industrial history and chemical contributions from multiple parties. In addition, we reviewed published theory and empirical observations of chemical weathering in PAHs. We reviewed the primary mechanisms (physical, chemical, and biological) by which PAH fingerprints change over time and subsequently developed a weathering model that could be integrated into a receptor modeling framework.

Results/Lessons Learned. We have developed a PAH weathering model that helps predict changes in source fingerprints over time due to various mechanisms. Our model closely predicts observed changes in PAH fingerprints over time, starting with unweathered “fresh” fingerprints and continuing through slightly and highly weathered fingerprints. We also demonstrate how incorporating this model into a receptor modeling framework can be used to better inform source apportionment and cost allocation proceedings.