A Passive Sampler for Contaminant Detection in Trees

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Background/Objectives. Trees are exposed to air, water, soil, and groundwater; therefore, they may come into contact with a variety of contaminants. Moreover, trees provide a readily accessible media that, if appropriately sampled, can provide data to make informed decisions about the presence of contamination in soil and groundwater (phytoscreening), the evolution of contamination over time (phytoforensics and dendrochemistry), and contaminant removal (phytoremediation). Despite multiple efforts to collect environmental contaminant data from trees, each method has significant burdens that have inhibited the widespread application of using trees for environmental investigations. For example, the collection of core material from trees is simple, but the analysis of the cores requires resource-intensive and often less sensitive equipment, such as (1) a field-portable gas chromatograph (GC) or time-of-flight mass spectrometer (TOF/MS) and competent technicians, or (2) SPME fibers, that have limited sorptive capacity. Although the use of these methods was very important in the development of these approaches and provided the fundamental basis for using trees as environmental sensors, the inertia inherent to these burdens, however, has precluded the widespread use of trees to find and solve environmental problems. The objective of this research is to provide a simple, cost-effective method to quantitatively sample trees for a wide range of priority pollutants.

Approach/Activities. A unique, passive sampler containing multiple adsorbent traps to target a broad range of compounds with high sensitivity was developed for use in trees. The sampler comprises a series of sorbent cartridges that are inserted in a particular tree for a specified length of time to collect a time-integrated measurement over days or weeks. These passive samplers were tested for proof-of-concept at two field sites. One site is located near Pensacola, FL, and is characterized by TCE-contaminated groundwater. Mature live oaks grow above the plume of TCE. The second site is located near Charleston, SC, and is characterized by BTEX- and PAH-contaminated groundwater. A grove of hybrid poplar trees was planted over the contamination in 1998. At each site, a small-diameter hole was drilled in 10 representative trees, a passive sampler was installed, and the hole was plugged. Installation of the samplers required basic hand tools and was accomplished within minutes at each tree. The samplers were retrieved within 14 days and retrieval was rapid. The samples were then sent to the laboratory for analyses by thermal desorption-GC/MS following EPA Method 8260C. No ice or preservatives are required during transport and the samplers have a 30-day hold time requirement, which makes the method well suited for international applications, as well. Results are reported in nanograms of specific compounds or compound groups per sample.

Results/Lessons Learned. At the TCE-contaminated site, TCE was detected in only 1 out of the 10 trees sampled. The low detection frequency can be explained by the presence of clean groundwater over the deeper TCE plume that does not come in direct contact with the tree roots. The tree reporting TCE was above the highest groundwater concentration and it is likely that the tree roots were adsorbing TCE in soil vapor. At the BTEX- and PAH-contaminated site, benzene, ethyl benzene, xylenes, isopropylbenzene, n-propylbenzene, trimethyl benzene, n-isopropyl toluene, and TPH compounds between C4-C15 were detected in the passive samplers. The reporting level for all non-TPH compounds was <25 ng. To summarize, this method may provide the necessary "missing link" to enable environmental professionals to easily and rapidly sample a tree in the same manner they would sample soil or groundwater, where samples are sent to an accredited laboratory for high quality and highly-sensitive analyses.