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Silencing the Noise: New Technology to Obtain Time-Integrated Average Groundwater Concentrations over Months

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Background/Objectives. For many environmental media (e.g., air, soil), the value of collecting samples integrated over time or space is widely recognized. However, currently accepted active and passive groundwater sampling methods rely on the collection of a single small volume of water from a monitoring well (i.e., a grab sample). The advantages of integrated samples include:

- Grab sampling of most environmental media has considerable noise (scatter) between individual samples that makes it difficult to determine the actual signal in the data (e.g., the long-term concentration trend in groundwater). By averaging the sampling over a long period of time, the confounding influence of spurious short-term fluctuations is eliminated.
- Time-integrated sampling means that the actual time observing the key environmental variable (such as concentration of air, water, or sediment) is greatly increased. For example, taking two grab samples per year means that two brief moments in time represent the entire year. A three-month integrative sampler can increase this temporal coverage so that 50% of the monitoring period will be represented by time-integrated sampling with the same level of effort.
- Costs can be reduced significantly as field trips to do the sampling are eliminated.

Approach/Activities. We have developed a passive time-integrated groundwater (TIGER) sampler for VOCs that combines an air-filled passive diffusion sampler with a sorbent-based passive vapor sampler. When the sampler is placed in a monitoring well, VOCs equilibrate between the groundwater and the air-filled sampler and then diffuse into the sorbent sampler at a rate proportional to the concentration in groundwater. Combining the two technologies into a single sampler solves two of the challenges associated with using sorbents in the aqueous phase to collect time-integrated groundwater samples: biofouling and sorbent saturation. As a result, the new sampler can be deployed in a monitoring wells for time periods of months without losing performance.

Results/Lessons Learned. We have conducted laboratory validation and field validation of this new time-integrated sampler to demonstrate the accuracy and precision of the sampler for measurement of the average dissolved VOCs in water over an extended deployment time. For a range of dissolved VOC concentrations and deployment times, the average VOC concentration determined using the TIGER sampler provided a good measure of VOC concentrations in groundwater. In addition, the sampler exhibited low duplicate variability indicating that it provides reproducible results. In some cases, the VOC concentrations measured using the TIGER sampler differed from those measured in grab water samples collected at the beginning and end of the sampler deployment period. However, the TIGER sampler did not exhibit a consistent high or low bias suggesting that the differences in concentration results reflect true differences in average VOC concentrations over the deployment period relative to the grab samples. This new time-integrated groundwater sampler will improve data quality by significantly reducing event-to-event variability in groundwater monitoring results.