Compound-Specific Isotope Analysis used to Identify the Origin of VOCs in the Indoor Environment: Internal Sources versus Subsurface Contamination

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Background/Objectives. Volatile organic compounds (VOCs) in the indoor environment could either originate from intrusion of vapor from subsurface pollution or from internal sources as e.g. dry cleaning facilities, oil burners etc. Until now, it has been hard or even impossible to distinguish the origin of VOCs. Traditionally, risk assessment of vapor intrusion from soil to indoor air combines investigation of soil, groundwater and soil gas measurements leading to an evaluation of the influence of subsurface contamination to the indoor environment. Only if this shows a possible risk, indoor air sampling and analysis are carried out. This approach is costly and time consuming.

The objective of this project was to examine, evaluate and develop the use of compound specific isotope analysis (CSIA) for risk assessment of vapor intrusion to indoor air, including identification of the primary source to the indoor air pollution.

Approach/Activities. Many elements (e.g., carbon and chlorine) occur as different isotope species differing in the number of neutrons in the atom. The isotopic ratios of specific pollutants may vary depending on the source material or fate in the environment. CSIA measures the isotope ratios of carbon ($^{13}C/^{12}C$) and chlorine ($^{37}Cl/^{35}Cl$) for specific chemicals in this case PCE and TCE. Large differences in the isotopic ratio of VOCs in the indoor climate compared to VOCs in the subsurface is an indication of different contaminant origin, and hence that indoor air contamination may originate from an internal source. In this project, we tested the method on three well-characterized sites varying in contaminant type and occurrence of internal and subsurface sources, analyzing 20 air samples.

Results/Lessons Learned. In the first case, CSIA showed clear indication of influence from an active dry cleaning facility to the indoor air in overlying housing. However, there was also indication of air transport from the subsurface source to the indoor air in the basement. In the second case, the isotope ratio of chlorine showed indication that the impact of the indoor air originated from a mix of sources. However, the isotope ratio of carbon indicated influence of an internal source. In the third and last case, there was no clear indication of the origin of the contaminant in the indoor air, as the chlorine ratio showed indications of an internal source and the carbon ratio of a subsurface source. Summing up, in some cases CSIA could indicate the origin of contaminants in the indoor air evaluating results from both chlorine and carbon isotope ratios.

Conclusive, CSIA makes it possible to evaluate the influence of soil vapor intrusion to the indoor environment based on measurements of indoor air, as the total exposure can be divided into contributions from subsurface sources and internal sources. CSIA generate data for a fast and less invasive approach for risk assessment regarding unacceptable vapor intrusion from subsurface contamination to indoor climate.

A second phase of the project is planned for autumn 2017 focusing on expanding and validating the data from the test sites. The results from the second phase are expected to be available by March 2018.