How Not to Overinterpret Your CSIA Data

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Background/Objectives. As compound specific isotope analysis (CSIA) continues to grow in use and transitions from a “novel” environmental tool to a seasoned one, it is pertinent that the remediation community pause to re-evaluate how and when it is employed. When an analysis grows in popularity it is common for its abilities to be exaggerated and for the data to be overinterpreted - or simply misinterpreted - and CSIA has not been immune to this phenomenon. These overinterpretations, though often small, can result in misguided site-management decisions, biased historical narratives, incorrect conceptual site models, and a loss of confidence in the analytical method itself. This presentation is designed to address the capabilities that CSIA has with respect to environmental remediation, as well as the misconceptions that may surround the analysis. The study will also emphasize the necessity of QA/QC for proper data evaluation, and how this knowledge allows end users to convert the results into action at the site.

Approach/Activities. A comprehensive review of CSIA, appropriate QA/QC, analytical limitations, and misconceptions are discussed. By using examples of real-world CSIA data from three different sites, this study highlights common pitfalls that can take place when interpreting the results and recommends steps that can be taken to avoid them. The importance of reviewing the CSIA results in historical, spatial and environmental context is demonstrated through three separate case study narratives. In conjunction with chemical, geochemical, and microbial lines of evidence, this study illustrates how CSIA can greatly enhance a conceptual site model without overinterpretation.

Results/Lessons Learned. When employing CSIA for contaminant source delineation, it is necessary to view the data from an unbiased position, and to interpret the data in context of the QA/QC. One site that utilized CSIA for TCE source distinction produced a single linear trend in a dual-isotope plot which is consistent with a single TCE source. However, close inspection of the data indicated that a single source is highly unlikely due to the spatial separation of the wells, the measured $\delta^{13}C$ values of the source area, and the groundwater flow direction, illustrating the dangers of relying on isotopic data alone. At another site where CSIA was used for source distinction, overlapping error bars (2σ) indicated that several $\delta^{13}C$ and $\delta^{37}Cl$ values were statistically indistinguishable. In this case, interpretation of the data without the context of standard error could have resulted in a very specific narrative that is now known to be inaccurate. A third site which employed CSIA for proving TCE degradation found TCE $\delta^{13}C$ values of -27.4 ‰ and -27.2 ‰ at the source area and the distal plume, respectively. This original data did not indicate TCE degradation. Further analysis of samples taken from the plume centerline resulted in TCE $\delta^{13}C$ values as high as -12.5 ‰, proving that degradation occurred and that preferential pathways were assisting in fast TCE transport from the source to a downgradient location. CSIA is a powerful tool with many uses. The unique data that it can provide has the ability to bridge a variety of data gaps. However, the usefulness of any analytical tool is determined by its end-user. Understanding the true capabilities of the analytical method and being able to interpret the results while also contextualizing the data is the key to unlocking the full potential of CSIA.