

Integration of synchrotron-based spectroscopic techniques and non-traditional stable isotope measurements to define reaction mechanisms controlling contaminant transport

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The integration of synchrotron-based spectroscopic techniques and non-traditional stable isotope measurements provides a powerful tool for delineating reaction mechanisms controlling the transport of metal and metalloid contaminants (e.g., Cr, Cu, Hg, Se and Zn) in groundwater flow systems. Recent advances in multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) provide the opportunity to apply stable isotope measurements of metals and metalloids in environmental systems. A thorough understanding of the extent of isotope fractionation associated with differing reaction mechanisms will provide a basis for application of these emerging techniques to field systems. Synchrotron-based spectroscopic techniques, including XANES, EXAFS, and recently developed techniques, such as confocal X-ray micro-fluorescence imaging (CXMFI), are powerful tools for characterizing reaction products. Coupling MC-ICP-MS measurements with a suite of synchrotron-based spectroscopy techniques provides a unique approach for identifying reaction mechanisms and the associated isotope fractionation. In situ XAS measurements during flow-through cell experiments further enhances our understanding of isotope fractionation under transport conditions, and more will lead to more rigorous constraints of reaction mechanisms. Combined, these measurements can lead to improvements in predictions of contaminant migration and the effectiveness of remediation systems.