Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37481

Using Microanalysis to Evaluate Volatility in Post-Detonation Nuclear Materials

MINDY M ZIMMER, KATHLEEN M CARTER, **COBLE A MATTHEW**, ALISON D ECKBERG, BENJAMIN J GARCIA, NICHOLAS P RICHARD, ZEB G TEICHERT, SEAN R SCOTT AND SETH WOOD

Pacific Northwest National Laboratory

Understanding the processes of debris formation immediately following a nuclear detonation is challenging because the device and surrounding material vaporizes and rapidly condenses upon cooling. Volatility of different radionuclides, including fuels and fission products, causes chemical fractionation. Additionally, environmental material swept into the fireball may melt rather than vaporize, resulting in varying degrees of mixing and physical aggregation with the initial condensates, especially for refractory species. If equilibrium is not achieved before the glass transition is reached, heterogeneities indicative of these processes are preserved, and it is from these signatures that we aim to evaluate volatility and time-temperature history. For example, Cassata et al. (2014) showed that fissiogenic xenon isotopes suggest chemical fractionation and timescale of debris formation. Moreover, major element compositions may distinguish early versus late-stage condensation or melting. Using non-destructive and destructive techniques, we aim to extensively characterize these post-detonation samples, including morphology, elemental and noble gas compositions, long-lived fission products, and actinide isotopics. New method development efforts include noble gas analysis and subsequent destructive analysis by solution ICP-MS or secondary ion mass spectrometry (SIMS). In-house software will enable rapid spatial alignment and combination of large particle datasets from multiple micro-analytical techniques (e.g., elemental compositions and images from SEM EDS and isotopic results from automated mapping via SIMS). Collectively, these analytical methods and interpretive tools will ultimately improve our capability to interpret volatility and the time-temperature history of material formed in a nuclear detonation.

Cassata et al., *J Environ Radioact* 137 (2014) 88-95