Tellurium behavior in the surficial environment

SARAH M. HAYES[1,2], NICOLE A. RAMOS[2], DALLON C. KNIGHT[2]

[1]U. S. Geological Survey, Reston, VA; shayes@usgs.gov
[2]University of Alaska Fairbanks, Fairbanks, AK

Tellurium (Te), often considered a critical element, is increasingly used in high technology applications, including solar panels and thermoelectric devices. Tellurite (Te^{IV}) forms are more toxic than tellurates (Te^{VI}) and thermodynamic datasets differ in their prediction of the dominant oxidation state under surficial conditions. This highlights the necessity for direct field observation of Te behavior under a variety of environmental conditions. Tellurium is enriched in, but not recovered from, gold-silver telluride deposits. Elevated Te concentrations occur in historic mine tailings at several locations across the western United States.

Eight mine sites were selected to represent a climate gradient from arid to alpine in order to assess Te behavior under a wide variety of climatic conditions. Te concentrations vary between 6 and >500 mg kg^{-1}; further characterization was performed using X-ray diffraction, X-ray absorption spectroscopy, micro-focused x-ray fluorescence mapping, electron microprobe analysis, and physiologically-based extraction tests.

At Delamar, a semi-arid site in Nevada, X-ray absorption analysis reveals that Te is primarily present in tailings as Te^{VI}, in a complex assemblage of primary and secondary Te-bearing minerals with low bioaccessibility (below 10%). Most of the Te is associated with Fe, likely coprecipitated with Fe (oxy)hydroxides. Tailings at Vulcan, CO, a humid continental climate, contain up to 150 mg Te kg^{-1}, but an efflorescent salt was also sampled containing >500 mg Te kg^{-1}. This precipitate was identified as a mixture of copiapite, rhomboclase, and gypsum and Te is present as Te^{VI}. Tellurium concentrations in tailings at Vulcan and other sites are correlated with higher concentrations of clay minerals, but also associated with iron (oxy)hydroxides.

Additional characterization of the remaining sites is ongoing, and will provide a better understanding of Te behavior in the surficial environment under a broad range of environmental conditions. These field observations can constrain available thermodynamic data and have value in assessing the potential human and environmental implications of Te in the surficial environment.