Isotopic fractionation of tellurium during reduction of Te(IV) and Te(VI) to Te(0)

T. BULLEN[1], S. BAESMAN[1], R. OREMLAND[1] AND J. AGGARWAL[2]

[1] Water Resources Discipline, U.S. Geological Survey, Menlo Park, CA 94025, USA; tdbullen@usgs.gov, sbaesman@usgs.gov, roremlan@usgs.gov
[2] Keck Isotope Laboratory, Dept. Of Earth Sciences, University of California/Santa Cruz, Santa Cruz, CA 95064, USA; jaggarwal@pmc.ucsc.edu

Tellurium (Te) is a Group VIA metalloid that has geochemical affinities to selenium and sulfur, but distinct redox properties that allow its chemical differentiation from those elements. In aqueous systems, Te occurs primarily as Te(IV)- and Te(VI)-oxyanion complexes, and it is hypothesized that reduction of oxidized Te species to Te(0) should result in isotopic fractionation accompanying breakage of the Te-O bonds which serves as the rate limiting step. Considering isotopic variability of Te together with variations in Te/Se and Te/S ratios in natural systems may prove useful for deciphering redox conditions and the relative importance of biotic and abiotic processes in present-day and paleo-environments. To provide a framework for understanding Te isotope variations in nature, we conducted a controlled laboratory study of the isotopic consequences of Te(IV)- and Te(VI)-reduction under both microbially-stimulated and purely abiotic conditions.

Paired aliquots of reduced black Te(0) and residual aqueous Te(IV) and Te(VI) were sampled along time series spanning approximately one week. Te from individual fractions was quantitatively separated using ion exchange chromotography, and Te isotope compositions were measured using multi-collector ICP mass spectrometry employing both "standard-sample bracketing" and "internal standard" approaches. Te(0) produced during experiments with washed cell suspensions of *Bacillus selenitireducens*, a microbe capable of respiring Te(IV), and *Sulfurospirillum barnesii*, a microbe capable of respiring Te(VI) was consistently lighter than coexisting aqueous Te(IV) or Te(VI). Throughout most of each experiment, isotopic discrimination resulted in an isotopic enrichment factor $\varepsilon \sim -0.7‰$ per amu for *B. selenitireducens* and -0.4‰ per amu for *S. barnesii*. Te(0) produced using cysteine as an abiotic agent to reduce Te(IV) was likewise consistently lighter than coexisting aqueous Te, with an intermediate isotopic enrichment factor compared to that in the microbial experiments ($\varepsilon \sim -0.5‰$ per amu). In the latest stages of all experiments, as the fraction of Te(IV) or Te(VI) remaining approached zero, the isotopic contrast between the aqueous Te and accumulated Te(0) fractions decreased, probably reflecting incomplete separation of solid Te(0) from the liquid fraction. The results of the microbial experiments suggest that *S. barnesii* may be more efficient at reducing Te than *B. selenitireducens*.