PP22A-04 - Variability of Triple Oxygen Isotopes in Meteoric Waters

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Abstract

Triple stable oxygen isotopes (^{16}O, ^{17}O, ^{18}O) are rapidly emerging as a tool to study hydrological processes and past environmental change. However, a paucity of data, preponderance of single-location studies, and lack of systematic sample collection limit observations of $\Delta^{17}O$ and our understanding of the mechanisms that drive variation in this isotope system. To more completely characterize the variability of triple oxygen isotopes in modern meteoric waters, we crowdsourced collection of a near-global sample set and analyzed each water sample for $\delta^{18}O$ and δD. From this, we capture a representative distribution of water isotope compositions from around the world and selected waters for $\Delta^{17}O$ analysis to include the largest possible range of $\delta^{18}O$ and d-excess. In this way we are able to systematically observe and explain triple oxygen isotope variability. Here we present $\delta^{18}O$, d-excess, and $\Delta^{17}O$ of more than 100 rivers, streams, and lakes from 12 geographic regions that span 6 continents and 17 Köppen climate classes. $\delta^{18}O$ ranges from -19.9 to 9.5‰, d-excess ranges from to -31.8 to 21.1‰, and $\Delta^{17}O$ ranges from -25 to 62 per meg, where $\Delta^{17}O$ is defined using a reference slope of 0.528 and all isotope values are normalized to VSMOW-SLAP. $\Delta^{17}O$ data are poorly described by a mean global value and show systematic variation. Unevaporated waters from the mid and high latitudes have higher $\Delta^{17}O$ (~25 to 50 per meg) than unevaporated waters from the tropics (6 to 27 per meg). This suggests that, unlike the $\delta^{18}O$-δD relationship, $\delta^{18}O$ and $\delta^{17}O$ may not fit a global meteoric water line, or that there is a global line but its slope is less than the canonical value of 0.528. In all 12 regions, evaporation tends to increase $\delta^{18}O$ and decrease $\Delta^{17}O$. We find that d-excess and $\Delta^{17}O$ are positively correlated (Pearson's $r > 0.76$) and that the slope between these two parameters is generally independent of region. Finally, we use a Monte-Carlo approach to explore variability of $\delta^{18}O$, d-excess, and $\Delta^{17}O$, as well as the relationships between these variables, and to identify the effects of climate (temperature and relative humidity) on triple oxygen isotopes. Taken together, this work expands and explains new measurements of meteoric $\Delta^{17}O$ and serves as a baseline for answering an array of hydrological and paleoclimate questions.

Authors

Phoebe Aron
University of Michigan Ann Arbor

Naomi E. Levin

University of Michigan
Christopher J Poulsen
University of Michigan Ann Arbor

Ian Z Winkelstern
Grand Valley State University

Emily Beverly
University of Houston

States, (2)University of Houston, Earth and Atmospheric Sciences, Houston, United States, (3)University of Michigan Ann Arbor, Earth and Environmental Sciences, Ann Arbor, MI, United States, (4)University of Arizona, Department of Geosciences, Tucson, AZ, United States, (5)Miami University, Geology and Environmental Earth Science, Oxford, OH, United States

Triple Oxygen Isotope ($\Delta^{17}O$) Signatures of Evaporation at Bear Lake, Utah since the Last Glacial Maximum

Natalie Rose Packard *and Benjamin Passey, University of Michigan Ann Arbor, Earth and Environmental Sciences, Ann Arbor, MI, United States*

Evaluation of triple oxygen isotopes in daily East African precipitation as a potential tracer of recycled continental moisture

Bronwen L Konecky[1], *Jeremy Diem*[2], *Michael W Palace*[3], *Jonathan Salerno*[4], *Jack Hutchings*[1] *and Joel Hartter*[5], *(1)Washington University in St Louis, Earth and Planetary Sciences, St. Louis, MO, United States, (2)Georgia State University, Decatur, GA, United States, (3)University of New Hampshire, Dept. of Earth Sciences and Earth Systems Research Center, Durham, NH, United States, (4)Colorado State University, Department of Human Dimensions of Natural Resources, Warner College of Natural Resources, Fort Collins, CO, United States, (5)University of Colorado at Boulder, Environmental Studies Program, Boulder, United States*

The effect of low sulfate in the Precambrian oceans on seawater-basalt reaction traced by triple oxygen and strontium isotopes

David O Zakharov, *University of Oregon, Earth Sciences, Eugene, OR, United States, Ilya Bindeman, University of Oregon, Department of Earth Sciences, Eugene, OR, United States, Ryoji Tanaka, Okayama Univ, Tottori, Japan, Craig Lundstrom, University of Illinois at Urbana Champaign, Department of Geology, Urbana, IL, United States, Mark H Reed, Univ Oregon, Eugene, OR, United States and David A Butterfield, University of Washington, NOAA/PMEL, Joint Institute for the Study of the Atmosphere and Oceans,, Seattle, WA, United States*

Determining Sources and Fate of Atmospheric Nitrate in an Alpine Watershed Using Triple Nitrate Isotopes

Leora Nanus[1], *Alisa Mast*[2], *Emily M. Elliott*[3] *and David W Clow*[2], *(1)San Francisco State University, Geography & Environment, San Francisco, CA, United States, (2)USGS Colorado Water Science Center Denver, Denver, CO, United States, (3)University of Pittsburgh, Pittsburgh, PA, United States*