Carbonate Paragenesis in the Afar rift system, Ethiopia: insights from clumped isotope thermometry

View Presentation | Add to Schedule

Authors: Jada Langston, University of Michigan Ann Arbor, Ann Arbor, MI, United States, Naomi E. Levin, University of Michigan Ann Arbor, Earth and Environmental Sciences, Ann Arbor, MI, United States, Zelalem K Bedaso, University of Dayton, Geology and Environmental Geosciences, Dayton, OH, United States, Jay Quade, University of Arizona, Department of Geosciences, Tucson, AZ, United States, Yohannes Haile-Selassie, Cleveland Museum of Natural History, Clevland, OH, United States, Michael Rogers, Southern Connecticut State University, Department of Anthropology, New Haven, CT, United States, Beverly Saylor, Case Western Reserve University, Cleveland, United States and Sileshi Semaw, Centro Nacional de Investigación sobre la Evolución Humana, Burgos, Spain

The stable isotope compositions of carbonates have been used extensively to understand the paleoecology of the Afar region in northeastern Ethiopia; however, the near surface fluid and temperature history of the Afar and its potential effects on primary carbonates has not been fully studied. The Afar is an active triple junction, where both tectonics and volcanism influence the deposition, burial, and fluid interactions of sediments. The abundant carbonates in the Afar are untapped resources for contextualizing the thermal and fluid histories of this rift system. Here, we present the stable isotope composition ($\boldsymbol{\delta}^{13}C$, $\boldsymbol{\delta}^{18}O$, Δ_{47}) from seven different carbonate morphologies from fluvial and lacustrine deposits from two separate sequences in the Afar Region (Gona and Woranso-Mille) that span ~4.5 to 0.5 Ma. We used carbonate Δ_{47} values to calculate the temperatures of carbonate formation and used them, along with carbonate $\boldsymbol{\delta}^{18}O$ values, to determine $\boldsymbol{\delta}^{18}O$ value of parent water. Based on initial isotopic data and assessment of their morphological features, the carbonates fit into three groups: 1) primary micritic carbonates, 2) crystalline carbonates in vugs, veins or fractures, and 3) primary carbonates with potential secondary alteration. The pedogenic carbonates yield mean $\boldsymbol{\delta}^{18}O_{carb}$, temperatures and reconstructed $\boldsymbol{\delta}^{18}O_{water}$ values of -6.8 ± 1.8‰ (VPDB), 35 ± 5°C, and -2.4 ± 1.8‰ (SMOW) (**n=49**). Crystalline carbonates yield mean $\boldsymbol{\delta}^{18}O_{carb}$, temperatures, and reconstructed $\boldsymbol{\delta}^{18}O_{water}$ values of -14.2 ± 6.2‰ (VPDB), 75 ± 46.4°C, and -3.9 ± 1.5‰ (SMOW) (**n=5**). For carbonates that may include secondary or altered carbonates, $\boldsymbol{\delta}^{18}O_{carb}$, temperatures and reconstructed $\boldsymbol{\delta}^{18}O_{water}$ values are -8.6 ± 3.0‰ (VPDB), 44 ± 13°C, and -2.7 ± 2.1‰ (SMOW) (**n=12**). Δ_{47} temperature resembles published surface water temperatures of the Afar (≤100°C) except for one sample (156 ± 13°C). Considering all carbonate groupings together, reconstructed $\boldsymbol{\delta}^{18}O_{water}$ values range from -6.7 to +0.8‰ SMOW and overlap with $\boldsymbol{\delta}^{18}O_{water}$ values from meteoric and hydrothermal waters in the Awash Basin, in the Afar today (-7 to +2‰ SMOW). Additional geochemical data and petrographic analysis of these carbonates will help further characterize them and interpret their paragenetic sequence.