

Bonamici, C.E., Kropf, G., Borchers, B., Parrish, G. (2019), Time-temperature paths from intragrain oxygen isotope zoning, Abstract V43A-02 presented at 2019 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.

Oxygen isotopes are a well-known geochemical tool with applications to equilibrium thermometry, fluid tracing, and magma and ore petrogenesis. High-precision, high-spatial resolution oxygen isotope analysis by SIMS has also enabled the development of oxygen isotopes as a tool for geospeedometry. Here, we detail Fast Grain Boundary (FGB), an updated computational approach and software tool for determining time-temperature (T-t) histories through modeling of oxygen isotope diffusion. FGB models a rock system, rather than a single phase (cf. thermochronometry based on He, Ar, Pb), and has the potential to constrain continuous thermal histories over a wide range of temperatures, including at high temperature (500-800°C). The new FGB also allows for inversion of the FGB model to extract thermal histories from intragrain oxygen isotope zoning data using the Levenberg-Marquardt (LM) algorithm. Tests with synthetic datasets show that the LM algorithm is able to distinguish between simple linear cooling and more complex thermal histories containing, for instance, reheating events. Inversion of an actual oxygen isotope data set from titanite are consistent with the previously determined T-t path for the sample region, showing a brief period of >700 °C conditions, followed by cooling below 500 °C in <5 m.y.. However, the inversion suffers from a flat-bottomed minimum and does not produce a well-converged T-t path. These results point to analytical precision as a continuing challenge in recovering tightly constrained thermal histories for the real data set and emphasize the need for further development of high-precision microanalytical oxygen isotope standards. In the meantime, we use FGB modeling to explore sampling and analytical approaches that improve the resolution of inversion solutions for current analytical capabilities. For instance, inversion most successfully recovers a well constrained T-t path solution when SIMS analysis targets oxygen isotope gradients developed near grain rims, as opposed to oxygen isotope values in grain centers. Additional tests that probe the sensitivity of the inversion results to modal mineralogy and relative grain sizes suggest that careful targeting of samples in the field can enhance the recovery of unique T-t paths.