Assessing Thermochronometer Systematics in a Natural Geologic Setting, Little Devil’s Postpile, Yosemite National Park

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Abstract - A better understanding of the systematics of several commonly used thermochronometers will provide the geologic community a basis to interpret thermochronologic data. To this end, this study focuses on intercalibrating several established and experimental chronometers. The Little Devil’s Postpile intrusion, located within Yosemite National Park, is an ideal location for this study. This approximately 100 m diameter asymmetrical basalt plug intruded the Cathedral Peak granite (quartz monzonite), at ~8 Ma. The thermal pulse resulting from the intrusion of the basalt systematically reset the age of the ~80 Ma host. Little Devil’s Postpile provides the opportunity to evaluate the relative performance of several thermochronometric systems in a natural geologic setting. Samples were collected along two transects within the Cathedral Peak granite to assess the resetting response of individual thermochronometers to a relatively short thermal pulse. This portion of the project focuses on analysis of 40Ar/39Ar in K-feldspar, biotite, and plagioclase. Preliminary data follow predicted behavior, where a higher closure temperature system such as biotite is affected to a lesser degree than K-feldspar at the same distance from the intrusion. 40Ar/39Ar analysis of the basalt reveals an intrusion age of 7.7 Ma. Age spectra from both proximal and distal biotites display little to no resetting. Samples closer to the contact are needed for more meaningful biotite data. Plagioclase displays jagged age spectra and low temperature excess argon however proximal samples appear partially reset. MDD modeling of distal K-feldspar sample (22 m) reveals the Cathedral Peak granite cooled quickly at ~80 Ma. K-feldspar samples proximal to the intrusion contact (4.5 and 6.86 m) display partial resetting. Forward modeling of the closest sample indicates that the maximum thermal pulse experienced by this sample was approximately 420°C, 100°C lower than predicted by the model proposed by Calk and Naeser (1973).

K-feldspar MDD Modeling

Multidomain diffusion (MDD) modeling and inversion of sample LDP10-01, from 22 m away from the intrusion indicates fast cooling of Cathedral Peak Granite ~80 Ma. (a) Ar/Ar plot (top), and log(Ar/Ar) plot (bottom) for modeling of sample LDP10-01 obtained using modified Autoarr program (Love et al., 1997) including domain structure and kinetic parameters (τ: 8, 7, 2, 4 x 10^12 s). In Ar/Ar plot, blue = observed data, red = model, gray = domain structure. (b) Inverse model results using Arrhenius 4.1 controlled random search code (Harrison et al., 2005; Zeitler, 2006). In thermal history plot (top) and age spectrum plot (bottom) green and red lines = modeled thermal histories. In age spectrum plot blue line = modeled portion of observed age spectrum. Gray line = unmodeled portion of age spectrum.

Plagioclase Kinetics

Plagioclase, an experimental thermochronometer display promise as a useful system. ~Ar and 39Ar Ar/Ar plots and measured K/Ca ratios for each sample displayed to left. Sample-specific kinetic parameters and closure temperatures are calculated using both 39Ar and 39Ar Ar/Ar as both are reactor-produced reference isotopes. Plagioclase data closure temperatures are 230-280°C. Kinetic parameters calculated from release of 39Ar are similar to those of 39Ar; however predict slightly higher activation energies and lower log D values.

References


