The Effects of Alpha Damage on Helium Diffusion in Zircons

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ABSTRACT

The annealing temperature of alpha damage in zircons is poorly understood. This damage is known to affect helium diffusion in zircons. In order to provide a more accurate approach to zircon-helium dating, which is used to constrain thermal histories below 180°C, I propose to establish this annealing temperature. I will characterize the relationship between the closure temperature of He in zircon and alpha dose using synthetically processed zircons that are free of damage and He. These zircons will then be saturated with He and will undergo various amounts of fast neutron irradiation, producing damage that is quantifiable. I will then analyze these samples using multiple characterization techniques (XRD, IR, TEM, TGA-GCMS) to provide a calibration of structural damage and closure temperature. Step-heating of these zircons will produce a closure temperature – alpha dose curve. I will then examine zircons from granites that have well-established thermal histories (time-temperature curves) which will provide closure temperatures at the age of these dated zircons. This can then be related to alpha dose by our previously made closure temperature – alpha dose curve. I will then calculate the amount of time necessary to accumulate said alpha dose and track back on the time-temperature curve of these granites to find the time and temperature at which this damage began accumulating. This will provide empirical estimates of the closure temperature of alpha-damage annealing and will allow for more precise calculations of alpha dose. These calculations are important for determining more precise zircon-helium dates and low-temperature thermal histories of samples.

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