American Mineralogist, Volume 95, pages 1192–1201, 2010

Radiation damage and uranium concentration in zircon as assessed by Raman spectroscopy and neutron irradiation

A.E. Marsellos[1,2,*] and J.I. Garver[2]

[1]Department of Earth and Atmospheric Sciences, State University of New York, Albany, New York 12222, U.S.A.
[2]Department of Geology, Union College, Schenectady, New York 12308, U.S.A.

Abstract

Radiation damage of natural and synthetic zircon grains is evaluated by Raman spectroscopy to understand annealing and stability of fission tracks. Analyses focus on a suite of 338 Paleozoic detrital zircon grains from metamorphosed strata in the Hellenic forearc that were variably annealed by a Miocene thermal event, as well as a suite of 97 synthetic zircon grains. The Raman wavenumber shift of ν_3 [SiO_4] reveals that radiation damage and damage distribution in this suite mainly depends on uranium concentration. In zircon with similar uranium concentration, the Raman wavenumber shift allows for the determination of radiation damage in different crystals, which is a function of effective accumulation time. Nine detrital zircons grains with moderate radiation damage were stepwise annealed at 1000 and 1400 °C, which resulted in progressive removal of radiation damage revealed in an increase of ν_3 [SiO_4] peak positions. For a partly reset sample that was brought to temperatures of ~350 °C in a geologic setting (Hellenic forearc), we use the Raman measurements and uranium determination to estimate a Zircon Damage Discrimination Factor (Z_{RDD}), which is our attempt to estimate only radiation damage in single grains by accounting for affects of the uranium atom in the Raman wavenumber. This discrimination allows for a separation of zircon fission track (ZFT) ages of single ages based on grains that have a low track retention (high damage, fully reset grain), thus refining the age determination of cooling in a rock that shows variable resetting.

Keywords: Geochronology, zircon fission track, radiation damage, uranium content, Raman spectroscopy