American Mineralogist, Volume 89, pages 1067–1077, 2004

Isotopic and chemical alteration of zircon by metamorphic fluids: U-Pb age depth-profiling of zircon crystals from Barrow's garnet zone, northeast Scotland

CHRISTOPHER M. BREEDING,[1,†] JAY J. AGUE,[1,*] MARTY GROVE,[2] AND ANDREW L. RUPKE[3]

[1]Department of Geology and Geophysics, Yale University, New Haven, Connecticut 06520-8109, U.S.A.
[2]Department of Earth and Space Sciences, University of California, Los Angeles, California 90095-1567, U.S.A.
[3]Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112, U.S.A.

ABSTRACT

U-Pb isotopic analyses were done using ion microprobe depth-profiling on zircon crystals from Dalradian rocks in Barrow's garnet zone, northeast Scotland, to determine the timing of metamorphic fluid infiltration and investigate fluid-zircon interactions. Zircon crystals collected from altered metasedimentary rock adjacent to a cross-cutting quartz vein and from relatively unaltered, continuously equivalent layers distal to the vein indicate that Paleozoic fluid influx caused isotopic and chemical alteration along zircon crystal surfaces and internal fractures. "Ion drilling" into natural zircon crystal faces yielded U-Pb depth profiles with 50–100 nm spatial resolution that permitted U-Pb isotopic age analysis of thin grain rims affected by fluid-mediated growth/recrystallization at 500–550 °C. We interpret the measurements to indicate that fluid influx at 462 ± 8.8 Ma caused the growth/recrystallization of new zircon along pitted crystal surfaces and fractures in Archean zircon grains. Our age estimate overlaps the accepted age range (ca. 467–464 Ma) for peak Barrovian garnet growth, confirming that metamorphism and fluid influx were contemporaneous. The new zircon was enriched in U, Th, and common Pb relative to host grains, suggesting that U, Th, and Pb were actively transported by upper greenschist-facies metamorphic fluids. We present the first field-based evidence that common Pb in zircon can serve as an indicator of metamorphic fluid infiltration. Archean ages for some detrital zircons suggest contributions from a Lewisian/Scourian provenance.