American Mineralogist, Volume 94, pages 1468–1478, 2009

Multistage boron metasomatism in the Alamo Complex (Central Iberian Zone, Spain): Evidence from field relations, petrography, and $^{40}Ar/^{39}Ar$ tourmaline dating

Alfonso Pesquera,[1,*] José Torres-Ruiz,[2] Pedro P. Gil-Crespo,[1] and Encarnación Roda-Robles[1]

[1]Departamento de Mineralogía y Petrología, Universidad del País Vasco, Bilbao, Spain
[2]Departamento de Mineralogía y Petrología, Universidad de Granada, Granada, Spain

Abstract

The Alamo Complex consists of structural-metamorphic domes surrounded by low-grade metasedimentary rocks of Upper Proterozoic to Lower Cambrian age that form part of the Schist Graywacke Complex (Central Iberian Zone, Spain). Tourmaline is ubiquitous throughout the domes, in which it occurs in tourmalinites, psammo-pelitic schists, quartzites, gneisses, migmatites, leucogranites, aplo-pegmatites, and quartz veins. Overall, tourmaline compositions can be described within the four component system schorl-dravite-foitite-magnesiofoitite, with K_2O < 0.23%, low Ca contents, Mg/(Mg+Fe) = 0.25–0.71 and X/(X+Na) = 0.18–0.43, where X = vacancies in the X site. Field relations and petrographic observations, combined with tourmaline $^{40}Ar/^{39}Ar$ data, provide evidence of intense boron metasomatism affecting this region. Tourmaline $^{40}Ar/^{39}Ar$ step-heating spectra for Cambrian-Ordovician orthogneisses are complex, yielding a pseudo-plateau age of ~370 Ma that is interpreted to reflect Variscan rejuvenation of older tourmaline. Tourmaline $^{40}Ar/^{39}Ar$ data for mylonitized and folded tourmalinites yield disturbed spectra with pseudo-plateau ages of ~355–342 Ma that are unsuitable for precise age determination. These ages, however, are consistent with published ages (340–350 Ma) for the second Variscan deformation (D_2). Tourmaline from fine-layered tourmalinite and metasedimentary rocks yield well-defined plateau ages of 317 and 315 Ma, respectively, recording an additional metasomatic event concomitant with anatexis and evolution of B-bearing granites, pegmatites, and hydrothermal fluids. The different tourmaline-forming stages reflect significant boron cycling within the continental crust of the Central Iberian Zone, driven by deformation, metamorphism, and magmatism during the Variscan orogeny. Boron-rich aqueous fluids related to Cambro-Ordovician magmatism are considered to be the primary source of boron.

Keywords: Tourmaline, petrography, chemical composition, $^{39}Ar/^{40}Ar$ dating, Alamo Complex, Central Iberian Zone, Spain