Arab J Geosci (2016) 9:246
DOI 10.1007/s12517-015-2223-7

ORIGINAL PAPER

Origin of tourmaline from the Kolah Ghazi granitoid body (SE Isfahan, Iran)

M. Mansouri Esfahani[1] · A. Safari Mirghale[2]

Received: 18 June 2015 / Accepted: 29 October 2015

Abstract Abundant tourmaline crystals, commonly up to 0.5 cm in diameter, are present in the middle Jurassic Kolah Ghazi granitoid body. They occur in the granitoid, quartz veins, and hornfels of the area. Electron microprobe analyses indicate that the tourmalines from the granitoid and hornfels display ferrous (ferrischorl), and those from quartz veins show tendency to magnesium (dravite) compositions. On the Al-$Fe_{(tot)}$-Mg and Ca-$Fe_{(tot)}$-Mg diagrams, the tourmalines from the quartz veins are related to metasediments (i.e., metapelites and metapsammites), while those of the granitoid and the hornfels related to granitoid, pegmatite, and aplite field. According to the petrographic observations as well as geochemical signatures, the investigated tourmalines are classified as magmatic and hydrothermal origin. The granitoid and hornfels tourmalines are chemically homogeneous and reflect high Fe/Mg, high F, and high Al values in R2 site (ave. 0. 20 apfu) with schorl end member, and so these may be considered as magmatic in origin. In contrast, tourmalines from quartz veins display a weak zoning pattern, dravite in composition with little Al values in R2 site (ave. 0.17 apfu). Moreover, its Mg and Fe concentration varies from 1.72 to 1.80 apfu and from 0.60 to 0.70 apfu, respectively, suggesting hydrothermal conditions of formation. Substitution mechanisms for the chemical evolution of tourmalines from the granitoid and the hornfels are the Fe^{3+} Al_{1}, $AlOR(OH)_{-1}$, $\square Al(Na\ R)\_{1}$, $\square Al(Na\ Mg)\_{1}$, and for the quartz–tourmaline vein substitutions display by $^{X}Na_1$ $^{Z}R^{2+}{}_{1}$ $^{X}\square\_{1}$ $^{Z}Al\_{1}$, $^{X}Ca_1$ $^{Z}R^{2+}{}_{1}$ $^{X}Na\_{1}$ $^{Z}Al\_{1}$, $\square Al(Na\ Mg)\_{1}$ that can be the traces of metasomatism evidences.

Keywords Magmatic tourmaline · Hydrothermal tourmaline · Kolah Ghazi granitoid · Sanandaj–Sirjan Zone · Iran

✉ M. Mansouri Esfahani
mmansouri_2001@yahoo.com

1 Department of Mining Engineering, Isfahan University of Technology, Isfahan 84156-83111, Iran

2 Department of Geology, University of Isfahan, Isfahan, Iran

Introduction

Accessory minerals provide evidence of differences in chemical and physical conditions that may not be recorded in major mineralogy. Among these minerals, tourmaline is of particular interest. It occurs as a primary phase in all products of granite magmatism and associated hydrothermal activity as well as related pegmatites (e.g., London and Manning 1995; Keller et al. 1999; Tindle et al. 2002; Trumbull et al. 2008; Yavuz et al. 2008).

A general chemical characteristic of tourmalines with magmatic origin is essentially unzoned and may be distinguished by high Fe/Mg, high F, and high Al in the R2 site and high Fe/(Fe + Mg) ratios with predominantly schorl in component. In contrast, tourmaline of hydrothermal origin can be considered by petrographical and chemical fine-scale zonation with compositions nearer to schorl–dravite solid solution, and they have little or no Al in the R2 site (London and Manning 1995).

Experimental studies (Benard et al. 1985; Henry and Dutrow 1996; Von Goerne et al. 1999) show that tourmaline is stable over a wide range of temperature from near-surface conditions to granulite facies and anatexis up to over 60-kb pressure (Henry et al. 2002). Tourmaline, however, tends to remain unreactive up to the highest grades of metamorphism and provides an important control on boron concentration in anatectic melts (London et al. 1996).

Published online: 24 March 2016