Chemical compositions of tourmaline in Li pegmatite from Sakihama, Myokenzan, Nagatare, and Okueyama, Japan

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Many pegmatites on a different scale are distributed with a granite in Japan. However, the number of chemically developed pegmatites are limited, such as an Li enriched pegmatite. In this study, a mineralogical approach was performed in the Li pegmatites from Sakihama, Iwate Prefecture, in the Kitakami Belt, Myokenzan, Ibaraki Prefecture, in the Abukuma Belt, Nagatare, Fukuoka Prefecture, in the North Kyushu, and Okueyama, Miyazaki Prefecture, in the Outer Belt of Southwest Japan. In particular, the chemical trends of tourmaline from each locality were discussed.

Though the Li pegmatites have different occurrences and minerals, they contain tourmaline in common. The tourmaline are continuously distributed from the wall zone to the core, changed the occurrence and macroscopic properties (*e.g.*, Shirose and Uehara, 2012; 2013; 2016). The general formula of tourmaline super group minerals is $XY_3Z_6(T_6O_{18})(BO_3)_3V_3W$ (X = Na, Ca, K, Y = Fe^{2+}, Mg, Mn^{2+}, Al, Li, Fe^{3+}, Cr^{3+}, Z = Al, Fe^{3+}, Mg, Cr^{3+}, T = Si, Al, V = OH, O, W = OH, F, O) (Henry *et al.*, 2011). A chemical variation of tourmaline in an Li pegmatite shows increasing (Li + Al) and decreasing Fe^{2+} at Y site from the country rock to the core of the pegmatite, reflecting the chemical development of melts (*e.g.*, Jolliff *et al.*, 1986; Selway *et al.*, 1999).

The scale of Li pegmatites in Nagatare and Myokenzan is larger than the others, and they are chemically developed pegmatites enriched in Cs and Ta in addition to Li. They occur as a dyke without a druse. The tourmaline from Nagatare and Myokenzan are commonly subhedral radial aggregates with small grain diameters. Many of the tourmaline from the core of the pegmatite are altered to muscovite and cloudy. The Li pegmatite in Sakihama occurs as a dyke with druses. There are intergrowth of tourmaline and quartz, and subhedral to euhedral tourmaline elongated to the core. The latter has a large grain size, and it is up to 10 cm in diameter. For Okueyama, the small Li pegmatite occurs with druse, in REE pegmatite with miarolitic cavities. The tourmaline from Okueyama are subhedral to euhedral crystals. The color of tourmaline in these localities changes from black to deep color and pale color toward the core of the pegmatite.

EPMA analyses show that a $^{Y}(Fe^{2+}) \leftrightarrow {}^{Y}(Li + Al)$ substitution of tourmaline toward the core of the pegmatite is significant in all pegmatites. However, the tourmaline from Sakihama had $^{Y}Mn^{2+}$ abundantly, and a $^{Y}(Fe^{2+}) \leftrightarrow {}^{Y}(Mn^{2+} + Li + Al)$ substitution occurred significantly, followed by a $^{Y}(Mn^{2+}) \leftrightarrow {}^{Y}(Li + Al)$ substitution. For the trends of $^{Y}Mn^{2+}$ contents in the tourmaline from the four localities, each locality shows different trends of the chemical development (Figure 1). The tourmaline from Okueyama was drastically enriched in $^{Y}Mn^{2+}$, in the Li rich part of the crystals from the druse. For the tourmaline from Nagatare, the contents of $^{Y}Zn^{2+}$ was characteristic (< 0.2 *apfu*). These chemical properties were harmonious with the associated minerals in the pegmatites. Masutomilite generally occurs from Sakihama, and the Zn-bearing tourmaline associates with gahnite. Comparing the trends of chemical compositions of tourmaline enable to obtain the detailed chemical conditions of the pegmatite and host rocks during the formation process.

Keywords: Li pegmatite, tourmaline, Sakihama, Nagatare, Myokenzan, Okueyama

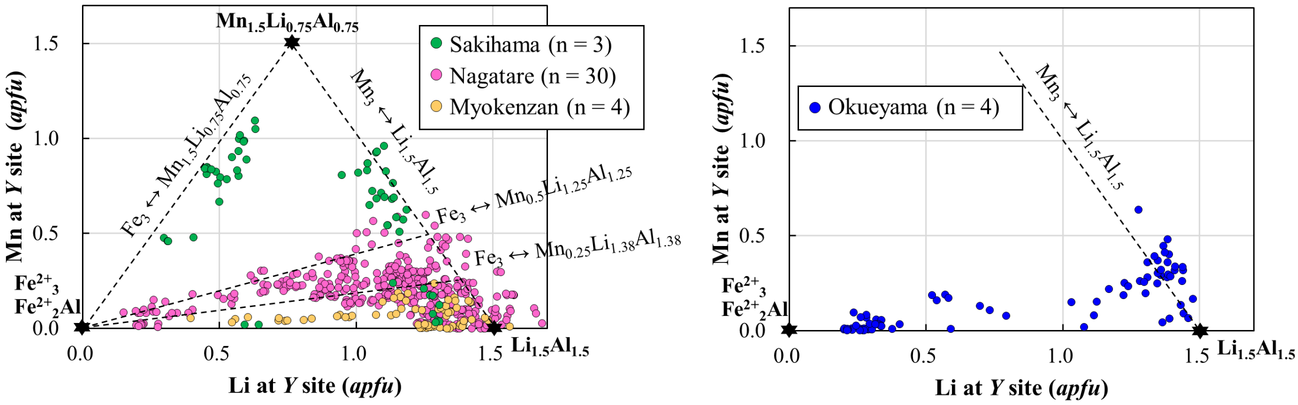

Figure 1 Chemical trends at Y site of the tourmaline from each pegmatite. "n" means the number of specimens. The Li contents were calculated.