SMP10-06 会場:A05 時間:5 月 26 日 16:45-17:15

ダイヤモンドと共存する新鉱物丸山電気石の発見と超高圧変成岩中の電気石の多様性
Maruyamaite, a new K-dominant tourmaline coexisting with diamond: Significance of tourmaline in UHP rocks

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Maruyamaite is a new end-member species of the tourmaline supergroup (IMA 2013-123, Lussier et al., 2014). The ideal chemical formula of maruyamaite is $K(MgAl_2)(Al_5Mg)(BO_3)_3(Si_6O_{18})(OH)_3O$, which is the K-analog of oxy-dravite. This new mineral was first reported as a K-dominant tourmaline coexisting with microdiamond inclusions from the Kokchetav Massif, Kazakhstan (Shimizu & Ogasawara, 2005) and named in honor of Professor Shigenori Maruyama (Earth-Life Science Institute, Tokyo Institute of Technology, Japan), who led the Japan-U.S.-Kazakhstan cooperative project on Kokchetav ultrahigh-pressure (UHP) metamorphism. The K content in maruyamaite is up to 0.576 apfu (2.76 wt% K_2O). Currently, the occurrence of maruyamaite has been reported exclusively from the type locality (the Kokchetav Massif) and maruyamaite is a unique K-dominant tourmaline species. Moreover, no K-rich dravitic tourmaline has been found from other UHP terranes (Marschall et al., 2009). The rarity of K-dominant tourmaline is probably due to the large ionic radius of K with respect to the X-site of magnesian tourmalines.

The systematic chemical analysis of various tourmalines including maruyamaite in diamond-bearing Kokchetav UHP rocks combined with detailed inclusion mineralogy demonstrated that K in tourmaline decrease with pressure (and temperature) decrease (Shimizu & Ogasawara, 2013). For instance, the figure shows that microdiamond occurs only in K-dominant core (maruyamaite) and the surrounding low-K parts (K-bearing dravite or oxy-dravite) contain low-pressure minerals such as graphite and quartz. Maruyamaite or "K-dravite" component can form continuous solid solutions with other magnesian tourmalines up to ~58% of K in the X-site, with a close relationship to pressure. In particular, the limited occurrence of microdiamond in maruyamaite strongly indicates that K-dominant tourmaline is a UHP phase. Ota et al. (2008) concluded that partial melting of gneisses under UHP condition had formed the maruyamaite-bearing tourmaline-rich quartzofeldspathic rock from the high δ^{11}B values of maruyamaite, which is quite unusual for high-grade metamorphic tourmaline.

There had been no experimental constraint on K-incorporation in tourmaline until fairly recently, however, K-dominant tourmaline (up to 0.71 K apfu) has been synthesized for the first time by Berryman et al. (2014). They showed that K-dominant tourmaline is stable at UHP conditions (2-4 GPa). It means that K-dominant tourmaline including maruyamaite can be a new UHP indicator. K in tourmaline also is a potential geobarometer once partition coefficient of K and Na between tourmaline and mica or feldspar is experimentally determined. Another important constraint is that K-incorporation in tourmaline structure requires not only high-pressure but also very high K/Na conditions (Berryman et al., 2014). A number of studies (e.g., Hwang et al., 2005) have shown that K-rich fluid had been present at the Kokchetav UHP stages and played an important role for the formation of metamorphic diamond and other UHP minerals such as K-rich clinopyroxene. The experimental results were consistent with the interpretation of the occurrence and chemical analyses of the natural maruyamaite-bearing rock.

Four generations of tourmaline from K-dominant maruyamaite to K-free low-grade tourmalines were recognized in the Kokchetav UHP gneisses based on their chemical compositions and inclusion contents. The tourmalines record the retrograde history from a diamond-grade partial melting to the latest greenschist facies overprint. This interpretation further emphasizes the feature of tourmaline for an excellent geochemical recorder of metamorphic events and a sink of light element such as boron in deeply subducted crustal materials.

Figure captions: (A) Photomicrograph of K-bearing tourmaline showing maruyamaite as domains rounded by red broken lines; (B) K zoning of tourmaline; and (C) Microdiamond inclusions in maruyamaite.

Keywords: maruyamaite, tourmaline, diamond, ultrahigh-pressure metamorphism, Kokchetav Massif, inclusion

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