Discovery of K-tourmaline with microdiamond in the Kokchetav UHP rock, Kazakhstan -Implications to boron cycling-

Rentaro Shimizu[1]; Yoshihide Ogasawara[1]

[1] Earth Sci., Waseda Univ.

http://www.earth.edu.waseda.ac.jp

Potassium tourmaline coexisting with microdiamond was newly discovered in tourmaline-K-feldspar-quartz rock at Kumdy-kol in the Kokchetav UHP Massif, northern Kazakhstan. The Kokchetav Massif is ultrahigh-pressure (UHP) terrane in Cambrian continental collision zone (e.g. Dobretsov et al., 1995; Kaneko et al., 2000). The Kumdy-Kol area in this terrane is characterized by abundant occurrences of metamorphic microdiamond. The minimum peak pressure condition has been estimated at 6GPa.

Though tourmaline is common accessory mineral in metapelitic rocks, little attention has been paid. Tourmaline is a chemically robust mineral, and retains information of each metamorphic stage. Tourmalines from the Kokchetav Massif, however, have been regarded as retrograde mineral until recently. The discovery of diamond in tourmaline, which will be discussed here, indicates that tourmaline was stable under diamond-grade UHP conditions. This study reports occurrence of tourmaline and discusses its geochemical implications.

The rock sample containing K-tourmaline consists mainly of quartz, K-feldspar, and tourmaline, with small amounts of titanite, hematite, phengite, chlorite, and zircon. The modal composition of tourmaline is up to 25%. Tourmaline shows euhedral to subhedral coarse grain (ca. 1mm). Microdiamond is included in zircon and tourmaline. Tourmaline in this sample is potassium-analogue of dravite, and K2O content reaches 2.76 wt%. Such chemical compositions have never reported before. Each tourmaline grain displays clear chemical zonation. The representative microprobe analyses of the core show K2O: 2.62 wt%, Na2O: 0.73 wt%, CaO: 1.24 wt%, MgO: 8.65 wt%, FeO: 3.35 wt%, TiO2: 1.12 wt%, Al2O3: 31.07 wt%, and SiO2: 36.45 wt%, and the empirical formula is written as (K0.575Ca0.280Na0.186)1.041(Mg2.226Fe0.382Ti0.146)2.755Al5.969Si5.987O18(BO3)3(OH)4.

K2O is concentrated in the core and decreased from the mantle to the rim. The K2O content is up to 2.76 wt% (XK-dravite = 0.55) in the core, and 0.47 wt% (XK-dravite = 0.11) at the rim.

Na2O increases at the mantle ranging from 0.59 to 1.73 wt%; CaO ranges from 1.24 wt% (core) to 3.26 wt% (rim). Mg increases at the mantle; Ti is higher in the core part.

Diamond is included only in K2O-rich part (core), and flaky euhedral graphite sometimes occurs in the rim part. Quartz, zircon, calcite, and aggregates of anhedral graphite also occur in the core and the mantle.

Occurrence of microdiamond inclusion suggests that the core part of tourmaline formed under UHP conditions. Flaky graphite in the rim demonstrates crystallization out of the diamond stability. These indicate K-rich tourmaline was stable under UHP conditions. The chemical zonation from mantle to core is corresponding to retrograde pattern, and it is consistent with the occurrence of graphite. Formation of diamond-bearing tourmaline-rich rock requires boron enrichment under UHP conditions. Boron may be carried by aqueous fluid of dehydration origin of phyllosilicates through UHP metamorphism. Moreover, the tourmaline in this study shows an example of diamond-grade borosilicate and gives great implications to boron enrichment through fluid effect during UHP metamorphism. Thus tourmaline is expected to retain information about fluid in crustal rock subducted to upper mantle depth.