DISCOVERY OF K-TOURMALINE IN DIAMOND-BEARING QUARTZ-RICH ROCK FROM THE KOKCHETAV MASSIF, KAZAKHSTAN

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Potassium tourmaline coexisting with microdiamond was newly discovered in tourmaline-K-feldspar-quartz rock at Kumdy-kol in the Kokchetav UHP Massif, northern Kazakhstan. 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 now. The discovery of diamond in tourmaline, which will be discussed here, indicates that tourmaline was stable under diamond-grade UHP conditions.

The rock sample containing K-tourmaline consists mainly of quartz, K-feldspar, and tourmaline (up to 25 vol%, ca. 1 mm coarse grained euhedral to subhedral), with small amounts of titanite, phengite, chlorite, zircon, biotite, apatite and hematite. Microdiamonds are included in zircon and tourmaline. Tourmaline in this sample is potassium-analogue of dravite, displays clear chemical zonation and K_2O content reaches 2.76 wt%. Such chemical compositions have never been reported before. Representative microprobe analyses of the core show K_2O 2.62 wt%, Na_2O 0.73 wt%, CaO 1.24 wt%, MgO 8.65 wt%, FeO 3.35 wt%, TiO_2 1.12 wt%, Al_2O_3 31.07 wt%, SiO_2 36.45 wt% and the chemical formula is written as $(K_{0.575}Ca_{0.280}Na_{0.186})_{1.041}(Mg_{2.226}Fe_{0.382}Ti_{0.146})_{2.755}Al_{5.969}Si_{5.987}O_{18}(BO_3)_3(OH)_4$. K_2O is concentrated in the core (2.76 wt%, $X_{K\text{-dravite}} = 0.55$) and decreased from the mantle to the rim (0.47 wt%, $X_{K\text{-dravite}} = 0.11$). Na_2O increases at the mantle from 0.59 - 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.

Twenty seven microdiamond grains were confirmed in three thin sections with laser Raman spectroscopy. Diamond is included only in K_2O-rich part (core), and flaky euhedral graphite sometimes occurs in the rim part. Quartz, K-feldspar, phengite, 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. This indicates K-rich tourmaline was stable under UHP conditions. The chemical zonation from mantle to rim corresponds 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 an aqueous fluid of dehydration origin of phyllosilicates through UHP metamorphism. Moreover, the tourmaline in this study is an example of diamond-grade borosilicate and gives great implications to B-enrichment through fluid effect during UHP metamorphism. Thus tourmaline is expected to retain information about fluid in crustal rock subducted to great depths.

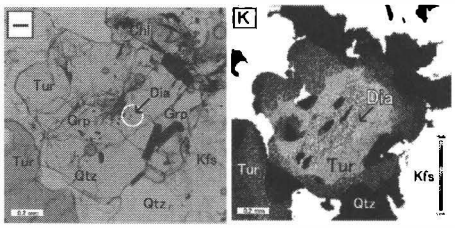

Fig. 1 Left: photomicrograph of K-tourmaline. Right: characteristic X-ray image of K of tourmaline.