A Boron and Tourmaline Point of View of the Central Nepal Himalaya

TALK

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The Himalayan range is known for the wide occurence of tourmaline, sometimes in large quantities; in fact we have found it in all formations of the Central Nepal Himalaya, from the Midlands to the Tibetan sedimentary series. We have undertaken a systematic survey of the boron content and tourmaline compositions of all types of rocks along a general section through the range in the Annapurna-Manaslu region.

The boron content of the whole rock varies from less than a ppm to more than 1000 ppm. Some formations are rather boron-rich such as the "Lesser Himalayan" granites or the upper Midland formations. Others vary from one sample to another, such as the Manaslu granite (from 12 to 664 ppm). In the Midlands formations, the boron content seems to first increase with the grade of metamorphism, from chlorite to garnet-grade, and then to lessen up to kyanite, a decreasing trend that clearly continues in Formation I of the Tibetan Slab.

Although a number of boron-bearing minerals such as danburite have been found in Nepal, most of the boron is contained in tourmaline. However, micas, and especially biotite, may reveal up to several hundreds of ppm of boron.

One can distinguish mainly two types of occurence of tourmaline: in the ground mass of rocks, or in the granitic paragenesis of aplitic to pegmatitic dykes. The latter only show up above the MCT.

Tourmaline in Central Nepal has a highly variable chemical composition that can be mostly described in terms of dravite-schorlite-(elbaite) end members (figures). These variations seem to be linked:

- to the composition of the host rock
- to the grade of metamorphism
- to the position in the structural edifice

The chemical composition of tourmaline obtained by microprobe analysis in the various rock types indicates Mg-rich tourmaline (dravite) in calcic gneiss, marble and restite, against Fe-rich tourmaline (schorlite) in granite and tourmalinite (fig a). Other rock types are mostly distributed between the dravite and schorlite end members, with little increase in the elbaite content. Tourmaline from the aplopegmatitc dykes also varies largely in composition, depending on the lithology of the host rock: the more pelitic the latter, the more dravitic the tourmaline.

In the Midlands there seem to be a rather good correlation between the grade of metamorphism and the composition of the tourmaline: from chlorite to kyanite inverted grade, there is a decrease in the elbaite (Al) and schorlite (Fe) contents (figure b). We have not found similar systematic variations in the zonation of the tourmaline. The zonation trend, related to small (a few %) variation in the chemistry, is usually homogeneous within a sample but varries randomly from one sample to another. This suggests that tourmaline grew rather rapidly during metamorphism.

For the granitic dykes intruding the Tibetan Slab and the overlying Annapurna formation, there is a global trend of evolution of the tourmalines from a dravitic composition in the Formation I to a very schorlitic (and more elbaitic) composition in the Annapurna limestones (figure c). This evolution encompasses a structural section of more than 10 km and may reflect the changes in the tectono-metamorphic conditions.

Altogether, boron and tourmaline, minor in abundances, trace the fossil path of fluids; they are distinctively sensitive to the chemical and physical constraints of the Himalayan building.

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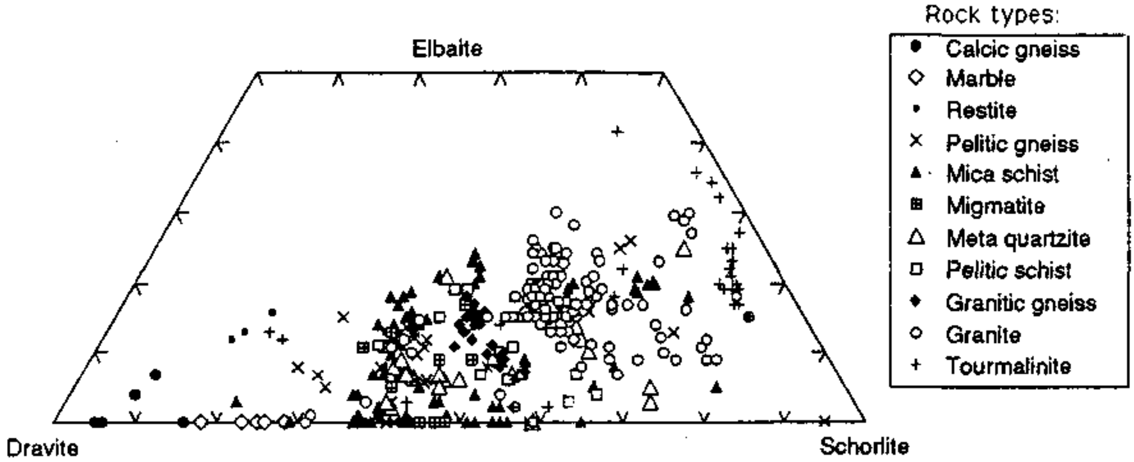

Fig. a. End member compositions for tourmalines from various rock types in Central Nepal.

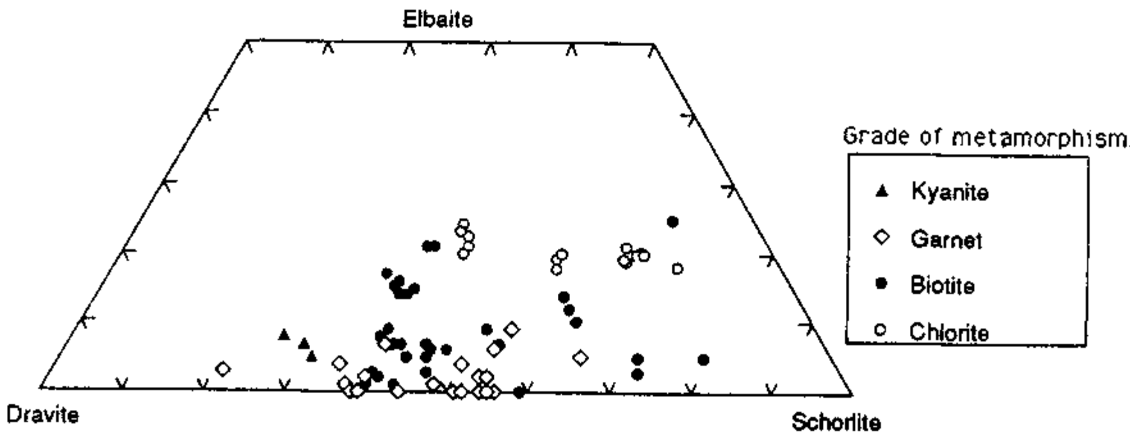

Fig. b. End member compositions for tourmalines in Midland Formations, Central Nepal.

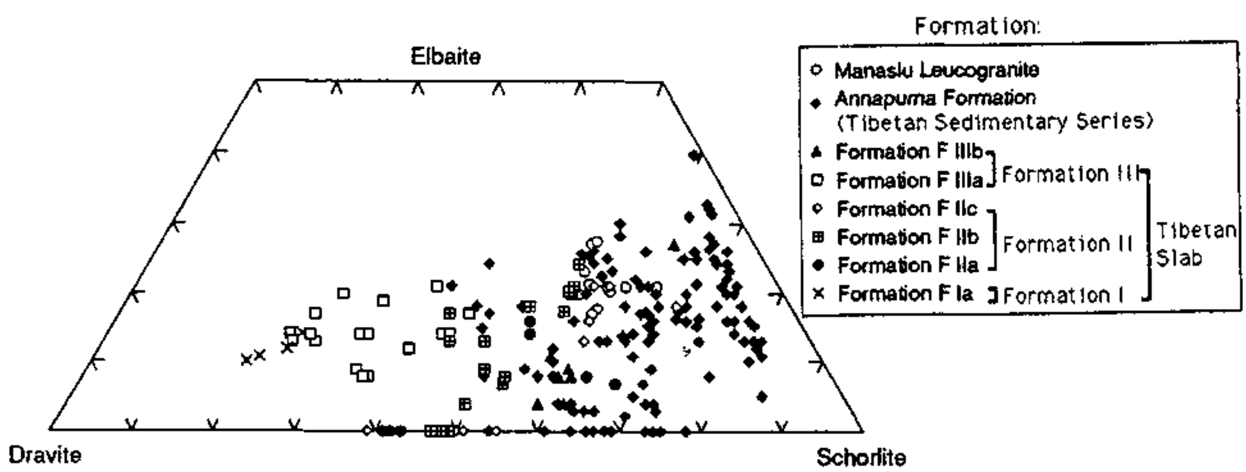

Fig. c. End member compositions for tourmalines from aplopegmatite dykes in Central Nepal.