Boron isotopes in tourmaline from the 3.7-3.8 Ga Isua Belt, Greenland: Implications for B concentrations in Eoarchean continental crust

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Boron is highly concentrated in Earth's crust relative to primitive mantle. However, when present-day crustal concentrations were achieved remains debatable. On the basis of B isotope compositions of metamorphic tourmaline in the Isua Supracrustal Belt, the earliest B mineral reported in the geological record, Chaussidon & Appel [1] calculated $\delta^{11}B$ = +27±11‰ for the Eoarchean ocean, compared to +40‰ today, consistent with the model [2] relating increase in sea-water $\delta^{11}B$ to proportion of B extracted from Earth's mantle into the oceans and crust. Our *in situ* ion microprobe analyses of Isua tourmaline, which is schorl-dravite showing color and compositional zoning, gave average (± 0.4 to 1.9‰) $\delta^{11}B$ = −7.1 to −14.2‰ (amphibolite), −12.9 to −25.3‰ (mica schist), −19.2‰ (metachert), −21.9‰ (metaconglomerate). $\delta^{11}B$ varies from grain to grain in most samples; grains in a kyanite-staurolite schist are isotopically zoned, possibly because the rims incorporated B released by muscovite breakdown. Rocks with 20-50 modal % tourmaline and its association with chromite, chalcopyrite, gersdorffite [(Ni,Co,Fe)AsS], sphalerite, galena, and pentlandite suggest a submarine exhalative origin, also proposed for tourmaline in pillow-breccia [3] and for Cu sulfides [4], *i.e.*, B, Zn, Cu, As and Pb were introduced hydrothermally into sedimentary and volcanic rocks together with Cr, Co and Ni remobilized from ultramafic rocks prior to metamorphism. The tourmaline-bearing rocks are found in both the *ca*. 3700 Ma and *ca*. 3800 Ma terranes [5] in the Isua belt. The highly negative $\delta^{11}B$ could have resulted from recycling of boron from older crustal rocks, *i.e.*, the *ca*. 3800 Ma terrane and others which are no longer exposed, and not from low seawater $\delta^{11}B$ [1,2].

[1] Chaussidon & Appel (1997) *Chem. Geol.*, **136**, 171-180. [2] Chaussidon & Albarède (1992), *EPSL*, **108**, 229-241. [3] Touret (2003) *Precambrian Res.*, **126**, 219-233. [4] Appel (1979) *Econ. Geol.*, **74**, 45-52. [5] Nutman & Friend (2009) *Precambrian Res.*, **172**, 189-211.