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A study on tourmaline in cordierite-bearing amphibolite facies metapelitic rocks from Alpe Sponda (Central Alps, Switzerland)

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Alpe Sponda, located in Ticino, Switzerland is very famous among mineralogists, because it is here where paragonite was first described by Schafhäuptl in 1834 and later accepted as a self-standing mineral species by Schaller & Stevens in 1941. Geologically, the Alpe Sponda belongs area to the northwestern part of the Simano Nappe in the Central Alps. In our present study we present bulk-rock geochemical data, major element mineral compositions, and P–T pseudosections from three tourmaline-rich metapelitic samples occurring in a small lens at Pizzo Forno, near Alpe Sponda. Our samples are kyanite-cordierite-bearing paragonite-biotite schist with large amounts of tourmaline (up to $\sim$ 20–25 vol.%). The rocks lack staurolite, which is present overall in the surrounding metapelitic schists, and are devoid of quartz. In comparison to classical metapelitic rocks, our samples are poor in SiO_2 and CaO but enriched in $Al2O_3$, MgO and Na2O relative to e.g. NASC (North America Shale Composite) and metapelitic rocks from the Ivrea Zone.

Tourmaline in Alpe Sponda samples shows strong colour zoning that is also displayed by its major elements. Chemical profiles measured within different tourmaline crystals show a pronounce decrease in concentration of Al (from core to the rim: 6.52–5.96 p.f.u.) and x-site vacancies (from core to the rim: 0.27–0.09 p.f.u.) and a concomitant increase in Mg (from core to the rim: 1.88–2.15 p.f.u.) and Na (from core to the rim: 0.64–0.82 p.f.u.). In a few cases tourmaline crystals show a detrital core, which is also seen in the major element data with even higher values for Al ($\sim$6.58 p.f.u.) and x-site ($\sim$0.39 p.f.u.) vacancies and lower values for Mg ($\sim$1.83 p.f.u.) and Na ($\sim$0.62 p.f.u.) than in the surrounding core. The combination of colour zoning and the major element data indicate at least two stages of crystal growth during prograde metamorphism.

Mineral equilibrium modelling based on the bulk-rock composition yielded peak metamorphic conditions of amphibolite facies grade (T = 570–650 °C and P = 5.8–7 kbar), which is consistent with the P–T conditions estimated previously for this part of the Central Alps.

Bulk-rock compositions together with mineral data indicate that Alpe Sponda samples described here were probably developed from a protolith with an evaporitic component containing Na- and B-rich minerals in an argillaceous matrix, yielding the high Al and Na contents. As the samples were collected from a layer within staurolite-bearing rocks having a different chemical composition, this layer can be interpreted as an evaporitic horizon in a more clay-rich environment.