Early Permian extensional structures of the central Southern Alps (N Italy), characterized by Boron-rich hydrothermalism

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Keywords: extensional tectonics, hydrothermalism, Early Permian geodynamics.

The Alpine region after the Variscan orogeny was characterized by an extensional regime associated to crustal thinning and an intense magmatic activity developed at different crustal levels during the Early Permian (e.g., Schaltegger & Brack, 2007).

At that time, in the central Southern Alps (cSA, N Italy), the opening of intracontinental fault-controlled extensional basins (e.g., the Orobic Basin) filled with volcanics and volcanoclastic sediments was controlled by a combination of Low- and High-Angle Normal Faults. Some parts of these Early Permian Low-Angle Normal Faults (LANFs) partially escaped the Alpine deformation, preserving their original features. Fault rocks formed along the contact between basement and cover, consisting of cataclastic rocks, are still discernible and are often sealed with cm to dm thick layers of dark, cryptocrystalline to microcrystalline tourmalinites (e.g., Zanchetta et al., 2022; Locchi et al., 2022) resulting from a metasomatism promoted by the circulation of Boron-rich fluids. Tourmalinites, composed of up to 70% in volume of tourmaline, are recurrent in various sites of the cSA (e.g., De Capitani et al., 1999) and are invariably located along Permian faults. Their age is indirectly constrained by their occurrence along Early Permian faults, especially LANFs, and in Upper Permian conglomerate where they occur as clasts. However, their genesis has never been deeply investigated, even if they are likely linked to the Uranium mineralization of the Novazza-Val Vedello district (De Capitani et al., 1999 and references therein).

To further characterize and assess the source of the hydrothermal activity responsible for Boron-rich fluid circulation during the Early Permian intracontinental extension, we studied several tourmalinite-bearing LANFs in the cSA. We applied a multidisciplinary approach: field-based structural analysis are combined with microstructural studies, mineral and whole-rock geochemistry, geochronology and determination of Boron isotopic composition of tourmaline. The isotopic and geochemical data provide important clues on this hydrothermal event and highlight its regional relevance, pointing to a magmatic source for the Boron-rich fluids. Preliminary results demonstrate a temporal relationship between tourmalinites and Early Permian magmatism in the cSA and exalt the role played by the extensional fault system as a preferred pathway for circulation of fluids of magmatic origin at shallow crustal levels. For this reason, the occurrence of tourmalinites can be considered as a proxy of Early Permian extensional structures in the cSA.

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