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The Permian post-orogenic collapse in the Alps: insights from the Campo unit (Austroalpine nappes, N-Italy, SE-Switzerland)

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The final stage of the Variscan orogeny (310-270 Ma) is characterized by an intense tectonic, magmatic and metamorphic event. During the Permian, acid and mafic intrusions were emplaced at all crustal levels and are associated to high-temperature contact metamorphism. While most of the studies focus either on the formation of Permian basins or on the lower crustal magmatic and metamorphic evolution, the characterization of the middle crust is lacking. Therefore, this study aims to unravel the processes active at mid-crustal levels during the Permian. We investigate the contact aureole of the Sondalo gabbro emplaced in a mid-crustal position during the Permian, exposed in the Austroalpine Campo unit (N-Italy). This work is based on a multidisciplinary approach linking structural geology, metamorphic petrology and geochronology.

The country rock of the gabbroic intrusion is composed of Grt–St micaschists and paragneisses indicating a prograde path in the amphibolite facies associated with the formation of a N-W steeply dipping S2 foliation. This foliation is pervasively reworked by a N-E trending sub-vertical S3 fabric made of Ms–Bt metasediments. This S3 fabric is also found in metapelitic septa in the core of the mafic intrusion, whereas in the narrow contact aureole a moderately dipping S4 fabric roughly parallel to the margins of the pluton is developed. From host-rock to the center of the intrusion, the metapelites show destabilization of muscovite, appearance of sillimanite, spinel, cordierite, crystallization of a large amount of garnet and finally disappearance of biotite and potassic feldspar. As a consequence, the kinzigitic restites of the contact aureole are replaced by Grt–Sil–Crd–Spl granulites in an intra-plutonic position. Qualitative P–T estimates indicate a barrovian prograde path during D2, similar to P–T evolutions found in other Austroalpine units (e.g. Ulten zone). Thermodynamic modelling of the high-grade granulites due to the thermal effect of the $\sim$290 Ma (U–Pb on zircon) mafic intrusion give conditions of $\sim$6 kbar and $>$ 900°C.

Our results bring constrains on the thermal and mechanical relation between the pluton and the host rock in the middle crust and confirm the mid-crustal position of the Campo unit during the Permian. Furthermore, this study highlights the contrasted evolution of mid-crustal levels compared to lower-crustal systems such as the Ivrea zone. Eventually at a larger scale, these results provide insights on the tectonic and magmatic processes and thermal conditions of the continental crust during Variscan post-orogenic evolution.