Thermochronological constraints on the tectonometamorphic evolution of the „Meran-Mauls nappe stack" (South Tyrol, Italy)

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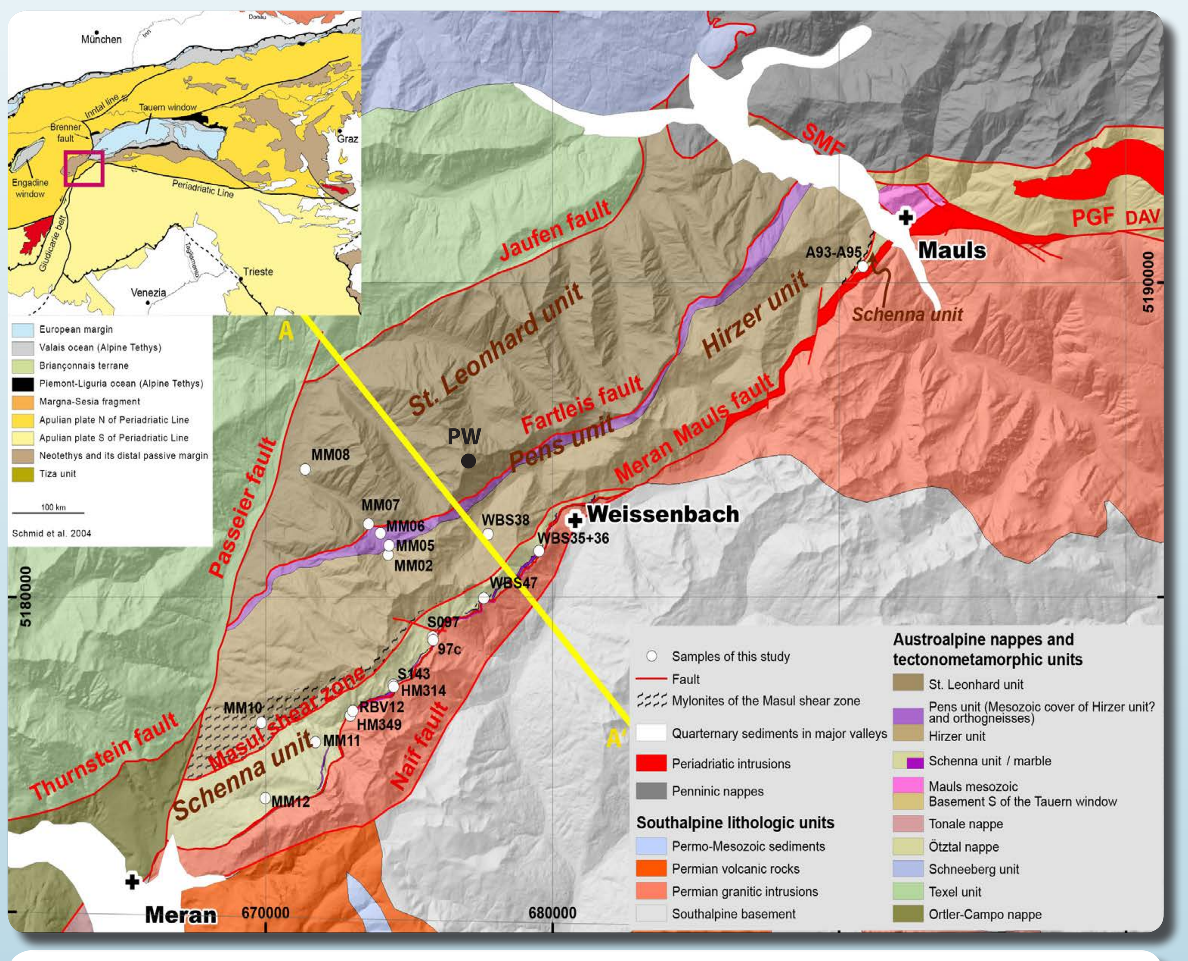

Fig. 1: Tectonic map of the study area. DAV: Defereggen-Antholz-Vals fault; PGF: Pustertal-Gailtal fault; SMF: Sprechenstein-Mauls fault; PW: Penser Weisshorn.

Introduction

Between Meran and Mauls in South Tyrol (Italy), the hanging wall of the Periadriatic fault system comprises four tectonic units separated by NW to NNW dipping shear zones. Bordered by the Passeier fault to the west, the Jaufen fault to the NNW, and the Meran-Mauls fault (MMF, part of the Periadriatic fault system) to the SE (Fig. 1), this so-called Meran-Mauls nappe stack forms part of the Austroalpine Drauzug Gurktal nappe system.

Three of these units consist exclusively of metamorphic basement rocks, the remaining one comprises a sedimentary succession of Mesozoic age. From south (bottom) to north (top) the units are named Schenna (Scena), Hirzer (Punta Cervina), Pens (Pennes), and St. Leonhard (San Leonardo) unit and are separated by the Masul shear zone and the Pennes-Mules shear zone (Fartleis fault) respectively (Fig. 2). All units experienced amphibolite-facies conditions during a Variscan metamorphic overprint. A Permian thermal event has not (yet) been verified, but it is well established in neighboring units (ca. 250-285 Ma; e.g. Schuster et al., 2001; Knoll et al., 2018).

Incomplete resetting of the Rb–Sr and K–Ar systems in both, biotite and white mica evidences low-grade conditions during the Alpine metamorphic evolution. Due to the low-grade overprint and the lack of other constraining factors, e.g. a sedimentary cover, the timing of nappe stacking is unknown.

A profile covering all four tectonic units was sampled and investigated using Rb-Sr biotite analyses, as well as zircon and apatite fission track thermochronology to reconstruct the tectonothermal evolution of the Meran-Mauls nappe stack.

cross section A-A'

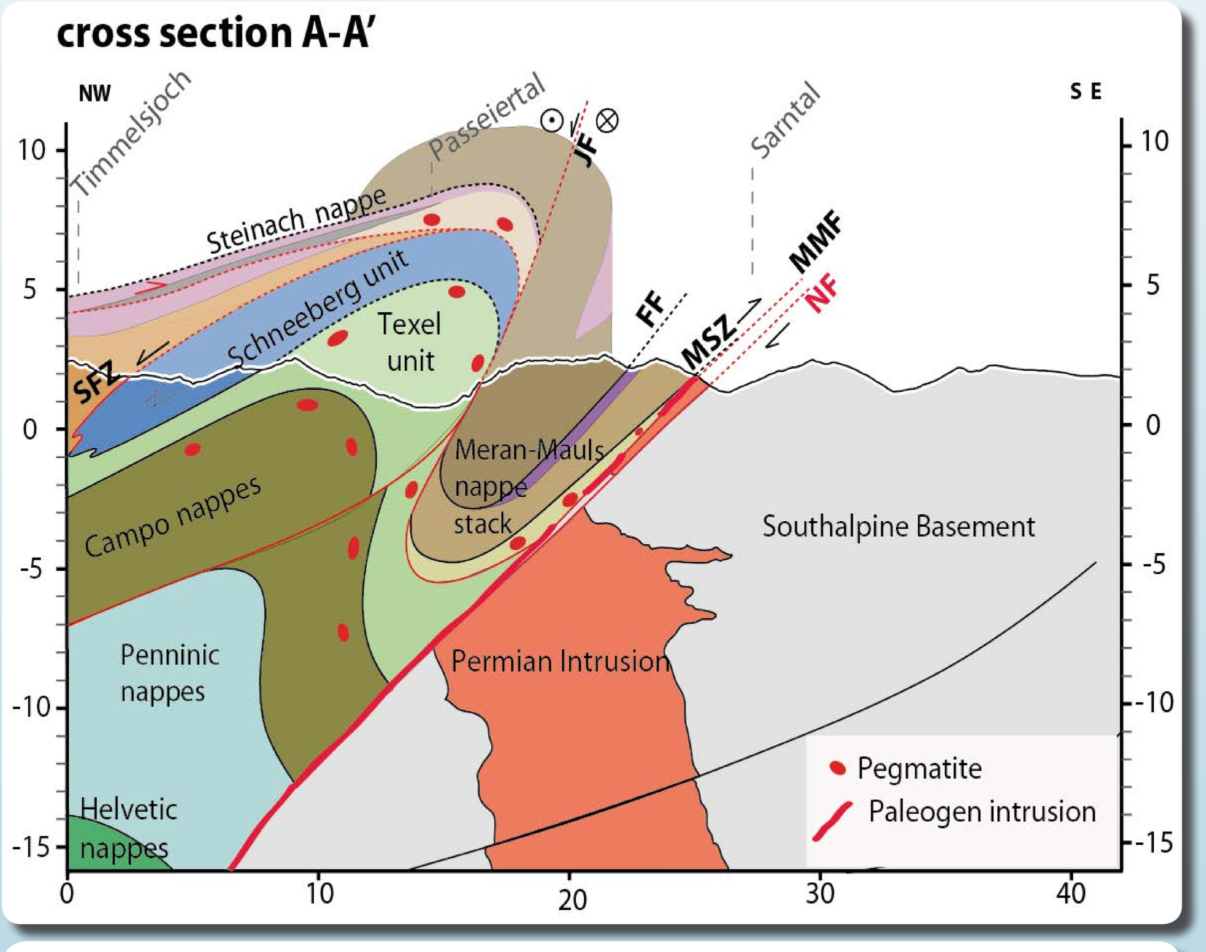

Fig. 2: NW-SE profile through the study area modified after Pomella et al. (2016). SFZ: Schneeberg fault zone; JF: Jaufen fault; FF: Fartleis fault; MSZ: Masul shear zone; MMF: Meran-Mauls Fault; NF: Naif fault.

Geology of the Meran-Mauls nappe-stack

Schenna Unit

Sillimanite- and kyanite bearing paragneiss intruded by post-Variscan pegmatite dikes. Close to the MMF, a more or less continuous, up to 20 m thick limestone and/or dolomite marble horizon is intercalated with paragneiss, quartzite and amphibolite. The marble layer is highly deformed and runs parallel to the MMF between Meran and Weissenbach (Fig. 1).

Hirzer Unit

Kyanite-bearing paragneiss, micaschist, orthogneiss, subordinary amphibolite and quartzite. Most of the mylonites of the Masul shear zone developed from para- and orthogneiss of the Hirzer unit.

Pens Unit

White-mica bearing orthogneiss with a weakly metamorphosed sedimentary succession (up to 150 m) that thins out towards the west. The sediments comprise stacked and folded slices of conglomerates, dolomites and often fossil-bearing limestones that are interpreted as (par)-autochthonous Mesozoic cover of the Hirzer unit.

St. Leonhard Unit

Kyanite-bearing paragneiss and orthogneiss with subordinate quartzite, amphibolite and micaschist.

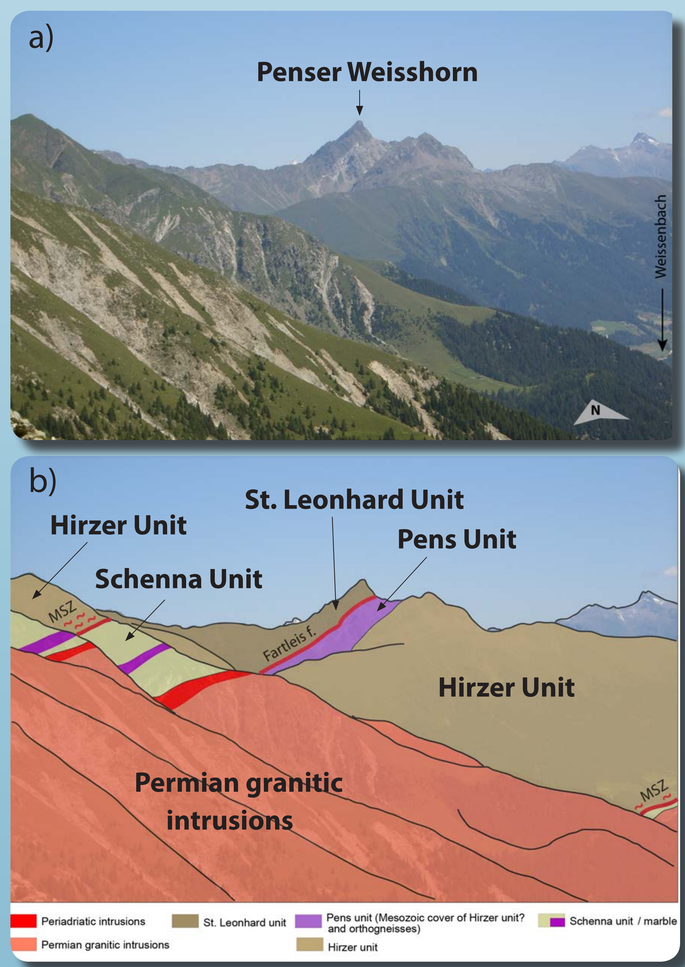

Fig. 3: a) Panoramic photograph across the center of the profile line; **b)** geological overlay (Fig. 1).

Fig. 4: a) deformed marble with siliciclastic layers from the marble layer in the Schenna Unit; **b)** close up of a pegmatite from the Schenna Unit; **c)** fine grained mylonite of the masul shear zone.

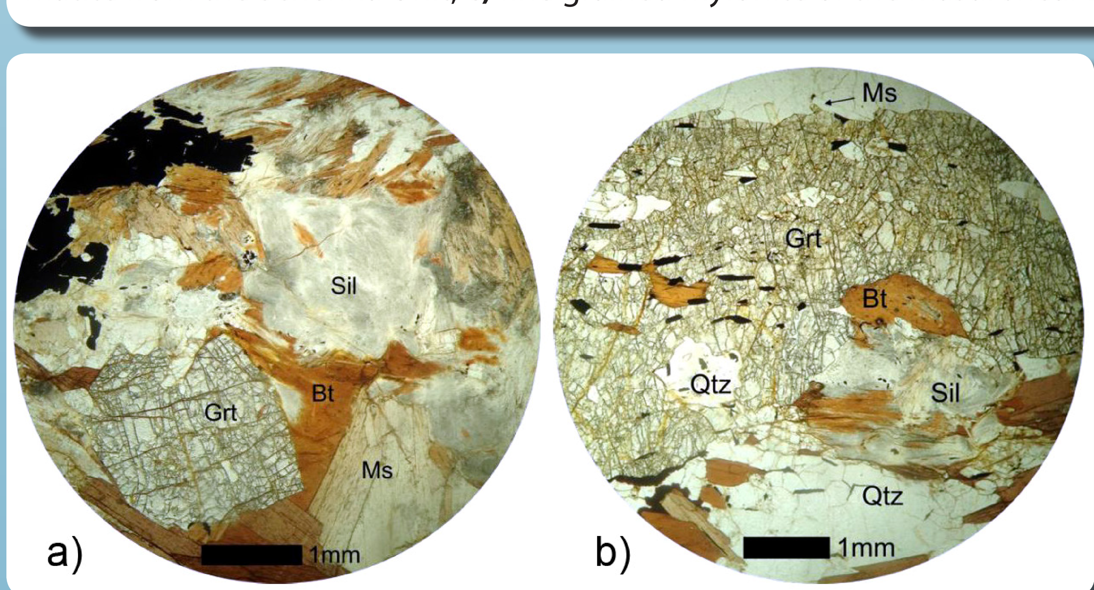

Fig. 5: Thin section photographs (parallel nicols) of paragneiss from the Schenna unit: **a)** fibrolitic sillimanite (Sil), garnet (Grt), biotite (Bt), muscovite (Ms), quartz (Qtz), plagioclase (Pl), and opaque minerals (sample MM12); **b)** Pseudomorphic replacement of garnet by fibrolitic sillimanite and biotite (sample MM12).

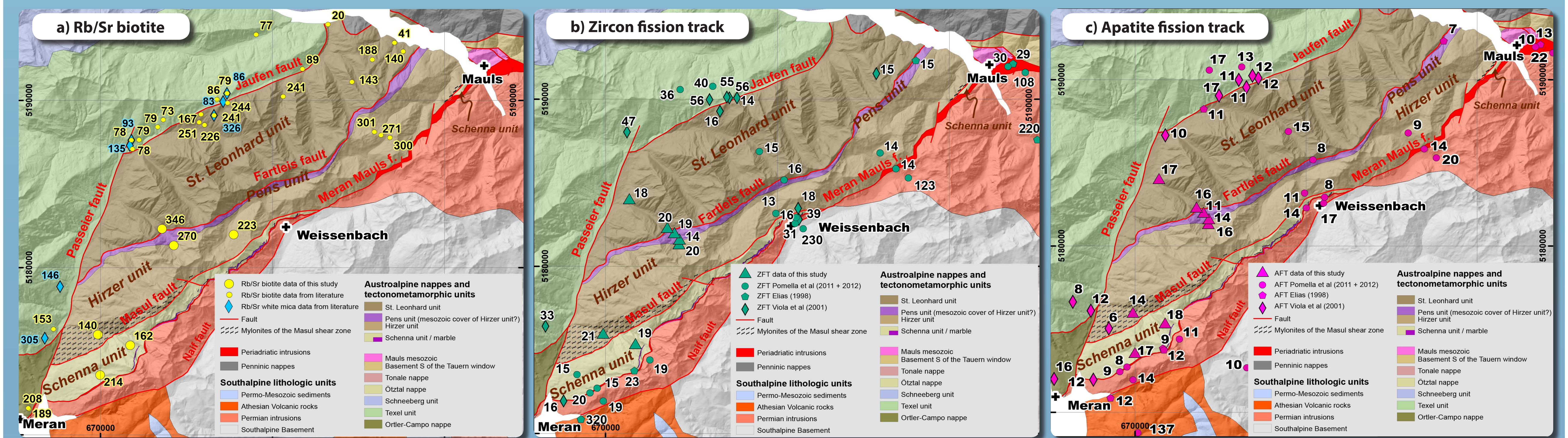

Fig. 6: Compilation of geochronological analyses from this study and from literature. **a)** Rb/Sr biotite data; **b)** zircon fission track data; **c)** apatite fission track data. Ages are given in Ma.

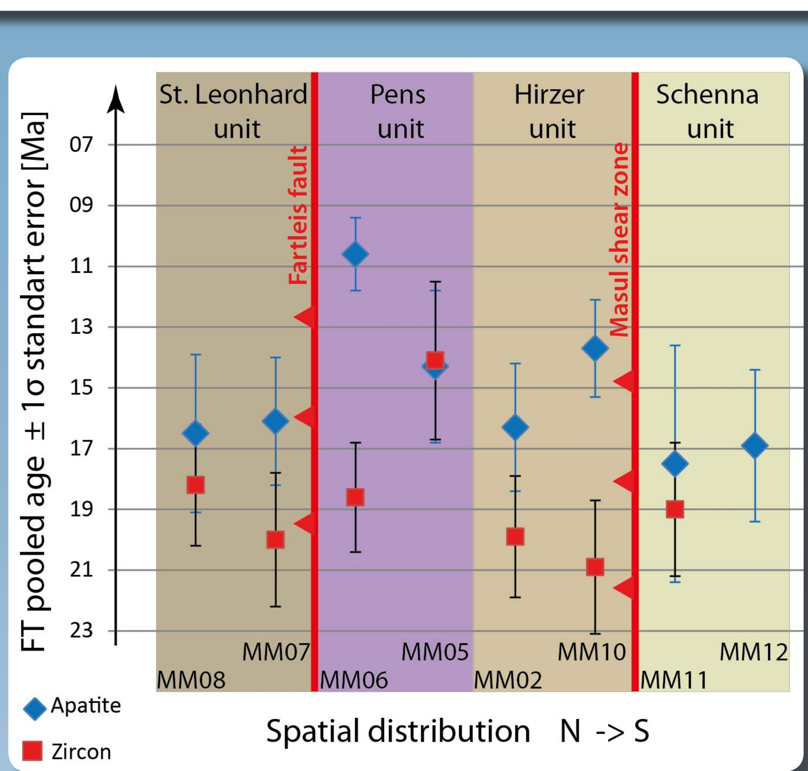

Fig. 7: Fission Track data from this study ordered according to their spatial distribution from N to S. For exact sample location refer to Fig. 1.

Geothermobarometry

Multi-equilibrium geothermobarometry using THERMOCALC v.3.33 in average P-T mode:

Paragneiss of the Schenna unit

(1) 3 Eastonite + 6 Quartz = Pyrope + Phlogopite + 2 Muscovite

(2) Phlogopite + Eastonite + 6 Quartz = Pyrope + 2 Celadonite

(3) Pyrope + Grossular + Muscovite = Phlogopite + 3 Anorthite

(4) Pyrope + Annite = Almandine + Phlogopite

P: 0.52-0.59 GPa **T: 570-630°C**

Paragneiss of the Hirzer unit

(1) 3 Eastonite + 6 Quartz = Pyrope + Phlogopite + 2 Muscovite

(2) Grossular + 2 Kyanite + Quartz = 3 Anorthite

(3) Pyrope + 3 Eastonite + 4 Quartz = 3 Phlogopite + 4 Kyanite

(4) Annite + 3 Anorthite = Grossular + Almandine + Muscovite

P: 0.39-0.55 GPa **T: 510-580°C**

Preliminary conclusions

- The entire nappe stack is characterised by an amphibolite facies Variscan metamorphic overprint, with slightly variable PT conditions between the units.
- Permian to Early Triassic Rb/Sr biotite ages are correlated with a Permian low-P/high-T overprint. Further indicators for such an event is the static growth of sillimanite on biotite as well as the occurrence of pegmatite within the Schenna unit.
- An Early Cretaceous Rb-Sr biotite age (140 ± 1.6 Ma) from HT greenschist facies mylonites of the Hirzer Unit can be interpreted as the lower limit for the age of the Masul shear zone.
- Thermal conditions during the Alpine orogeny were not sufficient to reset the Rb/Sr system in biotite in the Meran-Mauls nappe stack. Therefore the Alpine metamorphic overprint is limited to lower greenschist facies conditions (Fig. 6a).
- Zircon fission track data vary between 13 and 21 Ma indicating a Miocene cooling below ~250°C of the entire Meran-Mauls nappe stack. No spatial pattern or discrete changes along the fault zones could be detected in the age distribution (Fig. 6b & 7).
- Apatite fission track data vary between 6 and 18 Ma indicating a Miocene cooling below ~120°C of the entire Meran-Mauls nappe stack. No spatial pattern or discrete changes along the fault zones could be detected in the age distribution (Fig. 6c &7).
- The lacking zircon and apatite age changes across the Masul shear zone or the Fartleis fault argue against significant relative vertical movements on these structures in the brittle regime. Therefore stacking of the four units must have occurred prior to the Miocene major north-ward push of the Southalpine indenter.

References

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