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The evolution of the Austroalpine nappe stack in the hanging wall of the Giudicarie fault system

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During the Eoalpine orogenic cycle S-Apulia overthrusted N-Apulia along a SE dipping intracontinental shear zone (Schmid et al. 2004). High pressure metamorphic overprint affected the south-eastern-most parts of N-Apulia: the Texel complex experienced pressures of 12-14 kbar (Habler et al. 2006), the Schneeberg complex 8-10 kbar (Konzett & Hoinkes 1996) during this stage. In the hanging wall of this pressure-dominated corridor a nappe stack formed on top of the Ötztal nappe. The Cretaceous metamorphism within the SE-dipping Ötztal nappe increased from NW to SE, whereas the higher nappes (i.e. Meran-Mauls basement, Tonale nappe, Mesozoic Blaser nappe, Paleozoic Steinacher nappe) were almost unaffected.
At app. 80 Ma the Schneeberg- and the Texel complex were isothermally exhumed within the shear zone to reach a similar position as the Ötztal nappe, as indicated by time-temperature-, and pressure constraints. Probably during this stage the Schneeberg complex was highly deformed to form a megascopic sheath fold.
Late-Cretaceous E-SE directed normal faulting (e.g., Froitzheim et al. 1994, Wagreich 1995) brings the Ötztal nappe and its Mesozoic cover in the footwall in contact with the Mesozoic Blaser nappe, the Paleozoic Steinacher nappe and the Meran Mauls basement.
During the Tertiary this Cretaceous-age nappe stack overthrusted Penninic units and rather open folds developed within this orogenic lid (Meier 2003). In the hanging wall of the Meran-Mauls fault the wide folds were narrowed and finally overturned during NNW-ward indentation of the Southern Alps. This resulted in the present NW-dipping orientation of the Jaufen fault and the formation of a narrow syncline between the Jaufen and the Meran-Mauls fault. On the other hand in the hanging wall of the sinistral transpressive Northern Giudicarie fault less shortening due to the indentation of the Southern Alps occurred. The Paleogene folds of the Austroalpine nappes stack were only slightly affected and not overturned. Also the Pejo fault, separating the Campo nappe and the Tonale nappe, was not overturned and still dips towards SE, i.e. it preserved its original orientation.
A comparison of the evolution of the Austroalpine nappe stack in the hanging wall of the Meran-Mauls fault and the Northern Giudicarie fault argues for similar geometries and orientations during the Cretaceous and Tertiary deformation, with the present-day differences caused only by the Miocene indentation of the Southern Alps.

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The thermochronological evolution in the area of the Giudicarie fault system

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Based on 129 zircon fission track (ZFT) data a contour map of the present day ZFT age distribution in the area around the Giudicarie fault system was constructed. The most eye-catching feature is the corridor of young, Miocene ZFT ages, formed by small tonalitic intrusions along the Northern Giudicarie fault. This corridor connects Early Miocene (17-23 Ma) ZFT ages of the NE-Adamello with the Miocene (23-9 Ma) ZFT ages of the Meran-Mauls basement and the Tauern window. This narrow corridor is bounded to the SE by Southalpine sediments characterized by partially reset ZFT ages and towards NW by Oligocene ZFT cooling ages found in the Austroalpine units. This requires a tectonic model capable of explaining the presence of young tonalitic lenses, or, more generally speaking, a corridor of younger low-T cooling ages between two earlier or less exhumed blocks. The Eo- to Oligocene intrusion ages of the tonalities (32±1 Ma - 38.9±0.4 Ma, U/Pb dating on zircon using LA ICP-MS; Pomella 2010), their granitic texture, and the lack of contact metamorphism around the lenses argue against a late and/ or shallow intrusion of the tonalites in a fault zone already cooled below the zircon partial annealing zone (ZPAZ, 180-300 °C; Hurford & Green 1983).
As the small intrusive bodies are considered to be sheared

parts of the Southalpine Adamello batholith (e.g., MARTIN et al. 1993), sinistral transpression along the Northern Giudicarie fault would bring them to a greater depth during northwards transport instead of exhuming them relatively to the north-easternmost Adamello batholith, such as indicated by the ZFT data. This problem can be solved by a 3-phase model for the emplacement of the tonalitic lamellae. In a first step, at the Eo-Oligocene boundary, the northeastern units of the Adamello batholith intruded adjacent to the straight, dextral strike-slip Periadriatic Line. In the Late Oligocene/Earliest Miocene the NNW-ward movement of the Southalpine indenter leads to a bending of the fault and material from the northeastern tail of the Adamello was squeezed to the NE along the bent part of the fault. Finally, in the Early Miocene, the brittle Passeier-Northern- and Southern Giudicarie faults sinistrally dissect the bent part of the Periadriatic line. Along the northern part of the bend a nearly continuous tonalitic body persists along the Meran-Mauls fault as the subsequent brittle deformation took mostly place along the Naif fault in the footwall. Along the Northern Giudicarie fault small bodies were sheared from the former bent and already boudinaged tonalitic body, transported southwards, and exhumed by sinistral transpressive deformation.

The differences in ZFT ages between the Paleogene tonalites within the fault and the overlying Austroalpine basement infer differential exhumation within the hanging wall of the Northern Giudicarie fault with higher inferred exhumation rates closer to the fault. This interpretation is supported by a zircon fission track age of 11 Ma from a sample from the Tonale nappe, positioned very close to the Northern Giudicarie fault.

Within the footwall of the Giudicarie fault system the ZFT data also provided new insights. From the three main Permian plutons present along the Giudicarie fault system, the northernmost (Brixen pluton) and the southernmost (Kreuzberg pluton) yielded ZFT ages of about 100 Ma, while the intermediate Ifinger pluton cooled through the zircon partial annealing zone only in the Miocene. The Ifinger granodiorite overthrusts the Southalpine basement and the Permian rocks of the Athesian Volcanic District along the NW dipping brittle Naif fault. On this thrust fault an important age jump from Miocene to Permian ZFT ages can be observed, whereas across the Meran-Mauls fault further towards the NW nearly no change occurs. These data argue for an exhumation of the Ifinger pluton along the Naif fault when the Kreuzberg and the Brixen pluton had already cooled to below app. 200 °C.

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Kinematik und tektonische Geomorphologie der Lavanttal-Störung, Kärnten

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Das Lavanttal-Störungssystem ist eines der bedeutendsten Systeme der Ostalpen mit etwa 12km dextralem und einigen km vertikalem Versatz (LINZER et al. 2002), das während der im Miozän fortschreitenden Nord-Süd gerichteten Verkürzung zwischen dem europäischen Vorland und der Adriatischen Platte entstand. Das inneralpine Lavanttal-Becken ist eines der tertiären Becken, die aufgrund der ostgerichteten Ausgleichsbewegung zur Nord-Süd Verkürzung an einem Releasing Bend des Lavanttal-Störungssystems gebildet wurden.

Die strukturgeologische Bearbeitung einer Vielzahl von lokalen Aufschlüssen im gesamten Lavanttal erbrachten kinematische Daten mikrotektonischer Strukturen, die auf eine komplexe Störungsgeschichte mit älterem dextralen strike-slip Versatz an der Störung und einer jüngeren Phase der Störungsinversion mit sinistralem Schersinn hinweisen.

Die geomorphologische Bearbeitung des von den Gebirgsmassiven der Saualm und der Koralm begrenzten Tales ist relativ eindeutig, ist doch schon beim visuellen Vergleich beider Bergketten deren unterschiedliche Morphologie klar ersichtlich. Geomorphologische Parameter (z.B. Mountain Front Sinuosity, Flussgradienten, Hypsometrisches Integral usw.) lassen sowohl auf aktive Seitenverschiebungen und Abschiebungen an der Front der Koralm schließen, als auch auf relative Hebung der Koralm an einem Releasing Bend der aktiven dextralen Störung.

Die berechneten Werte weisen aber auch darauf hin, dass Erosionskräfte der Hebung sehr gut entgegenwirken konnten, außerdem zeigt sich die zeitliche Abfolge von Kippen des Tales und der später erfolgten Bildung der Schuttfächer (Transverse Topografie Symmetrie Faktor).

Die erfassten geomorphologischen und strukturgeologischen Daten werden durch seismologische Belege eines immer noch aktiven Lavattal-Störungssystems, die aus Verteilung der regionalen Seismizität, störungsparallelen Isoseisten und Herdflächenlösungen abgeleitet werden, gestützt.

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Scheelitvererzungen im Thurntaler Quarzphyllitkomplex, Osttirol: Petrographische und chemische Untersuchungen an Nebengesteinen und Bachsedimenten

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