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The Western Tauern Window (Eastern Alps): Timing and Interplay of Folds and Sinistral Shear Zones as Result of South-Alpine Indentation

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The Tauern Window (TW) is the only domain within the Eastern Alps where deep crustal, Tertiary metamorphic rocks were exhumed to surface. The window is bounded by large-scale faults, partly considered to be responsible for its exhumation (e.g. Selverstone 1988, Fügenschuh 1997), and it is also cross cut internally by large-scale shear zones, whose significance in terms of type and timing of deformation, exhumation, and large-scale kinematic links is the subject of our investigation. These shear zones (Ahorn, Olperer, Greiner, Ahrntal) are widespread throughout the western TW, from the mm- to the km-scale. They are sinistral and located in the steep limbs of upright antiforms, forming a mylonitic foliation, that strikes parallel to the axial planes of these upright folds.
We present new structural and geochronological data, obtained by in-situ dating of microstructurally defined syn- and postkinematic grains, to constrain the duration and termination of folding and sinistral shearing. Previous dating suggested initiation of shearing contemporaneous to nappe stacking between 32-and 30Ma, ongoing until 15Ma (Glodny et al., 2008). However, the fabric of the dated grains was not related to deformation phases defined from structural overprinting relationships, and the classical separation technique did not allow to separate synkinematic from pre- and post- kinematic grains.
The northern margin of the western TW is pervasively overprinted by the Ahorn Shear Zone (Rosenberg & Schneider 2008), which shows S-side up kinematic indicators in addition to the sinistral ones, and a pronounced southward increase in metamorphic grade from lower greenschist facies to amphibolite facies conditions, within 2km. Phengites of the mylonitic foliation dated with the Rb/Sr in-situ technique, yield formation ages of 14-24Ma . The southern margin of the western TW is overprinted by the sinistral Ahrntal Fault (Schneider et al. 2009), which cuts discordantly several nappes from the Zentralgneiss to the Upper Austroalpine units. Within the Upper Penninic nappes N-side up kinematic indicators occur, in addition to the sinistral ones. Newly formed biotites of Zentralgneiss rocks have been dated with the Rb/Sr technique (Kitzig et al. 2009), yielding 18-20Ma for their formation during sinistral deformation. Fine-grained phengites from the axial plane foliation of the upright folds were dated with the K/Ar method, yielding 14-17Ma. Ar/Ar in-situ LA analyses of sinistral mylonites (Ahorn, Olperer and Greiner) yield formation ages of syn-kinematic phengites between 24-12Ma. These grains are overgrown by post-kinematic phengites of 12-9Ma.
Northeast of the western TW, sinistral shear is accommodated by the brittle sinistral SEMP Fault system, whose activity has been dated to 17Ma (Peresson & Decker 1997). Several sinistral shear zones (Ahorn, Greiner, Ahrntal) of the western TW may coalesce into the SEMP Fault (e.g. Linzer et al., 2002). In the west, the Ahorn Shear Zone terminates nearly 10km east of the Brenner Fault, into a NW-striking fold belt. The Ahrntal Fault continues into the Jaufen Fault, which merges with the brittle sinistral Giudicarie Fault. Motion along the Giudicarie Fault initiated in the Miocene (Stipp et al., 2004), or already in the Oligocene (Müller et al 2001).
Based on these results, a temporal, kinematic and geometric continuity between sinistral shearing along the Giudicarie Fault, along the SEMP Fault, and throughout the western TW, can be assessed. The sinistral shear zones of the western TW are kinematically linked to upright folds, hence to crustal thickening. Upright folding and sinistral shearing were active since 24Ma and terminated at 12Ma.
In summary, the sinistral displacements of the Giudicarie System appear to be partitioned into upright folds and sinistral, transpressive shear zones in the western Tauern Window, both of which contribute to its exhumation. The coalescence of the sinistral shear zones into the SEMP Fault System coincides with the eastern termination of the ENE-striking upright folds, possibly indicating transfer of shortening into a strike-slip displacement. Therefore, the western TW as a whole, represents a Miocene, sinistral transpressive belt, accommodating sinistral

displacements associated with South-Alpine indentation by folding and sinistral shearing, and transferring these into sinistral movements associated with lateral escape along the SEMP System, until 12 Ma.