Dating the duration and termination of sinistral shear in the Tauern Window. Implications for indentation and exhumation

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The internal structure of the Tauern Window (TW) consists of two elongated sub-domes, striking ENE in the west and ESE in the E. The long axis of each sub-dome is parallel to upright folds and shear zones, which are sinistral in the west and dextral in the east. The formation of these structures has been interpreted as the result of a coeval, conjugate system, forming in response to South-Alpine indentation (Rosenberg et al., 2004), or as a change in the regional shortening direction through time (Polinski and Eisbacher, 1992; Neubauer et al., 2000; Mancktelow et al., 2001). The latter models suggested an Oligocene age for sinistral displacements, followed by Miocene dextral ones. Therefore, determining the timing of these different shear zones is a key to understand the tectonic significance of the structures described above. We focus on sinistral shear zones, which are common throughout the western TW. In addition to left lateral displacements, kinematic indicators in the YZ plane of the deformation ellipsoid of these shear zones point to differential vertical displacements. At the northern margin of the Zentral Gneiss, the sinistral Ahorn Shear Zone exhibits S-side up kinematic indicators (Rosenberg and Schneider, 2008) and at the southern margin of the TW, N-side up kinematic indicators are observed along the Ahrntal Shear Zone (Schneider et al., 2009). We performed absolute age determinations of deformation on syn-kinematically grown minerals and of post-kinematically grown grains overprinting the mylonitic foliation. For this purpose we selected syn-kinematic phengites of mylonites and ultra-mylonites from shear bands, pressure caps, newly formed mylonitic foliations and of statically grown phengites overprinting the latter structures. We dated these grains with the Ar/Ar method using an In-situ UV-laser ablation noble gas mass spectrometer. For comparison micas of an undeformed host rock were also dated using the same method. The obtained age values of syn-kinematic phengites vary between 8-24 Ma. This age variation is commonly found within single grains. Postkinematic, phengites overgrowing the syn-kinematic grains yield the youngest age values, namely 5-12 Ma. We observe a systematic relationship between the ages of the postkinematic grains and the age spread of the syn-kinematic ones. The age of the post-kinematic grains always coincides with the youngest age determined within the syn-kinematic grain. We interpret this relationship as indicating that the growth of post-kinematic minerals followed almost instantaneously the termination of deformation. As a consequence, the age of phengites overprinting the mylonitic foliation yields a precise age for the termination of deformation. The spread in the ages of the syn-kinematic phengites goes together with a spread in the Si content of these minerals, probably indicating continuous deformation during exhumation within a time interval of more than 10 Ma. Muscovite blasts of the undeformed sample yield age values varying between 22 and 34 Ma. We interpret these ages as cooling ages, following the metamorphic peak temperatures.

To conclude, sinistral shear in the western TW started at least 24 Ma ago and terminated at 5 Ma. Therefore, these shear zones do not predate dextral displacements within the eastern Tauern sub-dome, which are also Miocene. This conclusion suggests that they formed as part of an orogen-scale conjugate system, accommodating Miocene shortening due to South-Alpine indentation. Since these shear zones are transpressive, showing a component of vertical displacement, their age may also constrain exhumation of the Tauern dome.