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Internal structure and evolution of the Penninic subduction channel of the Tauern Window, Eastern Alps.

Philip Groß, Jan Pleuger, Mark Handy, and Timm John

Freie Universität Berlin, Institut für Geologische Wissenschaften, Tektonik und Sedimentäre Systeme, Germany (philip.gross@fu-berlin.de)

We investigate an internally ordered subduction channel and its evolution with the aim of improving the interpretation of geophysical images of subduction channels. Subduction channels are usually believed to lack internal structure, with blocks of oceanic crust tectonically mixed in a low viscosity matrix of metasediments, altered mafics and serpentinized ultramafics (e.g. Franciscan mélange). However, other channels display an internal structure comprising a large-scale layering. These are particularly interesting, because their continuous layering can be potentially imaged with geophysical methods (e.g. receiver functions), thus enhancing our view of subduction processes in active channels.

The central Tauern Window in the Eastern Alps provides a well-exposed example of such a structured subduction channel, with relics of the Alpine Tethyan ocean isoclinally folded and sandwiched between the Adriatic upper and European lower plates. Cross-sections across this fossil subduction channel based on newly compiled maps, as well as own structural analysis and thermobarometry reveal that a km-scale sheath fold formed during subduction and exhumation in the Tauern subduction channel. The sheath fold affects oceanic units from the Alpine Tethys as well as a very thin, distal unit of the European continental margin. The front of the sheath fold is deformed by 100m amplitude, upright isoclinal folds that trend perpendicularly to the sheath fold axial plane and that coincide in both location and orientation with structures affecting exhumed continental basement units. We interpret these later folds to have formed during Alpine collision, possibly at the front of a duplex roof thrust that separates subduction structures, including the sheath fold, in its hangingwall from collisional structures in its footwall.

The formation of the sheath fold in the Tauern Window coincided with decompression from peak metamorphic conditions (ca. 20 kbar at 500°C). We speculate that sheath and nappe folding is an exhumation mechanism in subduction channels that generates crustal-scale layering and therefore is potentially imageable by high-resolution geophysical methods in active subduction zones. Synthetic seismograms of such geometries could provide new insights in the interpretation of seismically imaged anomalous structures at the tops of downgoing slabs. We propose that similar structures may be found at the top of the down-going slab beneath the Eastern Alps as currently targeted by the dense seismological station array (Swath D) of AlpArray.