

Variations in the 3D temperature field in a fossil subduction zone resolved by RSCM thermometry (Tauern Window)

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Structural observations in the central Tauern Window reveal a crustal-scale sheath fold formed under high-pressure (HP) conditions (ca. 2 GPa). The fold is a composite structure that isoclinally folded the thrust of an oceanic nappe derived from Alpine Tethys onto a unit of the distal European continental margin, also affected by HP conditions. This structural assemblage is preserved between two younger domes at either end of the Tauern Window. The domes are associated with temperature-dominated Barrow-type metamorphism that overprints the HP-metamorphism partly preserved in the sheath fold.

Using Raman spectroscopy on carbonaceous material (RSCM) on 60 samples from this area, we were able to distinguish domains with the original, subduction-related peak temperature conditions from domains that were overprinted during later temperature-dominated (Barrovian) metamorphism. The distribution of RSCM-temperatures in the Barrovian domains indicate a decrease of peak temperature with increasing distance from the centers of the thermal domes, both in map view and cross section. This represents a geotherm where paleo-temperature increases downward, in line with previous studies using, e.g., oxygen isotope fractionation and calcite-dolomite equilibria. However, we observe the opposite temperature trend in the lower limb of the sheath fold, viz., tendentially an upward increase in paleo-temperature. We interpret this inverted temperature domain as the relic of a subduction-related temperature field. Towards the central part of the sheath fold's upper limb, measured temperatures increase to a maximum of ca. 520°C. Contours of equal peak-temperature are oriented roughly parallel to the nappe contacts and lithological layering in cross section. Further upsection in the hanging wall of the sheath fold, temperatures decrease to where they are indistinguishable from the peak temperatures of the overprinting Barrovian metamorphism. We propose the following hypothesis to explain the subduction-related peak-temperature pattern: The pattern reflects folding of a subduction-related temperature field. Possibly, sheath folding occurred during exhumation, after the equilibration at peak pressure and temperature conditions.