The Gurktal tectonic conundrum of Eastern Alps revisited: thrusting vs. normal faulting

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Orogenic thrust wedges can be superposed by a large-scale extensional deformation as a result of orogenic collapse, when rheologically weak layers are activated as ductile normal faults during an exhumation of higher-grade metamorphic units. A heavily disputed example within the Austroalpine nappe stack is the Gurktal nappe complex, which is underlain by the Bundschuh nappe complex (retrogressed polymetamorphic Bundschuh basement overlain by the monometamorphic Stangalm Mesozoic). Previous estimates of metamorphic conditions indicate that approx. 200 °C of the metamorphic profile is missing between the Bundschuh nappe (approx. 480–500 °C) and the higher part (250–280 °C) of the Gurktal nappe complex, suggesting a metamorphic break in between. To solve this paradox, we studied micro- and meso-scale fabrics of these units supplemented by studies of metamorphic T conditions and Ar-Ar white mica dating. The resulting data is presented here from footwall to hangingwall units.

Structural evidence suggests an ESE-directed ductile low-angle normal faulting passing from ductile, through ductile-brittle to purely brittle conditions under the same external kinematics. Dolomite microfabrics of the metamorphic Stangalm Mesozoic comprise symmetric as well as asymmetric fabrics indicating a mixture of coaxial and non-coaxial deformation regimes, implying partitioning of the shear strain. Calcite-dolomite thermometry gives a bimodal distribution of temperatures with maxima at approx. 360 °C and approx. 450 °C, while a white mica concentrate gives an Ar-Ar plateau age of 96.2±0.4 Ma.

The overlying phyllites and phyllonites of the Phyllonite zone are regionally considered to be part of the Murau nappe of the Gurktal nappe complex. The structure shows fabrics passing from initial ductile to subsequently cataclastic and brittle conditions, illustrating the passage through the ductile-brittle boundary during cooling. Raman spectroscopy indicates a preliminary deformation T of 319–382 °C (all Raman calibrations are after Kouketsu *et al*., 2014). A white mica concentrate gives an Ar-Ar plateau age of 87.1±0.5 Ma (age of ductile shearing), whereas another sample gives a mixed Ar-Ar age of 204.3±0.5 Ma suggesting the polymetamorphic nature of the Phyllonite zone. White micas of the first sample are more phengitic in composition than that one with the older age.

The higher part of the Gurktal nappe complex is comprised of two structural units, the lower Pfannock basement-cover unit and the overlying Stolzalpe nappe, with a nappe contact in between. Graphitic carbon from a semi-ductile shear zone within Upper Carboniferous conglomerate gives a deformation T between 260 and 288 °C, indicating the temperature of thrusting of the Stolzalpe nappe over the Pfannock basement-cover unit, potentially towards WNW according to the preliminary kinematic data, predating the ductile low-angle normal fault at the base of the Pfannock unit.

Consequently, we argue that a nappe stack was formed during a late Early Cretaceous continental collision, subsequently overprinted by an orogenic collapse stage, which also led to exhumation of high-pressure metamorphic units elsewhere within the Austroalpine nappe stack.

REFERENCES

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