EO-ALPINE TRANSPRESSION IN THE AUSTROALPINE CAMPO CRYSTALLINE COMPLEX (NORTHERN ITALY)

Dirk Scheuvens, Timo Krass & Oliver Schwarz

In the central Alps, the Austroalpine nappe stack is characterized by large basement exposures (e.g. Ötztal crystalline complex, Campo crystalline complex) and smaller areas with Permomesozoic cover units (Ortler nappe etc.). Kinematic, petrological and geochronological investigations clearly reveal a multi-episodic evolution during Alpine orogeny with Cretaceous high- to medium-pressure metamorphism and nappe stacking, subsequent cooling accompanied by latest Cretaceous low-angle detachment faulting and renewed Oligocene compression with an important backthrusting component in the south. The Cretaceous nappe stack is interpreted as a westward propagating orogenic wedge resulting from collision following subduction of the Meliata-Hallstatt oceanic domain. The presented models for the central Alps mostly result from investigations of the Ötztal crystalline complex and its surroundings whereas the southern Campo crystalline complex has achieved considerable attention only recently.

We have performed detailed mapping in the western part of the Campo crystalline complex (area around Passo di Gavia) to get new insights into the petrostructural evolution of this part of the Austroalpine nappe system. The Austroalpine basement rocks of the study area are positioned immediately below (i.e. in the footwall of) – but are generally unaffected by – the late Cretaceous ductile to brittle Peio fault zone. The low-angle sinistral transtensional Peio fault separates the Campo crystalline complex with Alpine cooling ages in the footwall from the Tonale unit with largely Variscan cooling ages and only a weak Alpine overprint in the hanging wall. Hence, the investigated area represents one of the southernmost Austroalpine areas within the central Alps where deeper crustal processes during eo-Alpine convergence can be studied.

The study area comprises four major units which generally dip moderately to the south. From the base to the top these are a quartz phyllitic unit with abundant lenses of marble, actinolite schist, and acid orthogneiss, a mica schist unit I with conspicuous horizons of albite porphyroblast schists and high amounts of tourmaline, a staurolite-bearing mica schist unit II associated with large bodies of a hornblende-bearing orthogneiss, and a sillimanite-bearing paragneiss unit. The units are variably metamorphosed with metamorphic grade increasing from greenschist facies in the north to amphibolite facies in the south. Both rocks of the lowest and the highest unit of the structural pile exhibit a main foliation S_2 that monotonously dips moderately to shallowl to the S. The main foliation of the quartz phyllites is cut by discordant (?Permian) mafic dykes, whereas the main-foliation of the sillimanite-bearing rocks is cut by partly undeformed pegmatites which have been dated at c. 314 Ma (THÖNI 1981). Both magmatic events can be used as time markers and confirm that the main foliation-forming event is Variscan in age (or older). However, mica schist unit I and II show a much more complicated structural record which will be outlined below.

In the area around Passo di Gavia the Variscan foliation S_2 is affected by a folding event D_3. In mica schist unit I, several flexure zones occur where the moderately S dipping foliation S_2 is bent into a steep position. The W-E striking "steep zones" represent high-strain zones that reactivate the main foliation S_2 and show prevailing S>>L fabrics (stretching or mineral lineation largely absent). Outside the shear zones mica-rich layers exhibit a mainly subhorizontal WSW-ENE trending crenulation lineation that is interpreted to be contemporaneous with large-scale bending of the main foliation. The crenulation lineation is locally refolded by cm- to dm-sized tight folds (D_4). In between closely spaced steep zones F_4 fold axes scatter in orientation defining an indistinct small circle with a centre at c. 330/70. Under the microscope, both F_3 and F_4 folds are characterized by dominant subgrain rotation recrystallization of quartz, by polygonization of micas within the hinge zones and a lack of recrystallization of feldspar suggesting upper greenschist facies conditions during D_3 and D_4.

Within mica schist unit II post-D_2 deformation is even more intense. The most conspicuous feature are large-scale non-cylindrical synclines, which are correlated with the D_3 flexure zones further to the N. The synclines are characterized by moderately S dipping long limbs (including parasitic folds with "S" geometries; view to the E), steeply oriented short limbs and undulating but mainly WSW-ENE trending fold axes. Anticlines are generally suppressed by W-E striking steeply dipping zones of intense folding and shearing resembling „flower structure"-like geometries. The steep shear zones exhibit mineral lineations that either show a pitch of more than 80° (type I shear zones) or are oriented subhorizontally and trend W-E (type II shear zones). Shear-sense indicators reveal both S-side-up and S-side-down kinematics for type I shear zones and sinistral kinematics for the type II strike-slip zones. Sinistral shear zones are phyllonitic in appearance and rarely overprint shear zones with a vertical displacement vector. Under the microscope microstructures in both types of shear zones point to (upper) greenschist to lower amphibolite facies deformation conditions.

The age of D_3 and D_4 folding and shearing is younger than the emplacement of late- to post-Variscan intrusives but older than exhumation and cooling of the Campo basement in late Cretaceous times, and therefore can be tentatively attributed to an eo-Alpine orogenic event.

The described tectonic inventory of the western part of the Campo crystalline complex (coherent low-strain blocks with large-scale non-cylindrical N-verging folds and mainly subhorizontal fold axes separated by steeply dipping high-strain zones with variable kinematics) is attributed to pure-shear-dominated transpressional shearing during eo-Alpine convergence. The different kinematics in shear zones with a vertical displacement component and the strong undulation of fold axes are probably the result of vertical extrusion of material and rotation of material lines towards a vertical orientation. The late sinistral shear zones are interpreted to result from an anti-clockwise rotation of the direction of convergence causing a switch from pure-shear-dominated to sinistral wrench-dominated transpression.

Eo-Alpine sinistral transpression within the more southern positioned part of the Austroalpine nappe system (in present-day co-ordinates) is in accordance with the geodynamic model of FROITZHEIM et al. (1996) which proposes a large-scale sinistral wrench fault at the southern edge of the Austroalpine unit separating the westward propagating Austroalpine wedge from the largely undeformed South Alpine unit.

References

FROITZHEIM, N, SCHMID, S.M. & FREY, M. (1996): Mesozoic paleogeography and the timing of eclogite-facies metamorphism in the Alps: A working hypothesis. – Eclogae geol. Helv. **89**, 1: 81–110.

THÖNI, M. (1981): Degree and evolution of the Alpine metamorphism in the Austroalpine unit W of the Hohe Tauern in the light of K/Ar and Rb/Sr age determinations on micas. – Jb. Geol. B.-A **124**: 111–174.

Authors' addresses:

Dr. Dirk Scheuvens, Timo Krass, Oliver Schwarz, Institut für Mineralogie, TU Darmstadt, Schnittspahnstrasse 9, 64287 Darmstadt, Germany