Geophysical Research Abstracts
Vol. 19, EGU2017-4175, 2017
EGU General Assembly 2017

Post-collisional plate boundary deformation: Implications for Alpine kinematics and architecture of Eastern Alps

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The Eastern Alps expose the plate boundary between the combined Europe-derived lower plate continental units and obducted Mesozoic Penninic ocean basin fill and the overlying continental Austroalpine nappe complex in the dome-shaped Tauern window. A structural study in Radstadt Mountains associated with reinterpretation of Ar-Ar geochronology of ductile low-grade metamorphic fabrics and the interpretation of a N-S cross-section of Eastern Alps allow recognize the following major processes: (1) A regular footwall progradation of thrusting from c. 100 Ma to c. 16 Ma is partly contemporaneous with orogen-parallel extension (Late Cretaceous and Miocene) in uppermost units. (2) Latest Eocene and earliest Miocene post-collisional plate boundary folding and shortening formed in the rheologically weak center of the orogen. (3) The interplay of Miocene outward thrust propagation and strike-slip faults is potentially controlled by inherited rift structures in the subducted plate.

The Lower Austroalpine nappe complex of the northern Radstadt Mountains in characterized by largely inverted nappes (with mainly Permian to Jurassic successions) including the prominent Quartzphyllite nappe. These nappes are thrusted over Penninic tectonic units of the NE edge of Tauern window during Eocene as dating of ductile fabrics of the Hochfeind nappe suggests (c. 50–54 Ma; Liu et al., 2001, Tectonics 20, 528–547). Successions of the Quartzphyllite nappe show a dominant foliation and a ca. WNW-trending stretching lineation formed during deformation stage D1 during nappe transport towards WNW during Late Cretaceous (40Ar/39Ar white mica: c. 78–80 Ma). Ductile shear zones in overlying basement units and isoclinal km-scaled folds with subhorizontal axial surfaces and local internal thrust splays in in the Quartzphyllite nappe are associated with D1 deformation. D1 fabrics are overprinted by D2 ductile fabrics at the structural base of the Quartzphyllite nappe to the underlying Penninic units. In the interior of the Quartzphyllite nappe, the foliation S1 is overprinted by kilometer-meter-scaled open N-vergent, ENE to E plunging D3 folds with amplitudes of ca. 1 – 2 km. These folds also affect the D2 thrust boundary of Penninic to Lower Austroalpine nappe complex. In outcrops, a non-penetrative axial plane foliation S3 formed by pressure solution or cataclastic deformation, and no recrystallization of these fabrics occurred. The D3 folding postdates, therefore, D2 thrusting dated at ca. 50–54 Ma and indicates a previously unrecognized stage of shortening of Lower Austroalpine units. This folding stage with a minimum shortening estimate of c. 30 percent is interpreted to be associated with internal dome formation within the Tauern window. Regional considerations allow date D3 N-S shortening to latest Eocene to earliest Miocene. D3 shortening is overprinted by D4 activation of the SEMP strike-slip fault and finally by Early Miocene ESE-directed D4 ductile normal faulting (Katschberg fault) and contemporaneous activation of the Mur-Mürz fault.

The new data are similar to D3 N-S shortening structures occurring over the whole N-S section in the Eastern and Southern Alps. These structures include internal thrusts within Northern Calcareous Alps (NCA), the footwall accretion and deformation of Penninic units along the northern floor thrust of Eastern Alps.