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POST-COLLISIONAL OVERPRINT OF THE ALPINE NAPPES: HOW MUCH OROGEN-PERPENDICULAR SHORTENING, HOW MUCH OROGEN-PARALLEL EXTENSION?

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Within the roughly E-W-striking part of the Alps (Eastern Alps and Swiss-Italian part of the Western Alps) post-collisional deformation follows Tertiary collision in the Alps (50-35 Ma). This deformation is characterised by post-nappe folding by ongoing N-S compression and contemporaneous orogen-parallel normal faulting (SCHMID et al. 1996). Orogen-perpendicular faults, such as the Simplon or Brenner normal faults, undoubtedly accommodate orogen-parallel stretching and contribute to the exhumation of neighbouring domes such as the Lepontine and Tauern dome, respectively. The ratio of this E-W extension over contemporaneous N-S-shortening, however, is a matter of dispute. This ratio largely influences the relative importance of tectonic unroofing versus denudation by erosion. On the basis of a sediment budget method it has recently been proposed that tectonic unroofing may contribute as much as 70% and 80% to total exhumation in the Lepontine and Tauern domes, respectively (KUHLEMANN et al. 2000).

Subduction retreat and associated extension in the Pannonian basin provide boundary conditions which are favourable for substantial orogen-parallel stretch in the Tauern window and further to the east. Regarding the Alpine transect across the Tauern window, the total amount of post-35 Ma N-S shortening between Adria and Europe may amount to a total of about 120 km based on an extrapolation of the data given for a transect across Eastern Switzerland (SCHMID et al. 1996). A slightly lower value for N-S shortening (86-113 km) results from a retro-deformation of post-30 Ma deformation within the Austroalpine units overlying the Tauern window, which yielded 170 km of orogen-parallel stretch (FRISCH et al. 1998). Hence, it appears that N-S-shortening and orogen-parallel stretch have similar magnitudes during post-collisional deformation. However, the activity of the Brenner normal fault did not start before about 20 Ma ago (FÜGENSCHUH et al. 1997). Hence, tectonic unroofing started to play a dominant role only after 20 Ma ago.

The situation is totally different in case of the Lepontine dome. Firstly, orogen-parallel stretching started as early as 35-30 Ma ago, i.e. during the so-called Niemet-Beverin phase (SCHMID et al. 1996) and lasted until the final stages of normal faulting across the Simplon normal fault at around 15 Ma ago. The estimated 60 km of orogen-parallel stretch (SCHMID & KISSLING 2000) are a consequence of diverging thrust directions in the Swiss Alps (top-N) and in the French-Italian Western Alps (top-WNW). These diverging thrust directions are kinematically related to a corridor of dextral shearing along the Tonale and Simplon shear zones. It is proposed that the Simplon normal fault represents a local tensile bridge which formed during a late stage within this zone of dextral shearing. The estimated 120 km of N-S shortening after 35 Ma exceeded the orogen-parallel stretch of about 60 km during the entire post-collisional deformation history. Hence, from a tectonic point of view, exhumation of the Lepontine dome must have been dominated by erosional denudation, induced by backthrusting along the Insubric line; this dome defi-

nitely does not represent a core complex in the footwall of a low angle detachment.

The N-S striking French-Italian Alps undergo a major change in thrusting direction from top-N to top-WNW after the Priabonian and at around 35 Ma ago (CERIANI et al. 2001) and coeval with orogen-parallel stretching in the Lepontine dome and dextral movements along the Tonale line. Orogen-parallel extension has not been described in case of the French-Italian Alps.

On the scale of the entire Alps post-collisional deformation is dominated by orogen-perpendicular shortening rather than by orogen-parallel extension, except for post-20 Ma deformation of the Eastern Alps east of the western margin of the Tauern window. In the latter case it is suggested that subduction roll-back in the Carpathians, rather than indentation by the Southern Alps and lateral extrusion due to an overthickened crust (FRISCH et al. 1998), represents the primary cause for very substantial orogen-parallel extension.

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