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# Structural evolution of the contact between two Penninic nappes (Zermatt-Saas zone and Combin zone, Western Alps) and implications for exhumation mechanism

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The boundary zone between two Penninic nappes, the eclogite-facies to ultrahigh-pressure Zermatt-Saas zone in the footwall and the blueschist-facies Combin zone in the hanging wall, has been interpreted earlier as a major normal fault reflecting syn-orogenic crustal extension. Quartz textures of mylonites from this fault zone were measured using neutron diffraction. Together with structural field observations, the data allow a refined reconstruction of the kinematic evolution of the Pennine nappes between the Simplon fault and Aosta valley.

Structural studies of this area show that structures correlated with northwest-vergent shearing ($D_1$) are overprinted by structures related to west- to southwest-vergent shearing ($D_2$) and finally, together with these, overprinted by structures related to east- to southeast-vergent shearing ($D_3$). Due to the variably strong overprint of $D_2$ and $D_3$on $D_1$ and of $D_3$ on $D_2$, evidence for all three deformation phases can be found above and below the contact between the Combin zone and the Zermatt-Saas zone. Textures of quartzitic mylonites from the Combin zone, the Monte Rosas nappe, and the Sesia zone have been analysed by neutron texture geometry and provide information about strain during $D_1$, $D_2$, and $D_3$ in different levels of the nappe pile. This information combined with structural field work, petrological and geochronological data allows a stepwise retrodeformation of the nappe pile.

Although $D_2$ and $D_3$ included movements along extensional shear zones, these parts

of exhumation were moderate.

Late during $D_1$ three north-vergent out-of-sequence thrusts characterised the structure of the nappe pile. The basal thrusts of the Sesia-Dent Blanche, Zermatt-Saas and Monte Rosa nappes may be considered as the strongly condensed overturned limbs of recumbent fold nappes. After retrodeformation of these folds southern parts of the Combin zone lie on the Sesia-Dent Blanche, its middle part on the Zermatt-Saas nappe, and its northern part on the St. Bernard nappe system. The continental constituents of the Combin zone (Cimes Blanches nappe, Frilihorn nappe) are derived from the sedimentary cover of the Sesia-Dent Blanche nappe and have been emplaced along a top-to-the-northwest thrust (Combin thrust). The top-northwest thrusting led to the substitution of the original cover of the Briançonnais units by the Cimes Blanches nappe.

The reconstruction shows (1) that the contact between the Zermatt-Saas and Combin zones is not a normal fault but a major thrust towards northwest which was only later overprinted by southeast-directed normal faulting; (2) that exhumation of the footwall rocks did not occur during crustal extension but during crustal shortening; and (3) that the Sesia-Dent Blanche nappe system originated from a continental fragment (Cervinia) in the Alpine Tethys ocean and the Combin-zone ophiolites from the ocean basin southeast of Cervinia.