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COMPUTER-AIDED 3D RETRO-DEFORMATION OF THE NORTHERN CALCAREOUS ALPS AROUND THE TRANSALP PROFILE

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To determine the amount of shortening, the depth of detachment and the style of deformation for the Northern Calcareous Alps (NCA) in the TRANSALP sector, we retro-deformed three-dimensionally an approximately 40 x 40 km area comprising the Lechtal and Allgäu Nappes. For the Lechtal Nappe, the largest coherent thrust sheet within the NCA, a three-dimensional model was constructed by splining lines from eight N-S cross sections, spaced E-W at about 4 km intervals. The data base consisted of all published and available geological surface and drillhole information, and preliminarily processed sections of the TRANSALP reflection seismic experiment. The model defines faults and seven stratigraphic layers of laterally variable thickness comprising the Permo-Triassic to Cretaceous stratigraphy.

Nearly all the structural features of the Lechtal Nappe are controlled by the Triassic Hauptdolomit (HD) layer. Where it is less than 500 m thick, imbricate thrusts develop. Sections where the the HD is more than 1 km thick are not faulted. Where the HD is thicker than 2.5 km, the whole thrust system is jammed. The consequence of jamming is folding of earlier detachments, development of backthrusts and fault-bend folding of the HD and the other layers.

The modelled area has four main thrusts which link to a detachment at 2-5 km depth below sea level. 3D fault displacements and heaves were determined using Allen Maps. Algorithms for fault-parallel flow and flexural slip unfolding were used to restore northwards movement on the thrusts and folding of beds over thrust planes, respectively. Minimum shortening estimates vary, from east to west, from 25% to 42% (with a typical error of 6%). Additional shortening in the west of the area is mainly accomodated by folding.

The Allgäu Nappe, subjacent to the Lechtal Nappe, is composed of a much thinner sequence of sediments. Its subsurface structure in the western part is markedly different to the structure in the eastern part. In the east the Allgäu Nappe can be traced about 10 km down-plunge, and can be restored to an initial width of approximately 20 km. In the western part the downplunge width is at least 15 to 20 km, with a restorable shortening of 32%.

As a consequence this means that the triple (Inntal, Lechtal, Allgäu Nappes) NCA nappe system was moved fairly uniformly to produce laterally heterogeneus shortening within the individual units. Therefore the clockwise rotation of the nappes by 30-40°, as shown by paleomagnetic data is likely a product of post-nappe block rotations. The best kinematic constraint for a predominantly northward movement of the nappes comes from the Thiersee Synform-Achental Thrust- Karwendel Synform structural assemblage, which can only be properly retro-deformed in 3D using a N-S kinematic vector.

The following results of our study are potentially valuable to TRANSALP interpretation:

The position of the basal datachment to the NCA can be estimated by depth extrapolation in the deformed crustal volume.

The downplunge extension of the Allgäu Nappe could be determined.

The internal stucture of the Lechtal Nappe, not clearly visible in the TRANSALP seismic data, could be constrained.

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