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Forward and hindward propagation of thrusting from Miocene - Recent in the Alps of Western Austria

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Paleomagnetic data from all main external tectonic units of the Western part of the Eastern Alps indicate large differential vertical axis rotations between the foreland and the Subalpine Molasse, and between the Helvetic nappes and the Subalpine Molasse. Large rotations of large blocks can only be accommodated by thrust planes, as rotation between vertical faults would create major space problems. Differential rotations should be expressed in differential shortening across the Alpine thrusts. As available shortening estimates across the Subalpine Molasse are far too small to account for the paleomagnetically determined rotations data, we re-examined several cross sections.

The Subalpine Molasse of Western Austria/Eastern Switzerland is formed by four slices, which show a synclinal geometry in the east and pass into horses separated by SSE dipping thrusts to the west. The frontal three slices are in contact with the north-(foreland-ward) dipping panel of the foreland Molasse (“aufgerichtete Molasse”) and are part of the duplex filling a triangle zone. A thrust at the base of these slices superimposes them out-of-sequence onto the foreland Molasse and therefore truncates the passive backthrust on top of the triangle zone.

The thrust at the base of the southernmost slice systematically superimposes the deepest part of the foreland sequence onto intermediate parts of the sequence. Seismic sections perpendicular and parallel to strike show that this slice sits on top of a major upper footwall flat and the northerly adjacent slice is a footwall imbricate. The footwall flat reaches far to the south beneath tectonically higher units, whereas the duplex slices within the triangle zone are frontal hanging-wall imbricates of a major thrust

sheet. Out-of-sequence thrusts dissecting the southernmost slice cut down to the basal detachment of Subalpine Molasse and stack older thrusts.

The age of triangle zone formation at the tectonic front of the Alps is constrained by southward wedging and onlap of Middle to Late Miocene (16-7 Ma) deposits against the triangle zone (growth strata geometry). However, the end of this activity is not constrained, because the youngest deposits still dip 15° to the NNW. Out-of-sequence thrusting of the northernmost Molasse slices onto the foreland-dipping panel of the foreland Molasse probably also contributed to tilting of the latter. It documents the end of foreland propagation of thrusting and the onset of internal thickening of the orogenic wedge during the Tortonian.

Apatite fission track dating in a well penetrating the southernmost Molasse slice in Eastern Switzerland revealed more than 1 km exhumation relative to the more northern slices postdating the Early Pliocene (4.7 Ma), which was related to thrusting (Cederbom et al., 2007, this volume). It shows that out-of-sequence thrusting started to propagate further into the Alpine orogen in the Pliocene.

The end of frontal accretion in the Alps was probably a result of vastly increased erosion in the Alpine orogen since the beginning of the Pliocene (e.g. Kuhlemann & Kempf, 2002). On the orogen scale, back-stepping of thrusting reached the internal part of the Alps, e.g. the Inn valley, where neotectonic activity is currently concentrated.

Cederbom, C., Schlunegger, F., Sinclair, H. D. & van der Beek, P. (2007): What can the Swiss Molasse basin tell us about the Late Neogene development of the Alps?- Abstr. 8th WAGS Davos, 10-11. Kuhlemann, J. & Kempf, O. (2002): Post-Eocene evolution of the north Alpine foreland basin and its response to Alpine tectonics.- Sedimentary Geology, 152, 45-78.