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Tectonics of the Western Alpine foreland: a review

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The Western Alpine foreland is composed of two structurally different regions: to the S, the Western Alpine Molasse Basin (WAMB) located NW of the Penninic frontal thrust and to the N, the Jura foreland Fold-and-Thrust Belt (FTB) forming the external outlier of the Alpine orogeny. The WAMB stretches from Lake Constance in the E to the city of Chambéry (France) to the SW. It initiated as flexural foreland basin, and subsequently evolved to become a wedge-top basin and a part of the detached Alpine foreland. The development of the Jura FTB is associated to the formation of a main décollement level over the mechanically more rigid basement s.l., and can be linked to a “distant push” from the Alps (Fernschub hypothesis) associated with the exhumation of the External Crystalline Massifs in the Alps.
The WAMB s.str. contains the Cenozoic erosional remnants of the Alpine orogenic wedge, resting on Mesozoic epicontinental platform carbonate series overlying a Paleozoic basement. The Jura FTB mainly develops in these Mesozoic series. The arc-shaped geometry of the Jura FTB and the trailing WAMB have been related to the lateral distribution and thickness changes of the Triassic evaporite layers. The Muschelkalk layers act as main décollement zone in the eastern area, and the Keuper layers in the western area. Strain is partitioned between several décollement levels and the brittle-ductile deformation is mainly concentrated in salt and evaporite layers of both ages. The structural style ranges from fault-and ramp-related folds, mostly in the Jura FTB, to evaporite-cored folds in the WAMB. In addition, secondary décollement levels have been proposed in the Liassic shale series. Strike-slip faults oriented N-S (sinistral) and NW-SE (dextral) cut from the Jura FTB into the WAMB, and are restricted to the detached sedimentary cover, as documented by seismic activity. Inherited basement structures main function as trigger for structures in the detached cover.
The tectonic development of the foreland is generally considered to occur between 15 and 4 My, though recent work suggests that it may have started earlier, and is still actively deforming, as documented by ongoing seismicity. The thrust propagation in the orogenic wedge is dependent on the basal friction and the evolution of the topography and we observe a forward-backward oscillating sequence of thrusts and thrust-related folds in which the Jura FTB and the WAMB are linked. The entire foreland evolves as a tapered wedge. The very low taper and the weak décollement allow for a broad wedge geometry and the formation of numerous backthrusts.
Paleostress analysis and recent earthquake data suggest a regionally uniform NW-SE oriented regional stress field that rotates with the arc of the Jura to be more W-E oriented. However, examinations on the major tear fault systems point to local deviations of the regional stress orientation. The broad strike-slip fault system are composed of 3 orders of self-similar imbricated Riedel shear faults that locally yield reorientations of the stress field , suggesting very strong strain partitioning. Ongoing distributed seismicity suggests that the foreland is possibly critically stressed.