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Geometry of growth strata in wrench-dominated transpression: 3D-model of the Upper Jurassic Trattberg rise, Northern Calcareous Alps, Austria

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Growth strata associated with wrench faults are known for a long time and have been documented from e.g. the San Andreas fault, the fault bounding the Catalan Coastal range, or the Spitsbergen fold belt. Here we document growth strata in Upper Jurassic pelagic limestones that are at least 700 m thick. The limestones are intercalated with several 15-40 m thick megaturbidite beds that are laterally continuous for at least 25 km and are therefore ideal marker beds. The growth strata are found in a zone of wrench deformation at the southern margin of the generally flat lying Osterhorn mountains south of Salzburg, commonly referred to as the Trattberg rise. The growth strata documented in this study are hitherto undescribed because they are largely exposed in wooded terrain, and were not accessible to direct observation on the medium to large scale. Hillshades from 1 m resolution DEMs and high resolution orthophotos provide a base for the detailed study and 3D-modelling of the area.

In the Northern Calcareous Alps, wrench tectonics controlled both facies distribution of (Upper) Jurassic sediments, and localized folds and thrusts during subsequent Cretaceous shortening. In the studied area, Upper Jurassic deformation is marked by moderate exhumation in the hanging wall of E-W striking faults that are subvertical at depth and curve toward a shallow southern dip upwards. Some topographically deeper splay faults end within and are sealed by the syntectonic deposits.

In the footwall of south-dipping oblique thrust faults, syntectonic deposits are dragged, and a syncline is exposed. In the southern limb of this fold, bedding dip changes from subvertical near the base of the succession to subhorizontal near the top. However, between megabeds two contradicting observations can be made:
(1) The thickness of the megabeds and the units between megabeds increases from the synclinal hinge toward the fault
(2) Truncation of the tilted fine-grained succession by the megabeds suggests folding followed by incision by the megabeds.
Wedge-shaped sedimentary units pinching out against the growing structure cannot explain the observations. Prior to deposition of a new megabed, the hanging wall of the fault must be slightly uplifted to create a step providing accommodation space for a sedimentary wedge tapering away from the fault. Further fault activity will drag and tilt these deposits, before the next megabed truncates the tilted beds.

In such a scenario, the
(1) relative magnitudes of the rate of deposition,
(2) the rate of overall vertical growth of the structure, and
(3) the rate of creation of local topography across the active fault
will determine whether wedging toward the fault or wedging away from the fault is the dominant process. In the example discussed here, the overall upward shallowing dip in the steep limb of the syncline and the pinch-out of the Upper Jurassic succession in the hanging wall of the fault suggests that onlap onto the growing structure is more important.