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Complex structural architecture of the Sierning Fold-and-Thrust segment, Northern Alpine Foreland Basin, Austria: kinematics and deformation controlling factors

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The syntectonic Northern Alpine Foreland Basin (Molasse Basin), is partly being affected by fold-and–thrust deformation at the alpine deformation front. The style and timing of deformation along-strike the alpine chain varies significantly. Regional scale 3-D seismic data combined with exploration wells gives an excellent opportunity to study the spatial structural architecture of the Austrian Sierning Fold-and-Thrust segment. After one successful gas find in this area, exploration activity is currently increasing. However, the seismic resolution of the structures varies from clearly imaged to noise dominated sections. Well control is sparse and of limited use, as dip data in older wells is often not recorded. In order to improve future exploration success, understanding of the detailed structural architecture is necessary. Thus, in order to improve seismic interpretation, knowledge of the kinematics and controlling factors of deformation are prerequisite. Regional to local seismic interpretations as well as forward and backward section balancing techniques are used to improve our understanding of this thrust belt.

In the Sierning Segment, Upper-Eocene to Lower Miocene Molasse foredeep sediments are deposited above thin Mesozoic sediments and crystalline basement. The foreland succession is detached at the basal shales and accreted to the advancing alpine wedge in Lower Miocene time. The structural inventory of this thrust belt is rather complex and comprises varying numbers of thrust sheets along strike (1-5), ramp-flat-ramp geometries, tear faults as well as belt-parallel strike-slip faults, frontal triangle and diffuse proto-thrust zones. Horst and Graben structures from the flexural loaded foreland crust lead to varying stratigraphic dips of the pre-deformed Molasse sediments (regional dip between 3-10°). At least one thick-skinned inversion structure interacts with the thrust sheet, localizing the frontal thrust.

Two of the major controlling factors can be deduced:

1) Mechanical stratigraphy: deep marine coarse clastic channel sediments are embedded within shaly sediments. Flat-ramp-flat paths of thrusts seem to depend on the channel stacking pattern, i.e. intermediate detachments only occur, where coarse clastics are rare.

2) Basement structure and pre-deformational thickness distribution of the foredeep sediments. In general, the number of thrust sheets increases with decreasing sedimentary thickness from west to east. In addition, the deformation front seems determined by the strike of the basement or strike of contours of sediment thickness. If oblique to the assumed shortening direction (SSE-NNW) enforced strain partitioning occurs. There, strike-slip faults accommodate parts of the general thrust movement.