Transfer zones, fold-fault relations and their influence on syn-tectonic sedimentation: inferences from analogue modelling

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The geometry of structures and sediments in Late Cretaceous Muttekopf Gosau basin (Tyrol, Austria) is consistent with deformation by fault propagation folding and strike-slip faulting.. Sedimentation was syn-tectonic as documented by on- and offlap structures which form progressive growth unconformities. Field data show a significant change in strike of the bedding planes across the growth unconformities, which could be indicative of synchronous strike-slip faulting and folding. Series of small-scale normal faults can be related to progressive rotation of fold limbs during trishear-type fault-propagation folding.

The interplay of deep water sedimentation on top of an actively growing fold is not well understood, especially the influence of tear faulting on sediment geometries has not been studied yet. Analogue modelling has been used to infer the kinematic boundary conditions favourable for the development of tear faults and to decipher deviations from the expected stratal patterns related to fold growth, which can be attributed to tear fault activity. Furthermore, sediment geometries are studies as a function of fold growth and sedimentation rate.

We used sand and sand-silicon experiments representing brittle and brittle-viscous rheological domains, resting on a basal velocity discontinuity. In the first series of experiments, we used two plates moving with a different velocity, producing multiple thrust systems divided by a dextral strike-slip fault. Additionally, the affect of pre-existing basement structures has been implemented by introducing an initially present offset between the independently moving basal plates.

In the second series of experiments growth of an antiform was simulated by pulling the sediments, which have been added step by step, over two ramps with a slope angles from 15 to 60 degrees. This series aims at investigating the influence of fold growth- and sedimentation rates on the resulting sediment geometries and structures.

Results of the first series show a significant effect of the tear fault activity on the strike of the thrusts. When sand was used and no offset from the beginning, the thrusts were not divided by the tear fault, but the strike of the thrust within the strike slip zone changed by more than 30 degrees. Experiments with an initial offset of the basal plates show this change of thrust orientation only during the the initial stages of the model. With increasing displacement the thrusts got separated and the strike-slip fault was the dominant structure. These models show a regular sequence of deformation and one distinct backthrust.

Results of the experiments with sand-silicon setups showed considerable differences. The change of strike is visible over a wider area on both sides of the tear fault. Therefore the change of strike is not more than approximate 15 degree. The thrusts are directly connected and are not divided by the tear fault at all. These models have structures over a wider area, but less pronounced, than those accomplished only with sand, further more than one backthrust evolved. In the previously described second series results show, when a progressive unconformity is generated on the faster moving ramp, the slower side is controlled by onlap structures. A constant growth of the structure ends in a constant onlap, whereas constant sedimentation results in offlap structures.

Results of the first series with changes in strike direction are comparable to field observations and especially the results of the second series accord to the field, where progressive unconformities on the western and constant onlap on the eastern part of the main tear fault could be described.