RELATIONSHIP BETWEEN SEDIMENTATION AND COEVAL THRUSTING: CRETACEOUS SYNOROGENIC SEDIMENTS OF THE NORTHERN CALCAREOUS ALPS (NCA), AUSTRIA

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The switch from passive margin to synorogenic sedimentation in the western NCA took place under deep water conditions and is documented by the transition from marly or siliceous carbonates to marls, sandy marls and coarse clastic deposits. Synorogenic sedimentation develops gradually and conformably from passive margin sedimentation in the Cenomanrandschuppe (CRS), the Allgäu and southern Lechtal thrust sheets. In contrast, synorogenic sediments on the northern Lechtal and the Inntal thrust sheets record surface uplift and subsequent erosion, then transgression and subsidence. To interpret these contrasting histories of synorogenic sedimentation correctly, I first discuss the expected distribution of synorogenic sediments in relation to nappe thrusting.

Cretaceous thrusts in the NCA were emergent and placed thrust sheets on top of deep water synorogenic deposits. Therefore a ramp-flat model is appropriate. Thrusting in a deep marine environment has following consequences: As the frontal part of the thrust unit climbs up the ramp, water depth above the area of structural thickening decreases. An isolated carbonate platform develops on top of the evolving structure, or, if vertical growth is fast, shortlived carbonate buildups, which shed biogenic detritus into the surrounding deep marine areas. Continued growth will uplift the thrust unit above the ramp and upper footwall flat above sea level. The thrust unit covers successively larger areas of the upper footwall flat and ends sedimentation in the overthrust areas.

The synorogenic sedimentary successions of the western NCA can be compared to specific positions in such a model (Ortner, 2003):

Upper Footwall sedimentation: On the upper footwall flat below the thrusted units, conformable onset of synorogenic sedimentation records distant onset of contraction related to orogeny, and deposition of shallow water biogenic detritus shows the approaching of the thrust unit. The youngest sediments below the thrust record the minimum age of thrusting at the point of observation. This situation is comparable to Aptian-Albian synorogenic sedimentation of the Tannheim and Losenstein Fms. on top of the Allgäu thrust sheet, which are overlain by the Lechtal thrust sheet, and to Albian-Cenomanian synorogenic sedimentation of the Lech Fm. on top of the southern Lechtal thrust sheet, which is overlain by the Inntal thrust sheet. The uppermost Lech Fm. locally contains shallow water detritus ("Urgonian") transported by gravity flows and thereby records the destruction of carbonate buildups at the flanks of the approaching Inntal thrust sheet.

Thrust-sheet-top sedimentation: On top of the thrust unit, where structural thickening has taken place, unconformable transgression of terrestric sediments on deeply eroded older rocks records surface uplift. Growth geometries in thrust-sheet-top deposits record internal shortening of the thrust sheet after emplacement. The Branderfleck Fm. on top of the northern Lechtal thrust sheet and of the Gosau Group on top of the Inntal thrust sheet are found in this structural position.

In the foreland and the hinterland of the structure, undisturbed synorogenic sedimentation will continue. The CRS formed the northern continuation of the Allgäu thrust sheet prior to the Campanian, when it was overthrust by the Lechtal thrust sheet. The CRS has a conformable and continuous synorogenic sedimentary succession from the Aptian to the Campanian, overlapping both Upper Footwall sedimentation below and thrust-sheet-top sedimentation on top of the Lechtal thrust sheet. The CRS formed the foreland during thrusting of the northern Lechtal thrust sheet. The hinterland in relation to the northern Lechtal thrust sheet record conformable sedimentation up the Cenomanian, and was then overthrust by the Inntal thrust sheet. It forms the upper footwall in relation to thrusting of the Inntal thrust sheet.

Using such a model for synorogenic sedimentation and coeval thrusting has great predictive power, especially when working in poorly exposed areas, because it uses simple geometric relationships between syntectonic sediments and their substratum.

Ortner, H. (2003): Cretaceous thrusting in the western part of the Northern Calcareous Alps (Austria) – evidences from synorogenic sedimentation and structural data. – Mitt. Österr. Geol. Ges., 94, 63–77, Wien.