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THRUST SEQUENCES IN THE EASTERN ALPS – CONSTRAINTS FOR INTERPRETATION OF THE TRANSALP SEISMIC SECTION

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The thrust architecture of the Eastern Alps is a result of polyphase shortening and normal faulting in different directions. In the northwestern part of the Eastern Alps, thrusting was accompanied by synorogenic sedimentation. In the Northern Calcareous Alps, a complete sedimentary column from the Jurassic to the end of the Oligocene is present. For a particular location, the youngest deposits below a thrust plane give the approximate age for thrusting.

The Middle to Upper Cretaceous active continental margin in the Alps was located in the western part of the Eastern Alps and is documented by slices of Flysch sediments and ophiolites (Arosa zone imbricates) within and below the Northern Calcareous Alps and along the western margin of the Austroalpine nappes. Thrusting propagated from more internal parts of the orogen to external parts of the orogen. In the area south and west of Salzburg, thrusting is documented by progradation of submarine fans from the Hauterivian (Rossfeld Fm; DECKER et al. 1987) to the Albian (Lackbach Fm.; DARGA & WEIDICH 1986). In the western part of the Northern Calcareous Alps, stacking of the Lechtal nappe onto the Allgäu nappe ended sedimentation of the Losenstein Fm., whereas sedimentation continued on the northernmost part of the Lechtal nappe and the Cenoman-Randschuppe with the Branderfleck Fm (GAUPP 1982). Sedimentation of the Branderfleck Fm. continues to the Turonian on the Cenoman-Randschuppe. The Inntal Nappe was thrust onto the Lechtal Nappe after deposition of the Aptian to Cenomanian Lech Fm. ("Lechtaler Kreideschiefer"; VON EYNATTEN 1996). A sedimentary development comparable to the Lech Fm. is the Triazza Fm. on top of the Silvretta basement complex (CARON et al. 1982, MADER 1987). The sedimentary succession of the Arosa zone reaches into the Turonian. The Arosa zone in the western part of the Northern Calcareous Alps seems to be a lateral equivalent of the Cenoman-Randschuppe further to the east. The most frontal slices of the Cretaceous Alpine orogen were incorporated during or after the Turonian. At least in the western part of the orogen, post-Turonian shortening resulted mainly in fold growth inside the nappes (ORTNER 2001). Middle to Upper Cretaceous shortening was W- to NW-directed.

Renewed north-directed thrusting with frontal accretion started during Eocene continental collision, resulting in frontal accretion of Flysch and Helvetic units. The nappes of the Rhenodanubic flysch became part of the Alpine orogen after the Early Eocene, the Helvetic nappes after the Middle or Late Eocene. This event is associated with the subduction of the Penninc ocean.

During the Early Oligocene an important new thrust formed within the Alpine orogen. The Inn Valley fault is, according to the preliminary results of the TRANSALP seismic section, a prominent thrust plane. Movement along this major out-of-sequence thrust led to subsidence in the front of the thrust and formation of the Molasse basin north of the present day Inn Valley, which formed the southern margin of the Molasse basin during the Early Oligocene. The Oligocene

sedimentary succession in the Inn Valley is in fact closely related to the Molasse basin in terms of subsidence and sequence stratigraphy (Inn valley: ORTNER & SACHSENHOFER 1996, ORTNER & STINGL (in press); Molasse basin: ZWEIGEL 1998). Thrusting propagated successively into the foreland, with two other thrust planes cutting the Northern Calcareous Alps out of sequence, until thrusting stopped in the Middle Miocene at the front of the Alpine orogen. Around the Middle Miocene, the thrust in the Inn Valley became active again, leading to uplift of the Augenstein surface in the hangingwall of the thrust.

In conclusion, three independent foreland-propagating thrust systems dominate the northwestern Eastern Alps: An older system of Early to Late Cretaceous age might be related to oceanic subduction of the Penninic ocean. This thin-skinned system led to formation of the Allgäu-, Lechtal and Inntal-Nappes in the western Northern Calcareous Alps and to stacking of the Juvavic nappe units on top of the (younger) Tirolic unit. An Eocene thrust system is related to closure of the Penninic ocean. Postcollisional shortening from Oligocene onwards led to formation of major thick-skinned out of sequence thrusts cutting the previously deformed nappe stack. The Molasse basin, originally reaching south to the Inn Valley, was segmented by progressively younger thrusts propagating towards the foreland. The Oligocene Inntal thrust led to the separation of the Bajuvaric and Tirolic nappe complexes.

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