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THE TECTONIC EVOLUTION OF THE CENTRAL NORTHERN CALCAREOUS ALPS

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The classical concept of the nappe structure of the Northern Calcareous Alps (NCA), nearly a century old, is in contradiction with modern stratigraphic, metamorphic and geochronological data. We present a new concept with the following nappe stack (from deeper to higher structural levels) (see Fig. 1): (1) Bavaric unit divided into a Lower and Upper sub-unit (Tief- and Hoch-Bajuvarikum). The Bavaric unit is largely eliminated in the central NCA by lateral extrusion in

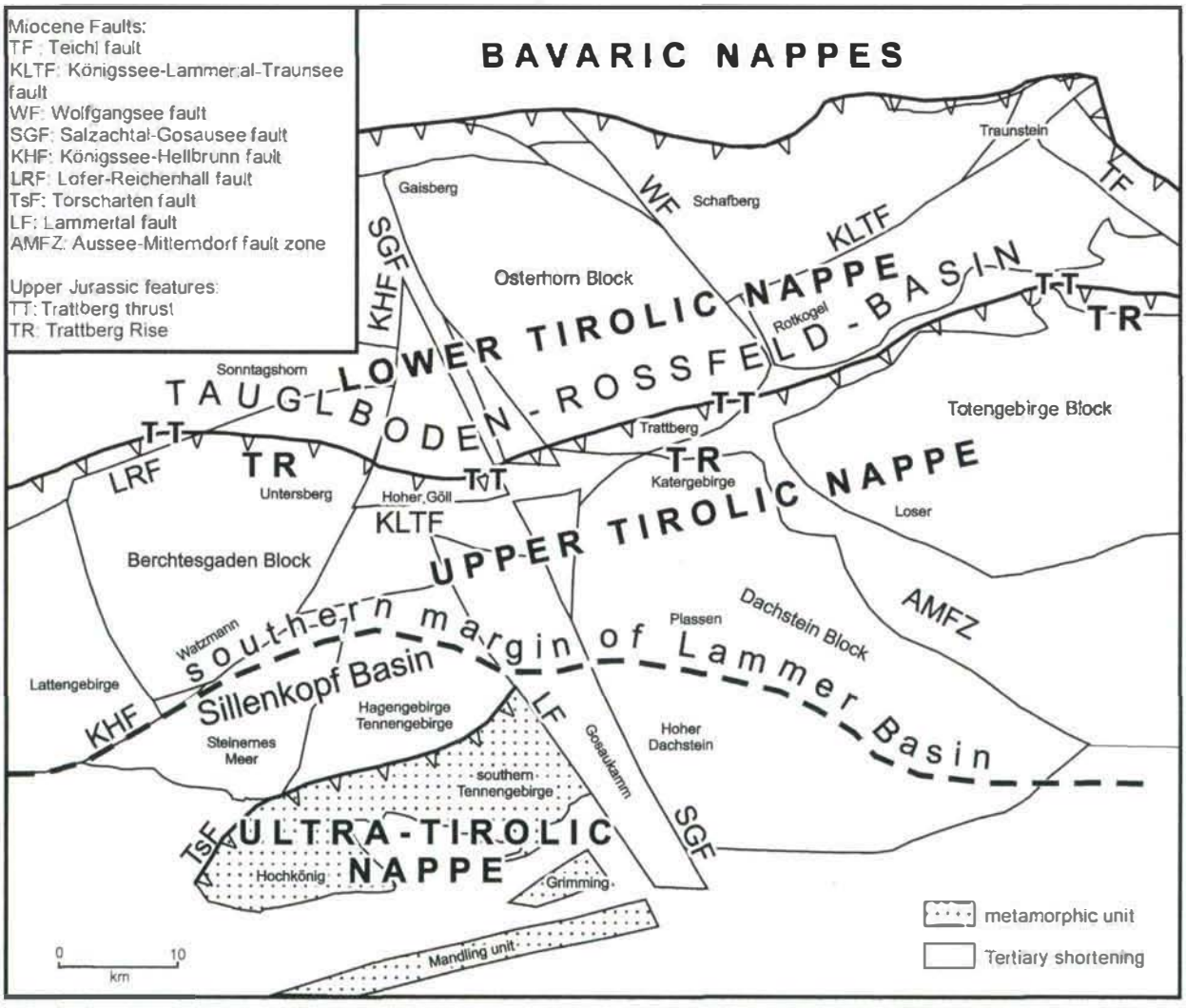

Fig. 1: Reconstruction of the Tirolic unit in the central NCA for Eocene (post-Gosauic) time. Further Eocene shortening occurred in shaded zones. Block movement and shortening in accomodation zones occurred during Miocene lateral tectonic extrusion.

Miocene time. (2) Tirolic unit, divided into two sub-units (Lower and Upper Tirolic sub-unit; Tief- and Hoch-Tirolikum) separated by an Upper Jurassic thrust fault (partly rejuvenated in Eocene time) and strongly block-faulted during Miocene lateral tectonic extrusion. (3) Metamorphic units of the (originally) southeastern margin of the Triassic carbonate platform, highly dismembered in the present state (Ultra-Tirolic unit; Ultra-Tirolikum). (4) Iuvavic unit (Juvavikum), which corresponds to the Hallstatt mélange nappe, also partly metamorphic and preserved in isolated bodies on top of the Tirolic unit. The classical subdivision into several Tirolic (e.g. Staufen-Höllengebirge and Totengebirge nappe in the central NCA) and „Upper Iuvavic" nappes (Berchtesgaden, Dachstein nappe), which are characterized by Upper Triassic carbonate platform sediments but thought to have been separated by the Hallstatt zone, is no more backed by the reconstruction of the geodynamic evolution since Triassic times. We propose a concept with an Upper Jurassic and a late Lower to early Upper Cretaceous orogenic event, which is in concordance with the diachronous history of the Austroalpine basement zone.

The Middle to Upper Jurassic („Late Kimmeric" or Eohellenic) orogeny caused formation of the Hallstatt nappe complex and thrusting over the external parts of the Triassic carbonate platform, which were also imbricated. In front of the advancing Hallstatt nappe, a deep-sea trench (Lammer Basin with carbonate-clastic radiolaritic flysch derived from the Hallstatt facies belt) was established in Callovian to Oxfordian time. The Kimmeridgian to Tithonian Trattberg thrust, a probably steep thrust with limited shortening, divided the Tirolic unit into the Upper and Lower Tirolic sub-units or nappes. The Upper sub-unit carried the Hallstatt nappe, the Lammer Basin, and the Trattberg Rise (as a thrust-related feature along its northern margin). It includes, from W to E, the former Berchtesgaden nappe, parts of the former Staufen-Höllengebirge nappe (Steinernes Meer, northern parts of Hagen- and Tennengebirge), the former Dachstein nappe, and the former Totengebirge nappe. The Trattberg Rise is represented in Untersberg, Hoher Göll, Trattberg, Katergebirge, and western Totes Gebirge. Immediately north of the Trattberg thrust, i.e., in the Lower Tirolic sub-unit, the Tauglboden Basin (Kimmeridgian to Tithonian) formed a trench and received carbonate-clastic radiolaritic flysch material from the Trattberg Rise.

The advent of an unknown source terrane (island arc?) from the southeast is manifested in Kimmeridgian time by the formation of the Sillenkopf Basin south of the former Lammer Basin, which was also filled by radiolaritic flysch and received detrital material from this terrane. This event may reflect the soft collision stage of the Upper Jurassic orogeny.

Deep-water conditions persisted in the Tauglboden Basin until Aptian time. In the Lower Cretaceous, the sedimentation shows a general coarsening-upward trend coupled with increasing input of siliciclastic material with crystalline and magmatic components. The youngest formation in this sequence is the Rossfeld Formation, which ended up in wildflysch sedimentation in Aptian time and reflects another orogenic paroxysm connected to prograding crustal shortening of the Austroalpine realm and remobilization of parts of the Hallstatt mélange. During this event, the internal parts of the Triassic shelf area were imbricated into nappes (Bavaric units), thus forming the external nappes of the NCA.

These two phases of nappe formation in the NCA correspond perfectly with the polyphase diachronous metamorphic history in the Austroalpine basement. A first metamorphic cycle, which included high-pressure metamorphism in the Hallstatt zone, yielded radiometric ages roughly between 160 and 130 Ma. This event affected the Greywacke Zone and its Paleozoic equivalents and parts of the NCA (see above). The second cycle, which includes high-pressure metamorphism in the crystalline basement, embraces ages from roughly 110 to 80 Ma. It is found in the Austroalpine crystalline basement

and overprinted Paleozoic terrains and the southern parts of the NCA.

The Gosau Group (Turonian to Eocene) sealed the nappe stack and reflects a prominent extensional event. Post-Gosauic (Eocene) orogeny caused final detachment of the NCA from their basement and thrusting over the Rhenodanubian Flysch as well as backthrusting along their southern margin. Internal deformation of the NCA included folding and rejuvenation of thrusts and caused out-of-sequence thrusting of individual blocks formerly considered as „Upper Iuvavic" nappes. Early to Middle Miocene lateral tectonic extrusion dissected the nappe stack and created a block puzzle, which veils the true nature of many of the older structures.

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