changed by the earliest Jurassic, when this shelf underwent wide rifting during Lias to Middle Dogger with formation of extensional, gradually pelagic basins (200–170 Ma). Contemporaneously, subduction of the Meliatic oceanic lithosphere commenced. These processes were likely triggered by a change in large plate kinematics – SE-ward drift of Africa and Adria with respect to Europe during opening of Central Atlantic. The Western Carpathian orogenic wedge nucleated by accretion of material scraped off the subducted Meliatic crust, accompanied by formation of early melanges rich in ophiolite material. In the Middle Jurassic time, the continuing rifting in distal European foreland resulted in breakup of the South Penninic-Vahic Ocean (ca 170–165 Ma). During the next periods, the Western Carpathian orogen behaved as an autonomous converging system driven by the downgoing Meliatic slab.

The Late Jurassic epoch started with incipient collision after closure of the Meliatic basin and by subsequent overriding of the Carpathian Austroalpine passive margin by the Meliatic accretionary complex, including a blueschist nappe (originally a distal passive margin element). In the peripheral foreland, compressional basins developed sequentially in front of thin-skinned thrust sheets of the later Hronic and Silicic nappe systems, which were filled with synorogenic, partly mass-flow deposits with decreasing amount of ophiolitic material (165–155 Ma). Activity of the pro-wedge slowed down during the latest Jurassic – earliest Cretaceous, while the retro-wedge grew at this time (155–140 Ma). After all the Meliata-related oceanic zones were consumed, thrusting relocated to the pro-wedge again, where the Gemeric basement sheets were stacked above the Veporic basement/cover superunit (140–125 Ma). In a coupled system, the collisional crust thickened considerably, as registered by structural-metamorphic and thermochronological data from the Veporic basement.

Throughout the late Lower Cretaceous, the wedge remained in a contractional regime. After foundation of an intracontinental underthrusting zone between the Fatric and North Veporic zones at ca 110 Ma, the pro-wedge began to grow rapidly by incorporation of the entire Fatric-Tatric crust. This was enabled by thermal softening of the Veporic basement and resulting decoupling of the Neotethyan collisional stack from the lower Fatric-Tatric plate. Subsequently the uplifted plug in the wedge centre – supra-Veporic mountainous area, which supplied the mid-Cretaceous peripheral flysch basins with clastic material (110–95 Ma), collapsed by orogen-parallel extension during the Late Cretaceous (90–70 Ma).

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Possible amounts of tectonic overpressure in the Adula nappe (Central Alps) derived from a new restoration of the NFP-20 East cross section

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Within the NFP20-East cross section through the Eastern Swiss Alps, the Adula nappe is remarkable for eclogite and garnet peridotite lenses testifying to Late Eocene high- to ultrahigh-pressure metamorphism. The pressure values established for these rocks by petrological methods exceed those of the over- and underlying units and define a gradient spanning from c. 17.5 kbar in the north to c. 30 kbar in the south. The oldest pervasive structures postdating high-pressure metamorphism are related to strong top-to-the-north-northwest shearing ceasing under amphibolite- to higher greenschist-facies conditions. Paradoxically, but similar to other ultrahigh-pressure units in the Alps, these movements were top-to-the-foreland, i.e. thrusting movements associated with decompression. Conventional kinematic reconstructions for the exhumation of the Adula nappe assume that peak pressures recorded in different parts of the nappe were lithostatic and combine the depths thus obtained with radiometric ages. In all published kinematic restorations, the Adula nappe is therefore restored to a depth from which it could only be exhumed to mid-crustal levels by a major to-to-the-south normal fault for which there is no evidence in the structural record. As an alternative to such models accepting that large part of the structural history during exhumation may have been completely erased by later shearing, we propose a purely structural restoration of the central part of the NFP20-East cross section. Benefitting from a probably unmatched wealth of structural and geochronological studies performed along this cross section, the new three-step restoration not only takes into account folding and relative movements between individual units but also nappe-internal thinning resulting from shearing which significantly contributed to the exhumation of the Adula nappe. The restoration results in maximum burial depths of the Adula nappe reaching from c. 47 km in the north to c. 62 km in the south. Assuming a density of 2700 kg/m^3 for the overburden, these depths would correspond to pressures between c. 12.4 and 16.6 kbar while the pressures actually observed are c. 40% (north) to 80% (south) higher. Various numerical and analytical studies have shown that tectonic overpressure, i.e. the isotropic part of the stress tensor exceeding lithostatic pressure, can be up to about the same amount as lithostatic pressure for realistic rheological properties and strain rates of rocks. Admitting such an amount of tectonic overpressure would therefore reconcile the petrological and structural records of the Adula nappe. Hence, we suggest to consider the possibility that tectonic overpressure rather than excessive deepening caused the high- to ultrahigh-pressure metamorphism in the Adula nappe.

The central Alps - eastern Alps boundary in western Austria: a crustal-scale cross section

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A N-S oriented crustal-scale cross-section was constructed east of the Rhine valley in Vorarlberg, western Austria, addressing the central Alps - eastern Alps boundary. The general architecture of the examined area can be described as a typical foreland fold-and-thrust belt, comprising, from bottom to top, the Subalpine Molasse, (Ultra-)Helvetic, Penninic, and Austroalpine nappes. These units overthrusted the autochthonous Molasse along a south-dipping listric basal thrust. The European basement together with its autochthonous Mesozoic/Cenozoic cover is found below this basal thrust.

In the northern part of the section seismic data allow to place the top of the autochthonous Mesozoic at a depth of 3500 m BSL with a moderate dip to the south along the cross section. Several seismic sections show normal faults offsetting the top of the European basement as well as the autochthonous cover and the overlying autochthonous Lower Marine Molasse. In the wider area of Lake Constance and the Rhine Valley (SW Germany, NE Switzerland, SE France) the European Basement is characterised by a mostly ENE – WSW striking Palaeozoic trough system. The observed faults are interpreted as fault structures originally belonging to this Palaeozoic trough system and reactivated during the flexure of the lower plate, due to the N-S convergence of the European and the African plates.

This flexure resulted also in the formation of the North-Alpine foreland basin, filled first with Flysch deposits followed by Molasse sedimentation. Due to the ongoing shortening the Subalpine Molasse was multiply stacked, forming a triangle-zone. The shortening within the Subalpine Molasse in the cross section has been calculated using the Lower Marine Molasse as a reference and amounts to approx. 46 km, (~70%).