Early Miocene on continued shortening was accommodated by distributed sinistral shear during eastward lateral extrusion (Ratschbacher, 1991; Linzer et al., 1995) of the central Eastern Alps. Three stages of Miocene deformations can be distinguished in the Calcareous Alps.

(1) Early Miocene N-directed shortening during the onset of eastward lateral extrusion led to the formation of (N)NE-striking sinistral faults. Older NW-striking faults continued to move dextrally. N-directed shortening in the Calcareous Alps correlate to the N-directed translation of the Adriatic plate.

(2) Middle Miocene NE-directed shortening of thrust- and strike-slip type during the subsequent stage of extrusion caused sinistral movements along E-W to NE-SW striking faults which were partially linked with NE-directed thrusts. The Königsee-Lammertal-Traunsee fault shows spectacular examples of convergent strike-slip duplexes, flower structures and connected thrusts. Thrust distances along thrust planes connected to strike-slip faults locally exceeded 6 km (Warscheneck nappe). Sinistral offsets at strike-slip faults reached up 30 km (Pyhrn fault). Most of the sinistral displacement along the Salzach-Ennstal fault occurred during this stage leading to the formation of positive flower structures. Older NW-striking dextral faults were partially reactivated as high angle reverse faults. Deformation style changed east of the overthrust Bohemian basement spur, which formed a morphologic high of the lower plate and which can be traced up to 50 km behind the alpine deformation front (Wessely, 1987). West of this basement spur, NE-directed thrusts dominated, whereas east of it extensional deformation prevailed. At the eastern margin of the Calcareous Alps, increasing extensional strain marks the transition towards the Vienna Basin. NE-directed shortening in the Calcareous Alps resulted from the drag of the eastward extruding central Eastern Alps which added a component of sinistral simple shear to overall N-directed shortening.

(3) Middle Miocene E-directed extension led to the formation of E-directed normal faults and to normal-sinistral movement along NE-striking faults. Deformation at the Salzachtal-Ennstal shear zone changed from transpression to transtension. Extension in the Calcareous Alps was associated with orogen-parallel detachment faulting in the central Eastern Alps. There, E-directed extension paralleled the direction of mass transfer towards the Pannonian Basin during lateral extrusion. Extensional faulting was induced by reduced lateral confinement east of the Alps due to the eastward motion of the Pannonian lithospaeric wedges.

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Chronology of Cretaceous tectonic events in the Central Western Carpathians

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The Cretaceous stage was the main period of tectogenesis of units in the Central Western Carpathians (CWC, here considered as an area between the Penninic-Vahic and Meliata-Hallstatt oceanic sutures, i.e. corresponding to the Austroalpine system). The paleotectonic evolution encompasses preorogenic pelagic and synorogenic flysch sedimentation, magmatism and metamorphism of different types, subduction of zones floored by oceanic or attenuated continental crust, stacking of collisional thick-skinned crustal imbricates and emplacement of d,collement cover nappes, as well as superimposed transpressional and transtensional movements. All processes involved exhibit a forelandward (generally northward) progradation and vergency of dominant structures. The interpretation of relatively rich, sufficiently age-constrained material and structural rock records enables a sophisticated temporal-spatial reconstruction of Cretaceous orogenic processes within the CWC, partitioned into seven principal periods:

(1) Late Jurassic - Early Cretaceous (150-125 Ma). Closing of the Meliata ocean and collision of its margins, exhumation of some HP/LT metamorphosed Meliatic units, loading of the South Veporic basement and cover by the collisional stack, general crustal thickening in the southern CWC zones. In the northern CWC domains (Fatric-Tatric-Vahic) an extensional regime, lithospheric stretching and mostly pelagic sedimentation continued.

(2) Late Early Cretaceous (125-110 Ma). Shortening prograded to the southern margin of the Fatric basinal realm, cessation of sedimentation in the transitional Veporic-Fatric Velkì Bok domain, contraction is heralded by huge olistostromatic bodies in the Fatric Zliechov basin, extension-related submarine basanitic volcanism and resedimentation events in the Fatric-Tatric foreland, probably bulge-related shallowing of the South Tatric ridge with Urgonian carbonate platforms.

(3) Mid-Cretaceous (110-90 Ma). Gradual underthrusting of the thinned Fatric crust beneath the North Veporic thrust wedge, d,collement of the Zliechov basin infill to form an accretionary fold-and-thrust belt with coeval flysch deposition in forearc or piggyback basins. Shortening started also in the South Tatric domain. Thermal relaxation and compressional uplift of the ultra-Veporic thrust stack due to underplating of the Fatric crust.

(4) Late Turonian (around 90 Ma). After elimination of the Fatric basinal area and pushing-up of its detached and imbricated sedimentary filling over the South Tatric frontal ramp, an extensive overthrusting, narrowly age-constrained event occurred in the CWC. The Krizna (Fatric) and Choc (Hronic) nappes were gravitationally emplaced above the Tatric cover.

(5) Early Senonian (90-80 Ma). Shortening relocated to the outer Tatric margin facing the Penninic-Vahic ocean, where flysch coarsening-upward complexes deposited during underthrusting of the Vahic crust. Contemporaneously, the Veporic metamorphic core complex was rapidly exhumed by top-to-the east unroofing. Small anatectic granitic bodies intruded the Veporic basement.

(6) Middle Senonian (80-70 Ma). Deeply denuded Veporic units were overriden by the Silicic relief nappes. Transtension in the inner CWC zones, accretion along their outer edge with terrigenous and pelagic sedimentation.

(7) Late Senonian - Early Paleogene (70-60 Ma). Collision of the Tatric sheet and overlying nappes with the Oravic continental ribbon (Kysuca and Czorsztyn units of the later Pieniny Klippen Belt) after diminishing of the Vahic basin, followed by dextral transpression within the collisional zone and wrench faulting inside the CWC area.

The maps of tectonostratigraphic units and principal structures of the Western Carpathians and adjacent areas

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The first, tentative versions of two map sheets in the scale 1:1,000,000 have been compiled to demonstrate the present state of knowledge about the general tectonic structure of the Western Carpathians and surrounding areas.

The aim of the first map is to outline the dominant composition and regional distribution of the principal tectonostratigraphic units. The units are specified according to the paleogeographic and paleotectonic principles (e.g. the time of structuralization), less based on the lithostratigraphic and deformation criteria. In general, the map is stripped off the "post-tectonic" sedimentary and/or volcanic cover superimposed on the tectonic edifice formed during the main Alpidic compressive events. Thirty one items of the legend comprise superunits of the Alpine-Carpathian foreland and the orogenic zone itself.

The structural map depicts the most important macro- to megascopic structures, especially antiforms, synforms, large-scale recumbent folds, buried horsts, low-angle thrust faults, high-angle con-tractional (reverse) faults, extensional normal faults and strike-slip and/or oblique-slip contractional and extensional fault zones. Narrow spacing of reverse faults indicates imbricated tectonic style, the com-bination of reverse faults and synforms or antiforms defines fold-and-thrust belts. Coincidence of several kinematic types of faults in one line points to re-peated reactivations of a long living "lineaments" (usually former sutures) with changing kinematic role through time. Five temporal periods of formation of principal structures shown (Paleozoic-Middle Jurassic, Late Jurassic-Early Cretaceous, Late Cretaceous, Paleogene-Early Miocene and Neo-gene) are distinguished by different colours. Based on the age of the main phase of structuralization and dominating tectonic styles, two principal structural-tectonic provinces may be recognized in the map. These are the Alpine-Carpathian foreland (North European Platform) and the Alpine-Carpathian orogenic belt. The former obtained its fundamental structural features already in pre-Alpine times, the latter exhibits polyphase Alpidic evolution and a wide range of tectonic styles.

The Southern Alps - Dinarides relationship

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According to the classic division of the Alps, the area south of the Periadriatic line belongs to the Southern Alps. These in general include the Southern Karavanken and Carnic Alps, the Julian Alps and Dolomites and the Sava hills (Sava folds) of Central Slovenia.

The division of the Dinarides originates from the Kober's "bilateral orogen" that determines the External, Central and Internal zone. However, only the terms External and Internal Dinarides have been in common usage. The area to the south, i.e. the Adriatic basin bears different geotectonic names.

The cross-section from the Adriatic basin to the Periadriatic line, at least in Slovenia, shows a