Central and Eastern Alps is characterized by strain partitioning into vertical thickening, orogen-parallel extension and lateral escape. The amount of "lateral extrusion", held responsible for the formation of the Carpathian arc by many workers, has been overestimated in our view.

The Alps-Dinarides superposition in NE Italy - observations and models from two interfering foldbelts

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The eastern Southern Alps are a complex, arcuate fold-and-thrust belt that developed at the north-eastern edge of the Adriatic (or Apulian) microplate. The present day, intricate architecture of this belt is the combined result of (1) Mesozoic rifting, basin and carbonate platform formation, (2) Cretaceous to ongoing plate convergence between Apulia and Europe with major changes in convergenc direction in the course of time, (3) the shape of the indenting Apulian microplate.

Rifting lead to swells with intermediate basins during early Liassic. Various high zones drowned during late Liassic, but the Friuli carbonate platform comprising the southernmost hills of Cadore and Carnia, and large parts of the Venetien plain remained high as long as to the Paleocene.

Flysch sequences date the Dinaric deformation as mainly late Paleocene to early Eocene. One of the peculiarities of the NW part of the Dinarides is the absence of metamorphism although some 250km of exposures exist across strike. This calls for a very low taper and long detachments along efficient decollement horizons. W to WSW-vergent Dinaric ramp-folds and ramp-flat thrust systems are well documented in the eastern and central Dolomites. In the Carnian Alps adjoining to the east they are less obvious, possibly due to the mentioned decollements. In the Mesozoic basinal sequences (N) the front of Dinaric thrusting advanced more to the west than in the Friuli platform (S), creating sinistral transverse zones following approximately the ancient paleogeography.

Alpine deformation began during late Miocene, extensive seismicity and folded Quaternary deposits indicate ongoing activity. The eastern South Alpine belt is located at the northern edge of the actual Adriatic microplate. It is a classical brittle fold-and-thrust belt with ramp-flat thrust trajectories and ramp-folds, three major thrust sheets with basement envolvement, and increasingly older sequences exposed towards the internal parts (N). Complex transverse patterns resulted from interferences with Paleogene (Dinaric) and Mesozoic structures. To the W, the belt ends at the Schio-Vicenza line (some 50km west of Venice) where the shortening is transferred southwards across the Po plain to the Apennines. To the E, the belt looses shortening (from some 55km in the eastern Dolomites to some 30km in western Slovenia) and gets gradually replaced by SE trending dextral strike-slip faults, that follow the NE Border of the Adriatic plate across Croatia and Bosnia towards Albania.

Miocene and Plio-Pleistocene volcanism of the Styrian and Klagenfurt Basins (Eastern Alps, Austria): geochemistry and geodynamic implications

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In the Neogene Styrian and Klagenfurt Basins, Alpine post-collisionextensional volcanic activity took place in Karpatian-early Badenian (K/Ar-ages: 16.8-14.9 Ma) and in late Pliocene-early Pleistocene (K/Ar ages: 3.8-1.7 Ma). The petrogenetic affinity changed from orogenic-type in the Miocene to anorogenic-type in the Plio-Pleistocene. Petrography, major (XRF) and trace (XRF, INAA) elements have been carried out on volcanics from numerous Miocene (outcrops and boreholes) and Plio-Pleistocene centres.

The Miocene lavas have a variable serial affinity, ranging from calkalkaline/high-K calk-alkaline (Kollnitz) to high-K calk-alkaline (Weitendorf, Mitterlabill) up to shoshonitic (Gleichenberg, Walkersdorf, Paldau). In the most voluminous Miocene volcano (Gleichenberg, 16.3-15.5 Ma) latites are the dominant lithotype; here trachytic and rhyolitic lavas locally occur. To the west, outcropping products are represented by relatively primitive (Mg# 66-70) basaltic andesites/high-K andesites (Kollnitz, 14.9 Ma) and high-K basaltic andesites (Weitendorf, 16.8-16.0 Ma). Boreholes samples are latites (Paldau and Walkersdorf) and high-K dacites (Mitterlabill). Incompatible trace element patterns of all the Miocene lavas, normalized to primitive mantle (Sun and McDonough, 1989), show a moderate negative Nb-, Ta- and Ti-anomaly and high LILE/HFSE ratios, typical of "subduction-related" magmas. On geochemical basis, three groups of rocks can been distinguished: the first, Gleichenberg latitestrachytes and Walkersdorf latites, have negative Ba-anomaly in respect to Rb and Th; the second, Weitendorf high-K basaltic andesites, Paldau latites and Mitterlabill high-K dacites show a small negative Ba-anomaly. Otherwise they share similar incompatible trace element patterns, including a significative negative Eu-anomaly in chondrite-normalized REE diagrams. The rocks of these two groups, all from the Styrian Basin, are geochemically clearly distinguishable from the Klagenfurt Basin volcanism, represented only by basaltic andesites and a high-K andesite from Kollnitz. These latter have a marked positive Th-anomaly and a steep chondrite normalized REE pattern with a strong LREE enrichment and no significative Eu-anomaly. The geochemical and petrological data so far obtained for the Miocene volcanism are compatible with a genesis by partial melting of a lithospheric mantle enriched by "subduction-related" components derived from the European lithosphere during the Paleogene N-S convergence which characterized the Eastern Alps/westernmost Carpathian transect. Such a delayed melting of a recently enriched lithospheric mantle is considered to be related to Miocene extensional collapse of the Eastern Alpine chain leading to the formation of the Pannonian Basin.

The studied Plio-Pleistocene volcanics are strongly silica-undersaturated and have a typical Na-alkaline affinity. They are mostly represented by lavas, except two vesiculated lava-like xenoliths within the pyroclastic rocks of Kalvarienberg and Riegersburg.

Their compositional variation roughly range from nephelinites (Wilhelmsdorf and Steinberg), to basanites (Steinberg, Klöch, Kindsbergkogel, Riegersburg).

The overall incompatible element pattern of the Plio-Pleistocene lavas is within the range of OIB; in respect to the OIB-average of Sun and McDonough (1989), they show an increasingly strong enrichment toward the most incompatible elements from P to Rb, which is in accordance with their strong silica-undersaturated character. In the Ba/Nb vs. K/Nb diagram these rocks plot in a narrow area, between the fields of Tristan da Cunha and St.Helena Islands. All these data are compatible with a derivation from low degrees of partial melting of an asthenospheric source.

Paleozoic evolution of the Tethyan domain

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Terranes now amalgamated in the Variscan orogen of southern Europe, formed a single ribbon like continent formerly attached to the northern side of Gondwana. This super-terrane detached from Gondwana in Silurian to form the northern margin of the Paleotethys. The western end of the super-terrane collided in late Devonian with the Laurentia-Baltica margin. The northern Paleotethyan elements are then incorporated into the Laurussian active margin as separate terranes: Mid and Central European and Intra-Alpine terranes.

Subsequently the Paleotethys started subducting northward under the accreted terranes. Terrane accretion and subduction of the Paleotethys have been responsible for the Variscan orogeny in Europe accompanied by crustal thickening up to a Cordillera stage in late Early Carboniferous. Then Gondwana and Laurussia are entering in a final continent-continent collision. The final closure of the oceanic domains is placed in Late Carboniferous. Crustal thickenning and arc magmatism during that period are rapidly followed by a general collapse of the Carboniferous active margin accelerating the closure of the remaining space between both super continents during the Late Carboniferous-Early Permian.

The northern orogenic areas have been affected by rifting since Carboniferous, starting with a major break-up along the Caledonian suture zone. In Late Carboniferous and Permian it is the Variscan accretionary complex which is affected by rifting. East of a paleo-Apulian promontory, this rifting graded into back-arc spreading (Hallstatt-Meliata marginal basin). The final closure of Paleotethys in these areas took place later between a migrating arc detached from Eurasia and a super-terrane derived from Gondwana, the Cimmerian continents.

On the Gondwana margin rifting took place first in Early Carboniferous certainly as a result of the partial collision with Laurussia at that time. But it is only when the Paleotethys engaged in an advanced stage of subduction that the Cimmerian blocks were removed from the Gondwana margin (inner Dinaro-Hellenides) to give birth to the Neotethys extending into the East-Mediterranean area.

The Cimmerian super-terrane comprises also a peri-Apulian plate domain: Tunisia, Sicily and southern Apulia and the Apulian elements from the Dinarides, Hellenides and Taurides. Due to a lack