based on paleo-heat flow estimates, indicate a similar increase in lithospheric strength with time. The impact of Plio-/Pleistocene volcanism on rheology appears to be relatively modest, which can be explained by a deep position of the magma chamber for this event.

Tertiary Basins in Slovenia

Reinhard F. Sachsenhofer[1], Bogomir Jelen[2], László Fodor[3], Emö Márton[4], Dragomir Skaberne[2], Joze Car[5] and Marko Vrabec[5]

[1] Department of Geosciences, University of Leoben, Austria
[2] Institut za Geologija, Geoloski Zavod Ljubljana, Slovenia
[3] Department of Applied and Environmental Geology, Eötvös Loránd University, Budapest, Hungary
[4] Geophysical Institute, Eötvös Loránd University, Budapest, Hungary
[5] Department of Geology, University of Ljubljana, Slovenia

Tertiary basins in eastern Slovenia form part of the Pannonian Basin System. They are situated at the junction between the Eastern Alps, Southern Alps, Dinarides, and the Pannonian realm. Major WNW-ESE to E-W trending fault zones (Periadriatic and Donat shear zones, Sostanj and Sava-Celje faults) separate different tectonostratigraphic units.

North of the Donat Line (Units A1, A2) the oldest Tertiary sediments are Eocene (Paleocene?) in age. After a phase of major erosion, more than 5000 m thick sediments were deposited during Karpatian to late Miocene times. Oligocene and/or early Miocene magmatism (Pohorje tonalite) and early Miocene dacitic volcanism are important features of Unit A1 (north of the Periadriatic Lineament).

South of the Donat Line (Units B1, B2) the oldest Tertiary sediments including andesitic tuffs are of Oligocene and lowermost Miocene age. Badenian to late Miocene sediments follow after a stratigraphic gap.

Sediments of Unit A1 (north of the Periadriatic Line) exhibit consistent CCW rotation of about 30°. Unit B2 (Sava Folds) is characterized by moderate (20 to 30°) CW rotations. The rotations must be younger than Badenian. Units A2 und B1 are more complex and both CW and CCW rotations occur. However, CW rotations are far more frequent. These rotations must have occurred in post-Karpatian time, probably simultanously with movements in Units A1 and B2.

Brittle deformation of NE Slovenia was characterized by NNW-SSE (NW-SE to N-S) compression and perpendicular tension. The above fault zones were characterized by dextral strike-slip. This deformation was associated with folding and verticalisation of beds. Dextral transpression took place during the early Miocene (Ottnangian, Karpatian), reoccurred several times during the late Miocene and Pliocene, and lasted to the Quaternary. Situated between the major shear-zones, the Smrekovec area (Unit B1) is characterized by sinistral transpression, while the Savinja block was affected by dextral transtension. In the Mura depression NE-SW tension occurred, probably during the middle and late Miocene.

Several magmatic phases and high rates of vertical and horizontal movements resulted in a complicated thermal history. Early to middle Miocene thermal events occurred in Unit A1 (e.g. Pohorje and Gora Radgona areas). Coalification data indicate Paleogene and/or early Miocene thermal events along the Periadriatic Lineament in Units A1 and A2. Present-day heat flows are high (70 to 120 mW/m^2). This is a result of thinned crust.

Paleogeographic and orogenic evolution of the Alps

Stefan M. Schmid and Nikolaus Froitzheim

Geologisch-Paläontologisches Institut der Universität Basel, Switzerland

The paleogeographic evolution of the Alps during the Mesozoic was controlled by three basins partly underlain by oceanic lithosphere: the Meliata-Hallstatt basin (opened in the Middle Triassic, closed in the Late Jurassic), the Piemont-Liguria basin (opened in the Middle Jurassic, closed in the Paleogene, and the Valais basin (opened in the Late Jurassic to Early Cretaceous, closed in the Eocene). Some paleogeographic domains cannot be traced all along the Alpine chain: There are no Austroalpine units (in the strict sense) in the Western Alps while there is no Briançonnais in the Eastern Alps, where Valais and Liguria-Piemont oceanic domains merge.

Cretaceous orogeny is the result of (1) collision between the Austroalpine continental crust and another continent further to the east (Eastern Alps) and of (2) subduction of oceanic crust and/or continental fragments (Sesia zone eclogites) under the Austroalpine-South Alpine margin (Western and Central Alps). Collision with the Briançonnais terrain and European distal margin is related to a second orogenic cycle during the Tertiary, also associated with eclogite facies metamorphism (Dora Maira-Adula-Tauern). Tertiary-aged N-S convergence amounts to 500 km in the Central Alps (and probably also the Eastern Alps) while E-W shortening in the Western Alps is essentially post-collisional, post-dating sinistral strike slip movement related to N-S-shortening in the Central and Eastern Alps. Post-collisional shortening in the

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

Gregor Schoenborn

Geological Institute, University of Neuchatel, Switzerland

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

Giancarlo Serri[1], Alberto Renzulli[1], Hans Kolmer[2] and J. Dostal[3]

[1] Istituto di Vulcanologia e Geochimica, Urbino, Italy
[2] Institut für Technische Geologie, Petrographie und Mineralogie, Graz, Austria
[3] Department of Geology, Halifax, Canada

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 latites-