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Tectonics of the Alpine–Carpathian–Pannonian region: introduction

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1. Introduction

Research on the Alpine–Carpathian–Pannonian system intensified during the past decade because of several reasons. These include the following.

(1) The specific nature of late-orogenic intracontinental extrusion processes with orogen-parallel displacement due to indentation by the rigid Southalpine/Apulian indenter, and formation of various sedimentary basins in the interior of the arcuate orogen. The ongoing research on Cenozoic/Neogene basins has shown the need for quantitative understanding of vertical motion of the underlying basement, as well as better understanding of the thermal and mechanical properties of the lithosphere underlying the various basins (Genser et al., 1996). At the same time, it has become apparaent for more structural studies to unravel the complex tectonic history of basins.

(2) The pre-collisional history, which includes a complex system of oceanic and continental plate boundaries, is not fully understood.

(3) The Phanerozoic history of the Alpine–Carpathian–Balkanian orogenic belt that is entirely different its geological evolution from the adjacent Russian platform.

Because of these factors, many international projects and workshops are dealing with various aspects of the considered region. Among these, the ALCAPA project ('Geological evolution of internal Alps, Carpathians and of the Pannonian basin') was one of the first, and was partially funded by Austrian authorities after the political opening of eastern European countries. A first volume of ALCAPA results that concern mainly the Mesozoic evolution of the region has been published previously (Neubauer et al., 1995). Many contributions to integrated reasearch on the Pannonian basin system have been published in two other Tectonophysics volumes (Cloetingh et al., 1993, 1995). Further results on Alpine (including some Carpathian) geology were recently published in a special volume of *Eclogae Geologicae Helvetiae* that is an outgrow of a meeting on 'Alpine geology' held at Basel, January 1995 (Froitzheim et al., 1996).

The present issue of Tectonophysics is an outcome of a meeting held in Romania (Covasna, October 14–24, 1994), the second major one within the ALCAPA project. The ALCAPA project has strong links with a number of programs funded by international scientific agencies. These include a.o.: The Task Force of 'Origin of Sedimentary Basins' of the International Lithosphere Program, and the PANCARDI project of the Europrobe program of the European Science Foundation.

2. Models and constraints

The papers in this special issue focus on the processes that operate on different scales. The main emphasis is on integrated research in the borderland

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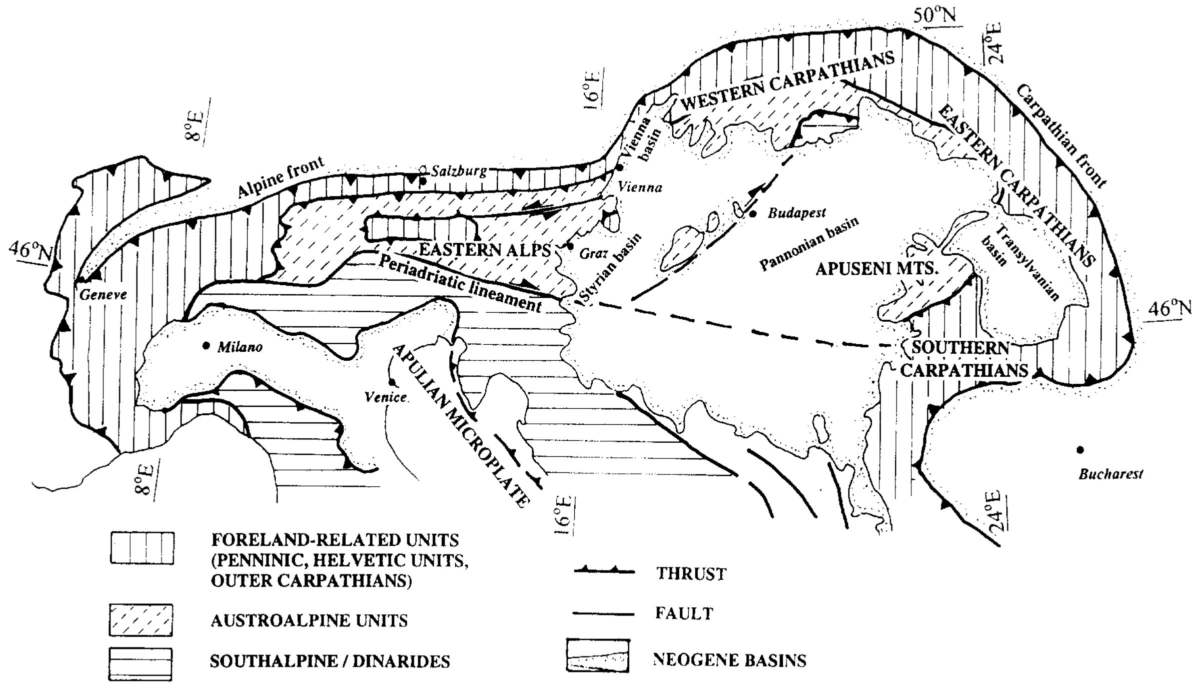

Fig. 1. Distribution of major geological units within the ALCAPA area.

between regional studies, lithospheric structure, and tectonic modelling. It includes mainly studies that yield constraints on the post-collisional history of the Alpine–Carpathian mountain belt and the associated sedimentary basin formation (Fig. 1). Contributions dealing with the Alpine development are presented first in a sequence from Alps to Carpathians followed by some papers that contribute data to the pre-Alpine history.

Linzer et al. (1997) discuss kinematics of nappe piling and subsequent dismembering of the Northern Calcareous Alps, a classical fold-and-thrust belt with a long and complex contractional history. These authors address the Late Cretaceous to Eocene top-NW internal nappe stacking, and later top-N emplacement of these units onto the European foreland units. The nappe pile was overprinted by Miocene strike-slip faulting mainly along a major and complex fault zone along which the structure is largely influenced by local heterogeneities. Peresson and Decker (1997) concentrate on the eastern portion of the same area, and arrive at similar conclusions. They constrain the important E–W extension, and subsequent post-Middle Miocene E–W contraction. They discuss possible causes of the E–W-contraction that is postulated in the collisional stop in the eastwards located Carpathian/European foreland boundary.

The late Palaeogene to Miocene history of Eastern Alps and Carpathians is largely related to the change from collision to subsequent strike-slip faulting, exhumation of previously buried metamorphic sequences, surface uplift and sedimentary basin formation. Hejl (1997) presents apatite fission track data from the Austroalpine units of east of the Tauern window. He shows a pattern of early Palaeogene cooling ages within Austroalpine units that are entirely unrelated to, and apparently unaffected by later strike-slip faulting and extension. Sachsenhofer et al. (1997) modelled subsidence data of the Miocene Styrian basin, and provide quantitative evidence for a very low effective elastic thickness of the Austroalpine units which is consistent with the occurrence of the Miocene Rechnitz metamorphic core complex to the east of this basin. Cooling of the Rechnitz metamorphic core complex is constrained by zircon and apatite fission track data by Dunkl and Demeny (1997). These authors also modelled the uplift rate derived from these new data demonstrating that the cooling rate was high during initial stages of the Early Miocene exhumation, and significantly lower during late stage uplift.

Rantitsch (1997) presents evidence, based on analysis of illite crystallinity, coal rank, microthermometry, of Alpine very low- to low-grade metamorphic overprint within the Southalpine unit along the Periadriatic fault that separates this unit from the Austroalpine units. This opens the question what process may be related to the overprint, e.g. the intrusion of tonalites as the effect of post-collisional slab break-off (Blanckenburg and Davies, 1995).

Szafián et al. (1997) modelled the lithospheric structure beneath the Pannonian extensional basin and its surroundings. Significant differences of the gravity field exist between the Western Carpathians where evidence of the subducted lithosphere is absent, and Southern Carpathians where the presence of a subducted slab can be resolved from the gravity record. These findings are consistent with contraction that ceased in the Western Carpathians during the Miocene and later and continued in the Southern Carpathians through the Pliocene (e.g., Meulenkamp et al., 1996; Posgay et al., 1996; Linzer, 1996).

Huismans et al. (1997) discuss the structural evolution of the Transylvanian basin that developed within the inner bend zone of the Eastern to Southern Carpathians on crust that was deformed during mid-Cretaceous orogenic events. They present new data in support of the complex polyphase history of the Transylvanian depression/basin that initially formed as a rift basin during the Late Cretaceous, and that was transformed into a foreland basin character during the Palaeogene, followed by an extensional basin phase in the Miocene. These major subsidence phases were separated by mostly contractional and/or extensional orogenic events that affected the basin fill (see also Linzer, 1996).

Lankreijer et al. (1997) modelled lateral variations of lithospheric strength in the Romanian Carpathians and relate strengths with formation of peripheral foreland basins along outer margins of the Carpathians.

Oncescu and Bonjer (1997) discuss microseismicity and strain release of the large Vrancea earthquakes in the Romanian Carpathians that are interpreted to result from a detached sinking slab beneath the Outer Carpathians.

Constraints on the pre-Alpine, Palaeozoic history of the ALCAPA region are presented by two contributions: Haydoutov and Yanev (1997) briefly discuss the Palaeozoic geological development of the Moesian microcontinent that is exposed within the Balkan peninsula. This microcontinent comprises two Palaeozoic terranes: a combined Late Precambrian to Cambrian ophiolite/island-arc sequence forms the Balkan terrane, and a Proterozoic to Vendian metamorphic sequence of continental affinity forms the Moesian terrane. These terranes also differ in Palaeozoic evolution of sedimentary sequences deposited on each unit. These are in line with the terrane concept applied to the eastern Mediterranean Alpine to Himalayan mountain belts where the Phanerozoic tectonic evolution is explained by accretion of various Cadomian and Variscan terranes to the southwestern European margin (Ebner et al., 1996).

The contribution of Schermaier et al. (1997) reviews the Austroalpine Variscan granites in the Eastern Alps, and displays compelling evidence of a two-stage tectonic development with earlier subduction-related granites, and later collisional type ones.

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