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Introduction

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INTRODUCTION

The Carpathians represent the eastern extension of the European Alps (Figure 1), but unlike the well-known classical Alps of Western Europe, the Carpathians of Central and Eastern Europe remain less known and are even somewhat mysterious to the outside world. The tumultuous political history as well as the language barriers prevented ideas and information from flowing freely through and outside the region. However, the area greatly contributed to the common knowledge in science and technology. Enormous amounts of geological work have been conducted, and thousands of papers have been published on the geology of the Carpathian region during the past 200 yr (see references in various articles of the volume). However, because of the language barriers and diverse concepts and interpretations, it is not easy for students of Carpathian geology and potential investors to cut through all the information and to get a clear picture about the geology and the hydrocarbon potential of the region. This situation has been well known to the editors of this volume, who both worked in the Carpathians and also spent a great deal of their careers in the American petroleum industry and had a chance to see the Carpathians from the view of outside world. In the early spring of 2000, they met in Krakow, where Jan Golonka, after retiring from Mobil, had just begun his new career as a professor at the Jagiellonian University and Frank Picha, after retiring from Chevron, had completed his AAPG Distinguished Lecture tour through the countries of Eastern Europe and the former Soviet Union. It was Jan Golonka's proposal to improve the worldwide visibility of the Carpathians by publishing an AAPG Memoir and Frank Picha's enthusiastic acceptance of the idea that started the hectic process of submitting proposals, forming international teams of authors, securing financial support, writing, and editing the manuscripts. It took 5 yr of intensive work to complete the task of publishing this volume, which, as we hope, would make the interesting geology of the Carpathians better known to the outside world.

The editors' intention is to overcome some of the communication problems and to provide the outside world with a comprehensive and understandable account of the complex geology and hydrocarbon potential of the entire Carpathian system, including the thrust belt, its foreland, and the late orogenic intra-Carpathian basins. Major attention is paid to petroleum systems and case studies of major oil and gas fields in order to provide an insight into past and present exploration and production activities in the region. Seventeen years have passed since the publication of the highly successful AAPG Memoir 45 on the Pannonian Basin edited by Royden and Horvath (1988). Our ambition is to provide an equally well-balanced and well-written account on the entire Carpathian system.

This publication is intended as a source of information to schools, governmental and private institutions, oil companies, and generally, to all geologists working both inside and outside the region. It should also provide qualified information about the hydrocarbon resources of the Carpathian region and give

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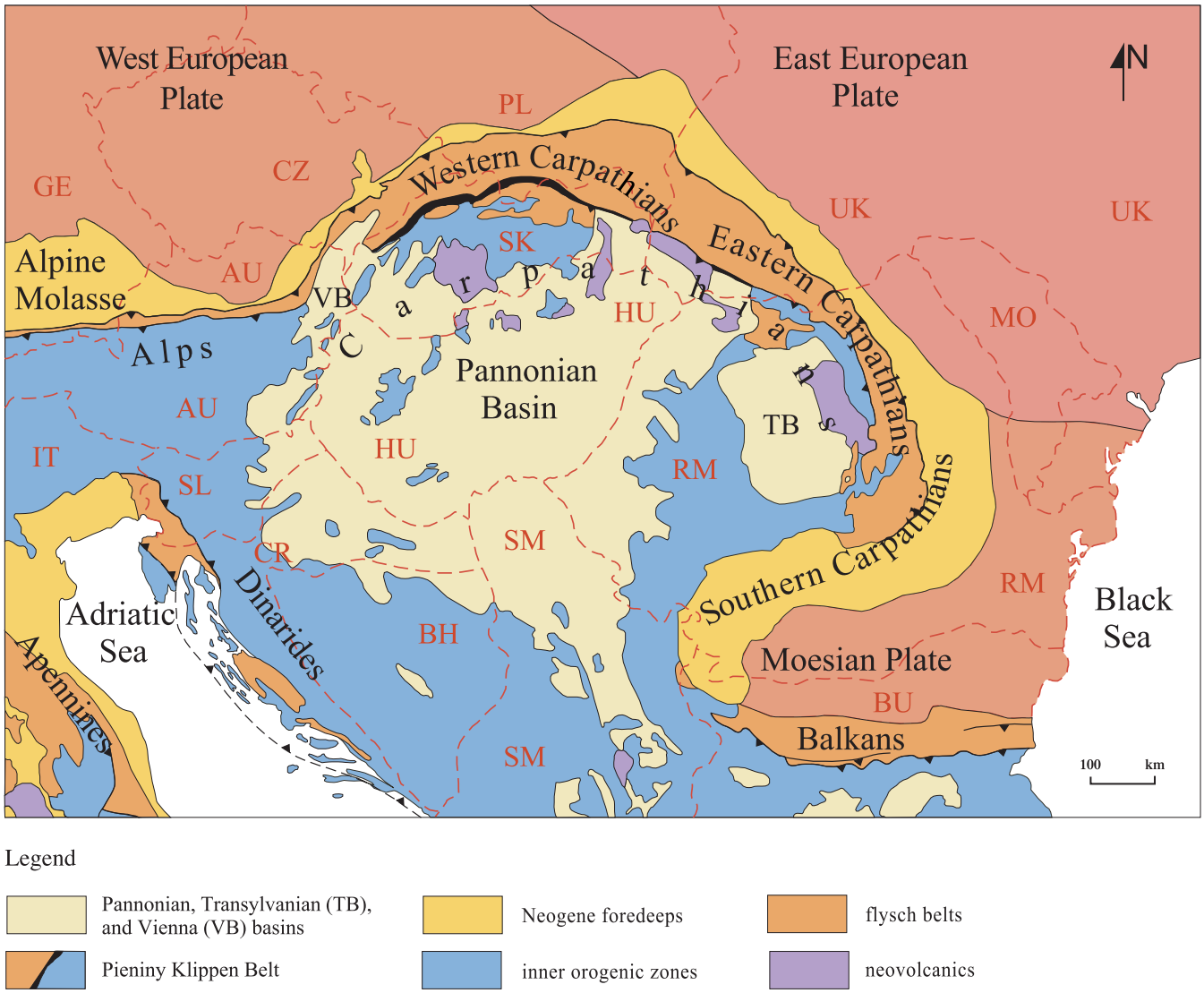

Figure 1. Index map of the Carpathians and the surrounding regions (modified after Picha, 1996). AU = Austria; BH = Bosnia and Herzegovina; BU = Bulgaria; CR = Croatia; CZ = Czech Republic; GE = Germany; HU = Hungary; IT = Italy; MO = Moldova; PL = Poland; RM = Romania; SK = Slovakia; SL = Slovenia; SM = Serbia and Montenegro; TB = Transylvanian basin; UK = Ukraine; VB = Vienna basin.

potential investors some guidance in pursuing various opportunities both in the redevelopment of the older fields and in the exploration for new reserves in the Carpathian thrust belt and its foreland.

THE PAST AND PRESENT STATUS OF THE CARPATHIAN GEOLOGY

The Carpathians extend over the territories of seven countries of Central and Eastern Europe (Figure 1), with a complex political and economic history and equally complex history of scientific and technical endeavors in the field of earth sciences and petroleum industry. The Carpathian region is one of the classical territories of the world, where some concepts of geology and petroleum geology were formulated and the petroleum industry was born. It was in the Carpathian region where, in 1853, the first oil well (Bobrka) was drilled; crude oil distillation was discovered by Lukasiewicz in Galicia, presently Poland (Karnkowski, 1999); the first industrial production of hydrocarbons was established in Romania in 1857 (e.g., Dicea, 1996); and the organic origin of oil was proposed (Zuber, 1918).

After the Second World War, for more than 40 yr, the countries of the Carpathian region were isolated from the rest of the Europe, and their geology evolved under different ideological and economic doctrines. On the one hand, enormous money was spent in search of mineral resources, including hydrocarbons. On the other hand, the ideological constraits, utmost secrecy, and limited flow of information from the western world led to theoretical and technological lagging in some areas of earth sciences. However, even during this time, significant achievements in understanding of Carpathian geology and hydrocarbon potential were accomplished. In the 1950s, the Carpathian Flysch belt served as one of the main territories in which the original concept of deep-water turbidites was formulated (Ksiazkiewicz 1954; Dzulynski et al., 1959). Thanks mainly to the Polish school (e.g., Dzulynski and Slaczka, 1958; Dzulynski, 1963, 1996; Dzulynski and Walton, 1963, 1965), the Carpathian Flysch became one of the best and thoroughly studied turbiditic facies exposed on land anywhere. It has commonly been compared with the deep-water sequences of the Apennines (e.g., Pescatore and Slaczka, 1984) and the Ouachita Mountains of Arkansas and Oklahoma (e.g., Golonka and Slaczka, 2000). In many aspects, the Carpathian Flysch, famous for its complexity and diversity, may serve as a model in exploration of hydrocarbons in deep-water deposits both along modern continental margins and in orogenic belts. Likewise, thanks to an intensive exploration for hydrocarbons and the publication of AAPG Memoir 45 (Royden and Horvath 1988), the late orogenic Pannonian Basin overlying the Alpine–Carpathian belt has become one of the best known back-arc extensional basins in the world. Numerous studies were also conducted on various aspects of the geodynamic evolution of the Carpathian region, the most comprehensive version being published by Golonka et al. (2000), and on the kinematics of the Outer Carpathian foreland fold and thrust belt (e.g., Roure et al. 1993). Since the early 1960s, growing attention was paid to the exploration for hydrocarbons underneath the thin-skinned Outer Carpathian thrust belt. Numerous deep wells have been drilled, and valuable new resources of hydrocarbons have been found, especially in the territory of the Czech Republic and Austria. The Carpathian region may thus serve as one of the best examples of exploration for hydrocarbons under the thin-skinned orogenic belts (Wessely, 1990; Picha, 1996). From numerous recent publications dealing with these accomplishments in Carpathian geology, perhaps two volumes, *Oil and gas in Alpidic thrust belts and basins of Central and Eastern Europe* (Wessely and Liebl, 1996) and *Peri-Tethys Memoir 2: Structure and prospects of Alpine basins and forelands* (Ziegler and Horvath, 1996), are the most comprehensive and informative.

The profound political changes that occurred in Eastern Europe in the early 1900s have had a significant impact, both positive and negative, on the geological activities in the Carpathian region. At the time of publishing this memoir, several nations in the Carpathian realm are still undergoing political and economic transformation, and some of them have already been admitted into the European Union. Geological institutions, universities, and extraction industries have been deeply affected by these changes. The geologists of the strong postwar generation are retiring and are not always replaced by younger colleagues. Large amounts of knowledge and experience, especially in the area of regional geology and past hydrocarbon exploration, are in a danger of being lost. At the same time, new technologies and concepts are being applied both in the theoretical and applied sciences. It is one of the intentions of this volume to bridge, at least partly, the gap between the past and present concepts and developments. For that reason, both senior traditional geologists and their younger technologically oriented colleagues were selected to contribute to this volume. Most of them have already published significant articles on geology and hydrocarbon potential of the Carpathian region and presented their contributions at various conventions and conferences. The mixture of authors from universities, national geological surveys, and industry should guarantee a balanced assembly of academic and industrial views.

THE STRUCTURE OF THE PUBLICATION

The volume is not a mere assemblage of chapters dealing with selected topics of the Carpathian geology but rather an attempt to put together a comprehensive account of the entire spectrum of regional and applied geology of the Carpathian realm (Figure 2). To accomplish this goal, we have combined main regional articles with contributions dealing with specific aspects of geology, geophysics, and hydrocarbon resources. Altogether, 30 articles authored by 107 geologists and geophysicists from Austria, Czech Republic, Hungary, Poland, Romania, Slovakia, Ukraine, U.K., and U.S.A. have been included in this volume (Figure 2). The written contributions are supplemented by numerous regional geological and geophysical maps and correlation charts, enabling better orientation throughout the entire region.

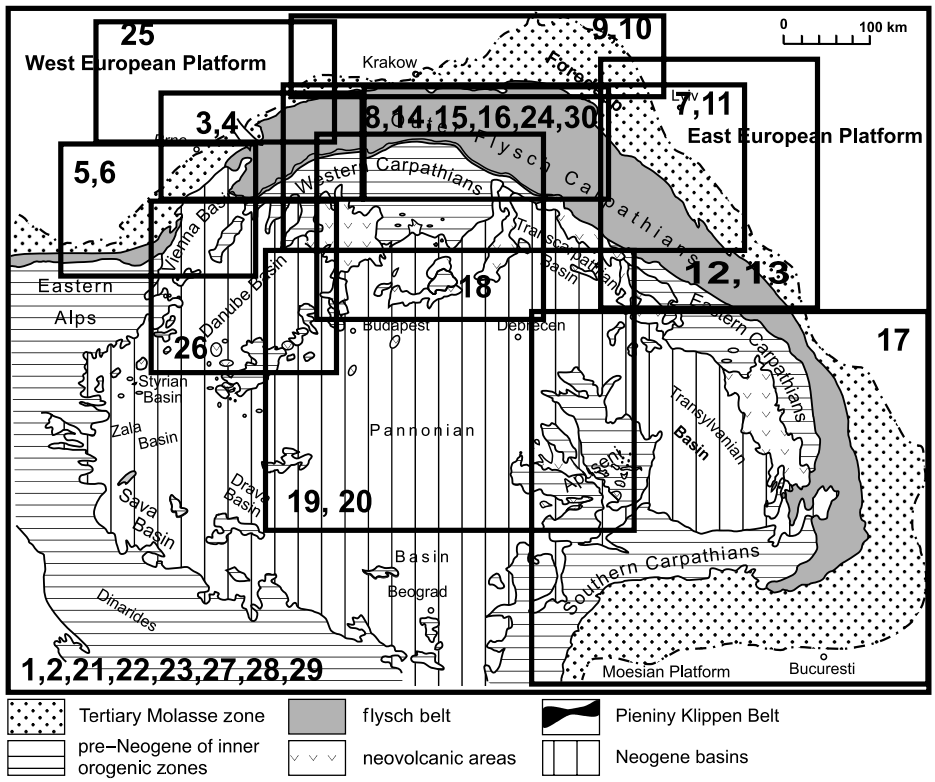

Figure 2. Index map of the Carpathians and the surrounding regions. Areas covered by various chapters of this volume are outlined and numbered. Geology simplified after Kovac et al. (1998). 1 = chapter 1 (Golonka and Picha); 2 = chapter 2 (Golonka et al.); 3 = chapter 3 (Picha et al.); 4 = chapter 4 (Kostelnicek et al.); 5 = chapter 5 (Arzmuller et al.); 6 = chapter 6 (Fuchs and Hamilton); 7 = chapter 7 (Slaczka et al.); 8 = chapter 8 (Dziadzio et al.); 9 = chapter 9 (Oszczypko et al.); 10 = chapter 10 (Mysliwiec et al.); 11 = chapter 11 (Kotarba and Koltun); 12 = chapter 12 (Popadyuk et al.); 13 = chapter 13 (Popadyuk et al.); 14 = chapter 14 (Dziadzio); 15 = chapter 15 (Dziadzio et al.); 16 = chapter 16 (Matyasik and Dziadzio); 17 = chapter 17 (Stefanescu et al.); 18 = chapter 18 (Janocko et al.); 19 = chapter 19 (Tari and Horvath); 20 = chapter 20 (Magyar et al.); 21 = chapter 21 (Pospisil); 22 = chapter 22 (Pospisil et al.); 23 = chapter 23 (Bielik and Adam); 24 = chapter 24 (Stefaniuk); 25 = chapter 25 (Hrusecky et al.); 26 = chapter 26 (Hrusecky); 27 = chapter 27 (Nemcok et al.); 28 = chapter 28 (Nemcok et al.); 29 = chapter 29 (Golonka et al.); 30 = chapter 30 (Sozanski et al.).

Considering the geological subdivision of the Carpathians as well as the historically evolved national groupings, the chapters were assembled into six major regional and thematic blocks (Figure 2).

1) *The geology and hydrocarbon resources of the Outer Western Carpathians and their foreland on the territory of northeastern Austria and Moravia in the Czech Republic*

The regional account on the westernmost sector of the Outer Carpathians adjacent to the Bohemian Massif by Picha et al. emphasizes the correlation of the Alps and Carpathians, as well as the impact of the newly defined Western Carpathian transfer zone and the Dyje–Thaya depression on the geological history of this region. Deep drilling and advanced exploration for hydrocarbons underneath the thin-skinned Outer Carpathian thrust belt enabled the formulation of critical concepts of the subthrust petroleum systems in the Carpathians and elsewhere (Wessely 1990; Picha, 1996). Examples of recently discovered subthrust fields in Moravia are presented by Kostelnicek et al. The geology and petroleum system of the highly prolific Vienna basin is dealt with in a contribution by Arzmuller et al. Fuchs and Hamilton discuss the depositional architecture of the giant Matzen field in the Vienna basin.

2) *The geology and hydrocarbon resources of the Outer Western Carpathians and their foreland on the territory of Poland and Ukraine*

This is the classical area of the flysch geology on which some of the concepts of deep-water turbiditic sedimentation were formulated (see above).

The regional geology of the Carpathian thrust belt is presented by Slaczka et al.; the hydrocarbon resources of the Polish Carpathians are described by Dziadzio et al. The Carpathian Foredeep and the European foreland are thoroughly discussed by Oszczypko

et al. and their hydrocarbon resources by Mysliwiec et al. The chapters by Kotarba and Koltun and by Popadyuk et al. deal with the hydrocarbon habitat of the Polish and Ukrainian Carpathians, which are among the oldest producing provinces of the world. The oil and gas fields of the Carpathian foreland and of the Boryslav–Pokuttya zone are presented by Popadyuk et al.; the Weglowka oil field in the Polish flysch belt is described by Dziadzo. The depositional architecture of the Ciezkowice Sandstone is discussed by Dziadzio et al., and the petroleum systems of the Polish Carpathians are presented by Matyasik and Dziadzio.

3) *The geology and hydrocarbon resources of the Eastern and Southern Carpathians on the territory of Romania*

The geology and the hydrocarbon potential of the Romanian Carpathians and their foredeep are presented by Stefanescu et al. Despite the long production history, beginning in the middle of the 19th century, the Romanian territory still represents an important hydrocarbon province of Europe.

4) *The geology and hydrocarbon resources of the Inner Carpathians and the Pannonian Basin on the territory of Slovakia and Hungary*

The complex geology of the Inner Carpathians, including the late orogenic and postorogenic basins in Slovakia and some adjacent areas, is presented by Janocko et al. The geology of the Pannonian Basin, well known from the AAPG Memoir 45 (1988), is briefly overviewed and updated by Tari and Horvath. Magyar et al. describe the largest oil and gas field, Algyo, in the Pannonian Basin.

5) *Crustal and lithospheric structure of the Carpathian–Pannonian region: A geophysical perspective*

The geophysical segment begins with a historical review of the crustal and lithospheric studies in the Carpathian region compiled by Pospisil and Adam. The main results of various regional geophysical surveys and studies are assembled in an account by Pospisil et al. for the entire Carpathian region. This account, authored by numerous geophysicists from several countries, presents a vast compilation of various geophysical data, including numerous maps and diagrams. The following six interpretive contributions deal with various aspects of crustal and lithospheric studies: the structure of the lithosphere by Bielik and Adam; the magnetotelluric survey by Stefaniuk; the North European platform below the Carpathian Flysch belt by Hrusecky et al.; the bivergent lithospheric extension in the Danube basin by Hrusecky; the timing of the tectonism as related to the rollback process in the lithosphere by Nemcok et al.; and the subduction of the Carpathian remnant oceanic basin by Nemcok et al.

6) *Special thematic papers*

Three thematic chapters are present in the volume: one on the plate-tectonic evolution and paleo-geography of the Circum-Carpathian region by Golonka et al.; another on the comparison of the Carpathians with the Ouachitas of the North America by Golonka et al.; and the last one on the history of the petroleum industry in the Polish and Ukrainian Carpathians by Sozanski et al. The comparison of the Carpathians and Ouachitas is an idea considered since the mid-1960s but never truly elaborated into a consistent account. The chapter by Golonka et al. is concerned mainly with the similarities and differences in the geodynamic evolution of these two orogenic belts.

Some unavoidable overlaps among the regional chapters exist, which the authors tried to minimize by emphasizing specific aspects of each region and by referring to other chapters in the volume.

SYNOPSIS OF GEOLOGY AND HYDROCARBON RESOURCES OF THE CARPATHIAN REGION

Three primary plate-tectonic settings (divergent, convergent, and back-arc extension) can be distinguished in the evolution of the Western Carpathians. The divergent process, characterized by rifting, opening of oceanic basins, and development of passive continental margins, began in the Permian and the Triassic in the Inner Carpathians (Meliata–Hallstatt Ocean) and in the Early to Middle Jurassic in the Outer Western Carpathians (Penninic–Pieninic oceanic basin).

The convergent orogenic process marked by subduction and formation of orogenic belts began in the latest Triassic or Early Jurassic in the Inner Carpathians by the closure of the Meliata–Hallstatt Ocean and the collision of the Inner Western Carpathian with the Tisza block. During the Late Jurassic and Early Cretaceous, the deformation progressed northward by accretion of various terranes of the Inner Carpathians and the Pieniny Klippen belt. By the late Senonian, most of the Penninic–Pieninic ocean was closed, and the Inner Carpathians were wholly deformed and exhibited signs of thrust. The oceanic crust of the Penninic–Pieninic ocean was subducted, and fragments of the rifted Apulian continental lithosphere collided with the attenuated and fragmented margins of the European plate. The Late Cretaceous deformation of the Inner Carpathians marks the primary break in the evolution of the Carpathian orogenic belt, which is also reflected in the division of the Carpathians into the inner and outer domains.

In the Late Cretaceous, a major foreland basin system formed in the Outer Carpathian zone dominated by the siliciclastic shelf, and deep-water flysch sedimentation formed in the Outer Carpathian zone. It displayed a complex topography marked by an existence of intrabasinal ridges (cordilleras), such as the Silesian ridge, which became major sources of clastic material. Because of the postcompressional relaxation in the late Paleogene, a hinterland deep-water flysch basin opened in the already deformed domain of the Inner Carpathians. During the Paleogene and early Miocene, the flysch sequences of Outer Carpathian depositional system were gradually deformed and thrust over the European foreland, where the youngest molasse-type Neogene foredeep formed. As the front of deformation, and with it the depocenter of the foreland basin, gradually progressed toward the European foreland, the deformed and uplifted inner zones of the foreland basin became the main sources of the clastic material for the younger depocenters closer to the foreland. The foreland basin thus represents a dynamic system of progradational deformation, erosion, and sedimentation.

The youngest plate-tectonic setting was marked by the formation of a subduction-related magmatic arc associated with back-arc rifting, extension, and thermal subsidence, which led to the development of the Pannonian Basin in the early to late Miocene. During the late phases of the Alpine orogeny, the predominantly northward-directed thrusting, especially in the Western Carpathians, was accompanied by the orogen-parallel, strike-slip faulting and escape tectonics. This is well documented by the opening of the pull-apart Vienna basin and the existence of transpressional tectonics in the suture zone of the Pieniny Klippen belt.

The tectonic shortening of the Carpathian domain apparently occurred not only in the decoupled thin-skinned thrust belt but also at the deeper crustal level, where the various blocks of previously rifted-apart blocks of the European continental margins were accreted back to the foreland plate instead of being subducted (Picha et al., 2006).

Diverse views exist on various aspects of the Carpathian geology, particularly on the extent of the European crust and lithosphere below the Carpathian belt, on the extent of the oceanic crust and lithosphere in various basins of the Carpathian depositional system during various stages of its evolution, on the character and magnitude of the late orogenic escape tectonics, and on the amount of the compressional shortening in the Carpathian orogenic belt. Readers will find diverse interpretations and accompanying discussion on these and some other problems of stratigraphy and structure in various articles in this volume. Hopefully, the complexity of the Carpathian geology and a wide acknowledgment of the differing views in this volume will help foster further interest in Carpathian geology.

THE CORRELATION OF THE ALPS AND THE CARPATHIANS

The correlation of the Alps and the Carpathians, two segments of the European Alpine system for a long time separated by the Iron Curtain, has stood out as one of the most important tasks in the process of opening the Carpathian geology to the outside world. Many similarities exist between the Alps and the Carpathians, yet significant geological differences do exist between these two parts of the European Alpine system. Among them, the limited presence of the Penninic oceanic crust and lithosphere in the Carpathians, the absence of the Pieniny Klippen belt in the Alps, and the existence of the Inner Carpathian Paleogene basin and a major back-arc extensional Pannonian Basin system in the Carpathians seem to be the most noticeable. At least some of these differences were apparently enhanced if not fully related to the existence of the Western Carpathian transfer zone (Picha et al., 2006), which actually separated the Alps and the Carpathians during both the divergent and convergent stage of their evolution.

The correlation of strata along the strike of the Alpine–Carpathian orogenic system thus should reveal both similarities and differences, the latter being commonly related to different settings of various segments of the entire system. As an example, the evolution of the Neogene foredeeps along the entire Alpine–Carpathian belt has been controlled to a great extent by the preexisting structural history of various segments of the foreland plate. This varies greatly along the strike of the belt. Typically, prominent depocenters marked by a high rate of subsidence alternate with areas of limited subsidence and deposition. In the Alpine–Carpathian region, the Bavarian–Austrian Molasse, with 4 km (2.5 mi) of Neogene deposits, the Boryslav area in western Ukraine, with up to 7 km (4.3 mi) of deposits, and the deepest Focsany depression in Romania, with 8–10-km (5–6.2-mi) deposits, represent the prominent depocenters. However, the segments of the foredeep, which evolved on the more stable crustal blocks of the foreland, such as the Bohemian Massif, are characterized by a low rate of subsidence and deposition (Picha et al., 2006).

As noted by Trumpy (1988, p. 107), ''We must abandon the cylindristic concept of parallel facies belts. Basins and swells may change their character

along strike. Major paleogeographic elements, such as the Brianconnais rise, may wedge out and be replaced, in another traverse, by a similar but not homologous swell.'' The right approach to correlation of various tectonic and stratigraphic units should thus strike a balance between the general trends and local anomalies. Moreover, the various segments in the general trends should be defined by geological attributes instead of national boundaries.

THE PROBLEMS OF THE LOCAL STRATIGRAPHIC NOMENCLATURE AND THE REGIONAL CHRONOSTRATIGRAPHY OF THE NEOGENE PARATETHYS

One of the primary goals of the regional chapters is the correlation of major stratigraphic and structural units of the Carpathian belt and in its foreland across national borders. Because of closed borders and the overall limited access to information in the past, the geological activities of various countries were commonly dominated by local problems. Inevitably, such a situation led to the development of national geologies for various segments of the Carpathian belt. This is most notably seen in the stratigraphic nomenclature. A plethora of names for local stratigraphic and structural units, which are not always clearly defined, has been introduced and often published in local periodicals little known outside the particular countries. Some previously recognized units have been given new names or upgraded to higher stratigraphic ranks and further subdivided. Such a proliferation of local terms has made the regional geology increasingly difficult, if not impossible, to comprehend. In that context, even some aspects of the regional chronostratigraphic stage system of Paratethys have become increasingly debatable. The uncertainties in definition of some stages (e.g., Karpatian) led to discrepancies in the correlation of strata and tectonic events between various regions. In our opinion, an alternative comparison of the regional Carpathian stratigraphy with the standard Mediterranean stratigraphic system of the Neogene would be desirable. The Paratethys, as a system of the northern Alpine foreland and intermontane basins, was not entirely isolated from the foreland basins and marginal seas of the Mediterranean region and from the north European epicontinental depositional system. In a broader sense, it might be debatable whether a highly diversified depositional system of Paratethys, strongly affected by local depositional and structural complexities typical for foreland settings, is warranted a separate regional stratigraphic nomenclature in the first place. Furthermore, the term Tethys is generally used for oceanic settings, e.g., Paleotethys and Neotethys; its application, in the term of Paratethys, for a continental setting of the Alpine foreland basins might be misleading to those not familiar with the Alpine region.

Many discrepancies in the regional correlation became apparent even during the preparation of this volume to some authors and to the editors. However, any solution of these stratigraphic problems goes far beyond the scope of this publication. The best we could have done was to keep the stratigraphic and structural terminology in various articles simple, consistent, and compatible with conventional usage understandable to readers and, if necessary, to refer to diverse views and interpretations. Hopefully, the publication of this comprehensive regional volume may lead to serious revisions of the present practices and possibly even to the development of a simplified stratigraphic and structural nomenclature applicable to wider segments of the Carpathian region.

HYDROCARBON RESOURCES IN THE CARPATHIAN REGION

To date, 6.8 billion bbl (984 million m^3) of oil and 53.7 tcf (1522 billion m^3) of natural gas (Table 1) have been produced in various parts of the Carpathian system: the Neogene foredeep in Austria, Czech Republic, Poland, Ukraine, and Romania; the outer zones of the Carpathian thrust belt in Poland, Ukraine, and Romania; the Vienna basin in Austria, Czech Republic, and Slovakia; the Pannonian and Transylvanian basins in Hungary and Romania, respectively; and in the subthrust plays in the Czech Republic, Austria, and Ukraine. A sizable production of around 200,000 bbl of oil still continues in those areas. By applying new technologies and new scientific concepts, it may still be possible to find additional reserves of hydrocarbons in the existing fields, as well as to discover new accumulations, especially at deeper structural levels. The subthrust plays below the shallow frontal zones of the thin-skinned Carpathian thrust belt seem to be the most promising targets (Kostelnicek et al., 2006; Picha et al., 2006). Numerous deep wells have already been drilled through the thrust belt into the underlying European platform, where the presence of hydrocarbons was established in various formations, from the crystalline basement to the Neogene strata of the European platform. Commercial accumulations of oil and gas have been discovered and put on production in Austria, Czech Republic, and Ukraine. The Carpathian

Table 1. Cummulative production of oil and natural gas from the entire Carpathian system, including the Neogene foredeep and the foreland platform both in front and below the thrust belt, the Carpathian thrust belt, and the late and postorogenic intermontane basins in all countries of the Carpathian region. Based on data reported in various chapters of this volume.

	Cumulative Production			
	Oil		Gas	
	Million bbl	Million m^3	tcf	B m^3
Austria	788	113	2.7	77.4
Czech Republic	38	6	0.6	16.5
Slovakia	24	4	0.9	25.5
Hungary	634	101	7.4	208.8
Poland	167	24	6.9	196.3
Ukraine	713	102	8.3	235.9
Romania	4439	634	26.9	761.9
Total	6803	984	53.7	1522.3

region thus represents one of the best examples of successful subthrust exploration used in defining the fundamentals of hydrocarbon exploration under thrust belts elsewhere (Picha, 1996).

THE FUTURE OUTLOOK

The main objective of this volume is to provide a comprehensive overview of present knowledge on the geology and hydrocarbon resources of the Carpathians and their foreland. While pursuing this goal, we are well aware that various investigations have continued, and new data and concepts have emerged even during the publication of this volume. One of the desired goals of future investigations would be the comparison of the Carpathian Flysch depositional sequences with the deep-water turbiditic systems of modern continental margins and recently explored hydrocarbons in the Gulf of Mexico, along the margins of Africa, South America, and elsewhere. Such a comparison may help in better understanding the distribution of various facies and possibly even changing the attitude toward the ever-increasing fragmentation of the stratigraphic nomenclature of the Carpathian Flysch belt. On the practical level, the better understanding of the facies distribution may positively influence the future exploration for hydrocarbons in the Carpathians and other regions with similar structural and stratigraphic settings.

Another area of continued interest would be the investigation of the deep structure of the Carpathian belt. Significant amounts of work, including various geophysical investigations and deep exploratory drilling, have already been done (see the various contributions in this volume); however, any further progress would depend on the application of advanced geophysical, especially seismic, techniques and further deep scientific and exploratory drilling. One such deep drilling project has been recently considered in the hot spot of the Zakopane area of Poland. Its goal is to verify the existence of the late orogenic rifting in the outer zones of the Carpathian thrust belt. Of great importance, both theoretical and economic, would be the potential exploration for hydrocarbons in deeper structures (6–7 km; 3.7–4.3 mi) below the Neogene foredeep and the thin-skinned Outer Carpathian thrust belt (Dziadzio et al., 2006; Mysliwiec et al., 2006; Picha et al., 2006; and others).

We believe that geological investigation of the Carpathian belt will continue with a renewed enthusiasm; new resources of hydrocarbons will be discovered and developed; and the famed past of the Carpathians will thus be followed by an equally bright future.

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