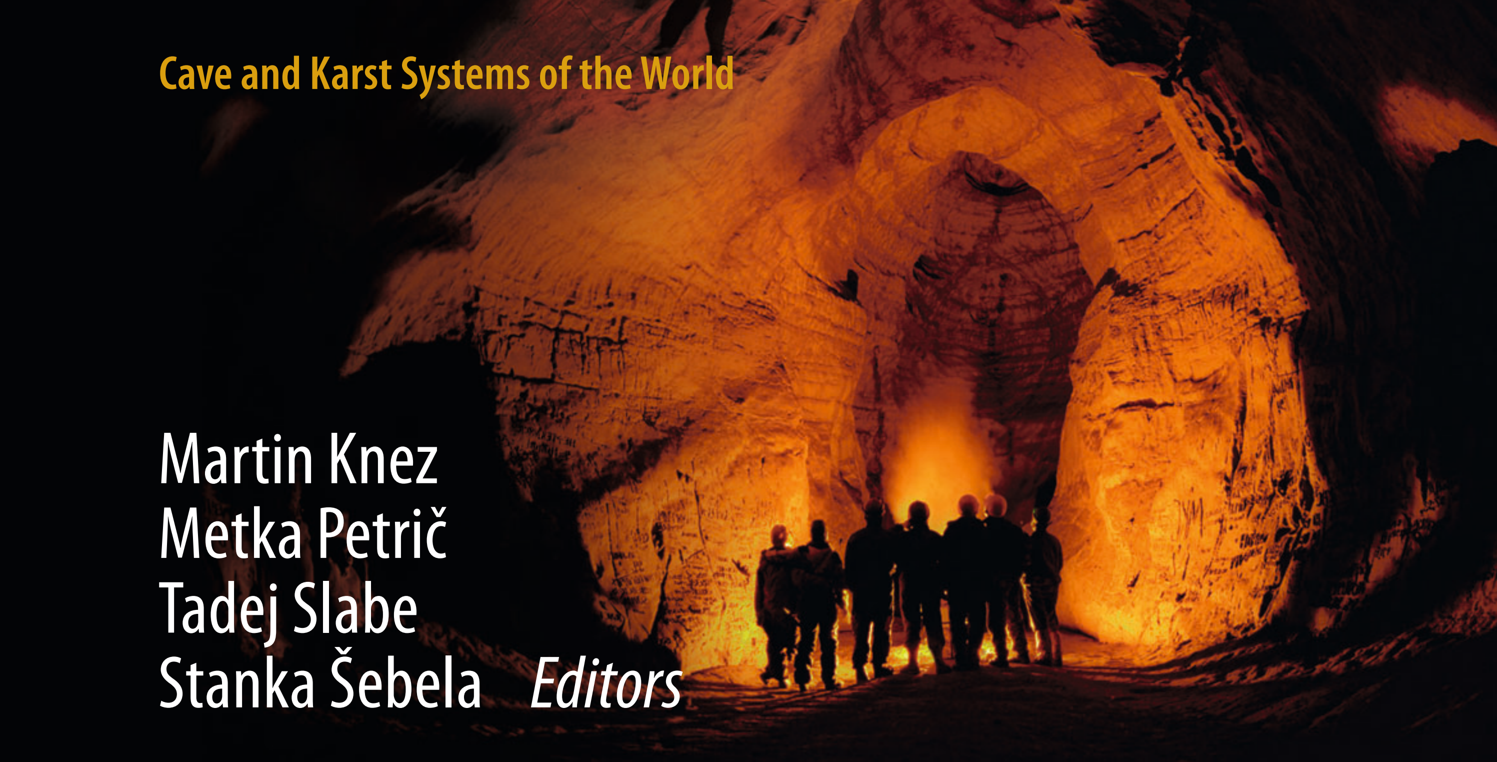
Cave and Karst Systems of the World



Martin Knez
Metka Petrič
Tadej Slabe
Stanka Šebela *Editors*

The Beka-Ocizla Cave System

Karstological Railway Planning in Slovenia

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The Beka-Ocizla Cave System

Karstological Railway Planning in Slovenia

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Preface

A good knowledge of the natural and cultural heritage of karst is a precondition for the rational planning of life on it. The karst can be known and understood primarily through the comprehensive study of its surface, caves, waters, and ecological characteristics.

The Karst Research Institute of the Research Centre of the Slovenian Academy of Sciences and Arts has been involved in developing this basic knowledge, establishing interdisciplinary connections among the most important fields of karstology, and in consolidating them into an integral science of karstology for almost seven decades. We try to organize the knowledge to make it as useful as possible for planning life in karst regions and are directly involved in larger major projects. The Institute regularly publishes a selection of new research and knowledge.

Planning without a thorough understanding of the environment and consequently a vision of its development—even though within the boundaries of environmental protection legislation—is certainly not sufficient. We wish to build a foundation for the rational planning of activities on karst based on good karstological research, as much in individual fields of karstology as in interdisciplinary studies. Such planning must take natural and cultural characteristics and vulnerability of karst landscapes into consideration and overcome the inevitable pursuit of profit. Environmental planning must realistically consider the socioeconomic conditions for the benefit of local karst population and the short- and long-term development of karst regions. While the mission of the Karst Research Institute is primarily to expand the basic knowledge of karst, karst phenomena, and karst waters, we are also aware of the need for the continuous and effective communication of karstological knowledge to the wider social community, including through our participation in the more important and directly useful projects.

Ten years ago the Karst Research Institute established a postgraduate karstology program and incorporated karstology courses in the undergraduate geography curriculum. The International Academy of Karst Sciences, an international association of karstologists, was established to link international knowledge and experience more effectively and to find the best foundations for the rational planning of life in various karst regions around the world.

The Karst Research Institute is involved in individual projects, related to the development and protection of the natural and cultural heritage of karst areas, regional planning, water supply systems, the construction of transportation infrastructure, the closure of dump sites in karst areas, the collection of data on karst caves and their protection, karst ecology and determining the extent of human influence on the karst underground, and planning and monitoring the exploitation of karst phenomena for tourism.

We have assembled and published extensive sets of selected directly applicable research studies on karst waters, results of our participation in the planning and construction of expressways on karst, management of caves for tourist purposes, and ecology and protection of the underground. This time we are adding experience acquired in karst planning of the railway route, one of the most demanding projects on Slovenian karst. We recognize that this does not include certain individual topics or the total contribution of karstology to planning life on karst, but we do hope they are a step in the right direction and a challenge for the future.

The area where the new Divača (435 m above sea level)—Port of Koper (0 m above sea level) track will run is divided into two sections. The first leg will run mainly on carbonate rock from Upper Cretaceous, Paleocene, and Eocene. The second leg will run on Eocene flysch. The book presents results of the research on the northern section of the railway running on and through the karst.

The route of the railway near the Divača station on top of the Classical Karst plateau runs about 3 km on the surface and then enters the first, 6,700 m tunnel (T 1), which ends in the upper part of the valley of the Glinščica stream. After a 250 m bridge the railway enters the second, 6,000 m tunnel (T 2). In some places the route runs more than 300 m below the surface.

The last part of the second tunnel passes from the Classical Karst plateau area to the first, 450 m viaduct below the Črni Kal motorway viaduct. The route then runs almost entirely in tunnels T 3, T 4, T 5 and T 6, and in the penultimate T 7 tunnel turns south. With the last, 650 m viaduct the track nears the border with Italy and enters the final, 3,800 m tunnel T 8. The route continues down the Rižana River valley where the otherwise constant 17 ‰ grade eases. The track meets the Port of Koper loading station at sea level.

The total length of the route is just over 27 km, which includes eight tunnels (20.5 km, 75 % of the route), the longest two (near 13,000 m) running through karst. The route also includes three bridges and two viaducts with a combined length of 1,100 m (5 % of the length of the route).

During the initial planning stages, the northern section of the route of the future railway across the karst was considered part of the fifth Pan-European Transport Corridor Barcelona–Kiev.

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Geological Setting

The geomorphological and speleogenetic history of the investigated area depends to a great extent on the geodynamics of the marginal parts of the fold and thrust belt of the Dinaric orogene (i.e. External Dinarides) or the underthrusting of the Istrian Peninsula below the Dinaric range, especially from the Middle Miocene on (Placer et al. 2010). In the process, mainly sedimentary rocks of the Mesozoic passive margin of the Adria-Apulian microplate (Stampfli and Mosar 1999) and Paleogene synorogenic depositional areas have been included. The underthrusting of Istria is a result of the anticlockwise rotation of the Adria microplate (Stampfli et al. 1998) and the related, generally N–S-oriented stresses (Marton et al. 1995; Bressan et al. 1998; Placer et al. 2010), which also caused reactivation and horizontal movements of the older NE–SW striking faults (Jurkovšek et al. 1996; Bressan et al. 1998).

Tectonically, the surroundings of the Glinščica valley with the discussed cave system lie at the border between the Istria–Friuli underthrust zone and the Čičarija anticlinorium (Placer 2005; Placer et al. 2010) (Fig. 1). The latter is a part of the Komen thrust sheet (Placer 1981, 1998) of the Kras–Notranjsko folded structure (i.e. a part of the External Dinaric imbricated belt of the northwestern External Dinarides). These tectonic units correspond to the northwestern part of the Cretaceous Adriatic carbonate platform and the Upper Cretaceous to Eocene synorogenic carbonate platform, which occupied the northeastern part of the Adriatic microplate. Shallow-marine carbonate successions of different Cretaceous formations are separated from the Upper Cretaceous/Lower Palaeogene to Eocene palustrine and shallow-marine limestone of the Kras Group (Košir 2003) by a regional unconformity (Fig. 2). The synorogenic carbonate platform was buried by prograding hemipelagic marl and deep-water clastics (flysch).

The oldest carbonate rocks of the area that crop out in the nearby Matarsko Podolje lowland (Čičarija anticlinorium) comprise Lower Cretaceous limestone and dolostone (Šikić et al. 1972). They are overlain by an Albian to Upper Santonian shallow-marine carbonate succession composed predominantly of limestone with local intercalations of dolostone and coarse-grained non-depositional calcareous-dolomitic breccia. The sequence ends with a second-order unconformity marked by a prominent paleokarstic surface (Otoničar 2007), which is overlain by up to a few tens of metres thick sequence of Upper Cretaceous (Maastrichtian) dark grey palustrine to Lower Eocene shallow-marine foraminiferal limestone that gradually passes over to hemipelagic marl and deep-marine siliciclastic flysch. The unconformity typically separates the underlying passive margin carbonate succession from the overlying deposits of the synorogenic carbonate platform at the periphery of the foreland basin (Košir and Otoničar 2001; Otoničar 2007).

The Cretaceous and Palaeogene sequences of the wider vicinity of the investigated area are parts of the southwestern flank of the aforementioned Čičarija anticlinorium (Placer 1981) and the imbricated structure of the Istria–Friuli underthrust zone with an alternate dip of the strata. The area is dissected by numerous faults with two main directions, NW–SE and NE–SW (Placer 1981, 2005; Placer et al. 2010; Jurkovšek et al. 1996). The most important NW–SE striking faults have a mainly thrust fault character, while transverse to this direction normal and strike slip faults are found. The folds and faults display the multi-phase kinematic evolution of the

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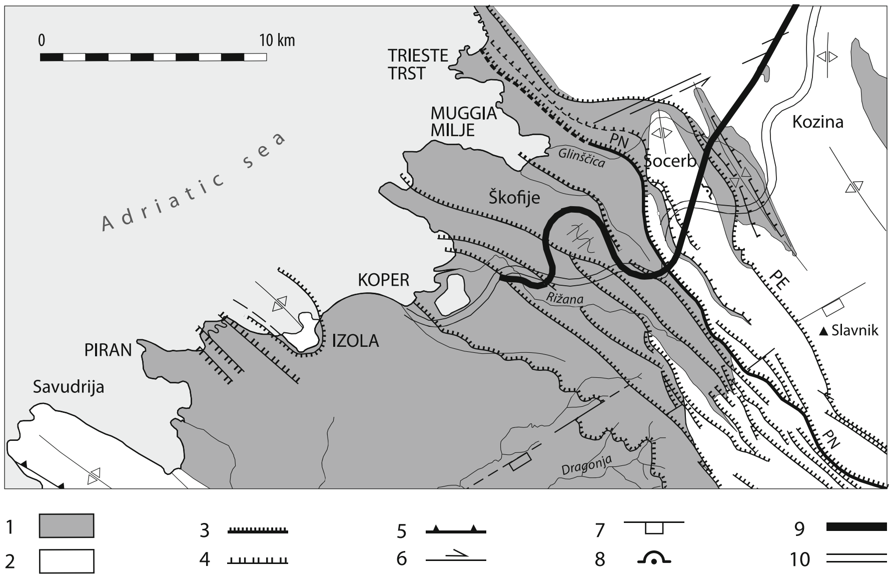

Fig. 1 Istria-Friuli underthrust zone. *1* upper ductile horizon: flysch, *2* platform carbonates, *3* thrust faults (*PE* Petrinje thrust fault, *PN* Palmanova thrust fault), *4* secondary thrust faults of the Strunjan structure, *5* thrust front of External Dinarides, *6* strike-slipe fault, *7* normal fault, *8* Cave, *9* railway, *10* motorway (from Placer et al. 2010)

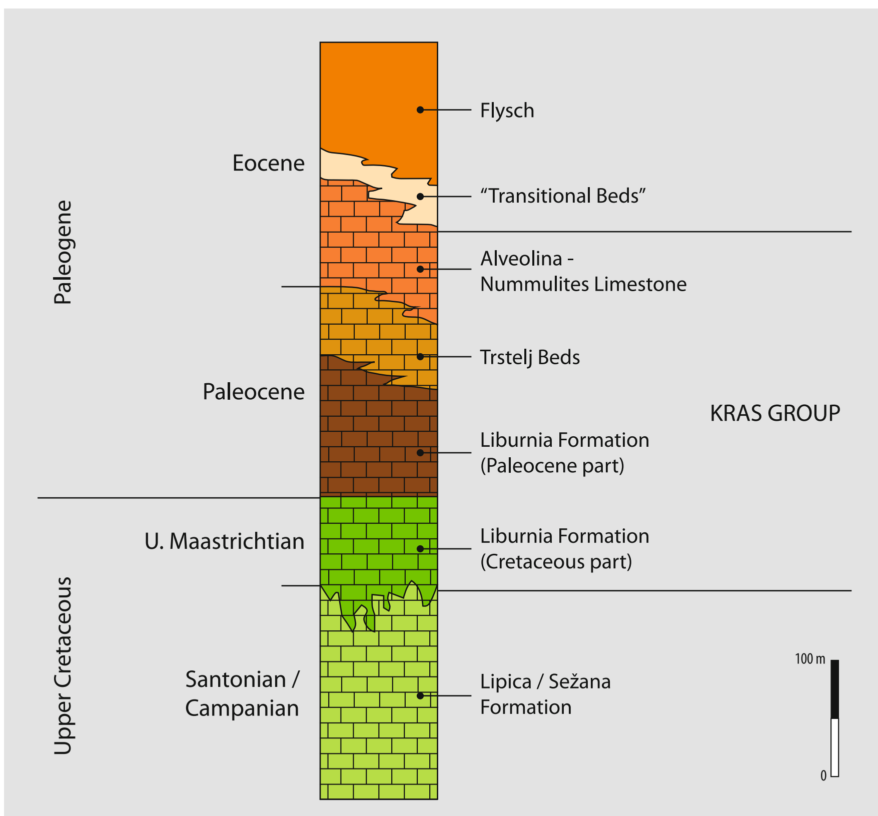

Fig. 2 Generalized Upper Cretaceous to Eocene lithostratigraphic column of the Kras and Matarsko Podolje, SW Slovenia (modified from Košir 2003)

area, which is related to the changing stress fields from Cretaceous to the recent (Jurkovšek et al. 1996). The Beka-Ocizla cave system is located in the highest major slice of the Istria–Friuli underthrust zone, which is determined by two major thrust faults of the zone, i.e. the Palmanova fault and the Petrinje fault (Fig. 1).