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KARST FEATURES DISCOVERED DURING MOTORWAY CONSTRUCTION BETWEEN DIVAČA AND KOZINA (SLOVENIA)

KRAŠKE OBLIKE, ODKRITE PRI GRADNJI AVTOCESTE MED DIVAČO IN KOZINO (SLOVENIJA)

TADEJ SLABE[1]

[1] Karst research institute - ZRC SAZU, SI-6230 POSTOJNA, SLOVENIA

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Tadej Slabe: Kraške oblike, odkrite pri gradnji avtoceste med Divačo in Kozino

Na 7,5 km trase avtoceste med Divačo in Kozino je bilo na vrtačastem površju oziroma tik pod njim odkritih 50 starih jam. Večina jih je bila zapolnjena z naplavinami in mnoge so bile zaradi znižanja kraškega površja že brez stropa. 6 je bilo brezen, skozi katere prenika voda s prepustnega površja do podzemeljskih voda. Stare jame hranijo sledi začetnih obdobij razvoja kraškega vodonosnika, ko je bil še visoko obdan in ponekod tudi prekrit s flišem. Jame brez stropa so danes samosvoj del kraškega površja. Več jam je ohranjenih pod cesto, ena pa je dostopna skozi umetni vhod.
Ključne besede: krasoslovje, gradnja avtocest, Kras, Slovenija.

Abstract UDC: 551.44:625.7/8 (497.4)

Tadej Slabe: Karst features discovered during motorway construction between Divača and Kozina

During the construction of new motorways (30 km) over Kras about 200 caves were discovered; in the area between Divača and Kozina (7,5 km) there were 50 old caves, most of them filled by sediments and some of them roofless, and 6 shafts. Old caves provide information on initial stages of the karst aquifer development when it was still surrounded and sometimes even covered by flysch. The more important caves are being preserved, either hidden below the roadway or made accessible by an artificial entrance.
Key words: karstology, motorway construction, Kras, Slovenia.

Introduction

During the continuation of new sections of motorway over Kras the researchers of the Karst Research Institute ZRC SAZU work to discover and explore karst phenomena. Karstological control is financed by DARS and it is organised within the Institute of Protection of Natural and Cultural Heritage, Nova Gorica. This report is the continuation of such descriptions by which we noted karst phenomena in other sections of the motorway and researches which deepen the knowledge of early periods of this part of Kras development (Slabe 1996, 1997a; 1997 b).

During the construction of 30 km of new motorways in Kras more than 200 caves were discovered and in the section, 7,5 km long, between Divača and Kozina there were 50 fossil caves, most of them filled with sediments and several roofless; 6 among them were shafts. Fossil caves contain traces of the initial periods of the karst aquifer development. The more important caves are preserved, either hidden below the road or accessible by artificial entrances.

This section of the road also is designed to be impermeable so that untreated water, including spillages, cannot gain access to the underground karst systems. The waste waters are collected in oil reservoirs.

KARST SURFACE

From Divača the road passes over Divača podolje, rises at its border to Kozina karst plain and continues over it to Kozina. The first part of the motorway lies in Rudist Cretaceous limestone of Lipica formation and continues over Cretaceous and Paleocene limestone of Liburnian formation,

Fig. 1: Surface dotted with dolines.
Sl. 1: Vrtače na kraškem površju.

where coal may be even found; a belt of milliolid limestones of Slivje formation follows, later Eocene Operculina limestone, then broader belt of Alveoline nummulitic limestone; the latter is found before the Kozina rise in the road and over it as well as in the initial part of the karst plain. Due to the anticline-sinkline structure of this part of the karst this setting repeats towards Kozina in a similar but reverse order. Before construction started the surface was dotted by dolines (Fig. 1). The biggest was 200 m in diameter and they were 35 m deep. There were fields in the bottom of some cultivated dolines. Old cultivated dolines were investigated by archaeological excavations. Usually in the bottom of such dolines were either piles of rocks and stones, later cov-ered by soil, or there were thick layers of limestone below the soil without any traces of human impact. Mag. Andrej Mihevc measured the amount of soil transported into dolines after human ac-tivity. He stated that a 0,14 m thick layer of soil was transported from the surface into the dolines; obviously some of it was washed off. Mag. Nadja Zupan Hajna made macroscopic description of sediments in dolines and sampled their layers for mineralogical analyses.

In some places below relatively thick layers of brown and red soil, in particular along distinctive fissures, the surface is often dissected and in other places the epikarstic part of aquifer is shallow. Below the soil typ-

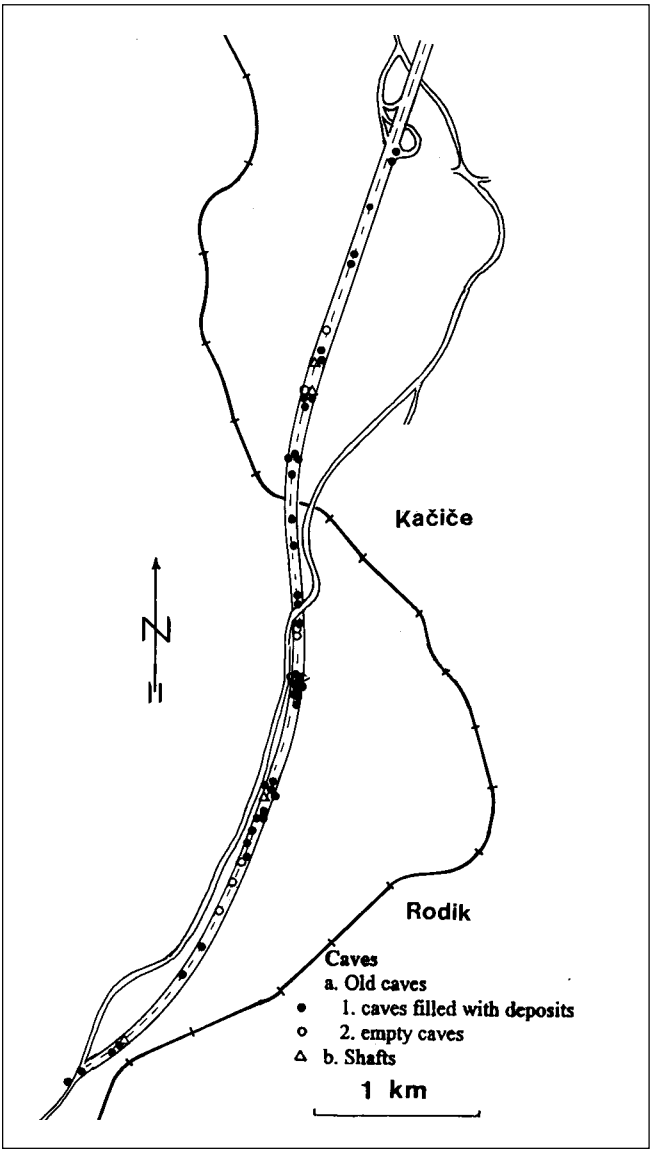

Fig. 2: Caves within the roadway.
Sl. 2: Jame na trasi avtoceste.

ical subcutaneous rocky features developed. The undersoil rocky surface of Alveoline-nummulitic limestone is unique. On the border of dolines developed along faults, there are walls with typical rocky relief. Karren and solution pans predominate.

An important part of the karst surface is occupied by roofless caves; they are described in the next section.

CAVES

Caves are found in all types of limestone. Their frequency mostly depends on local properties of bedded or fissured rocks and how the aquifer is developed and also the extent to which an area has been researched.

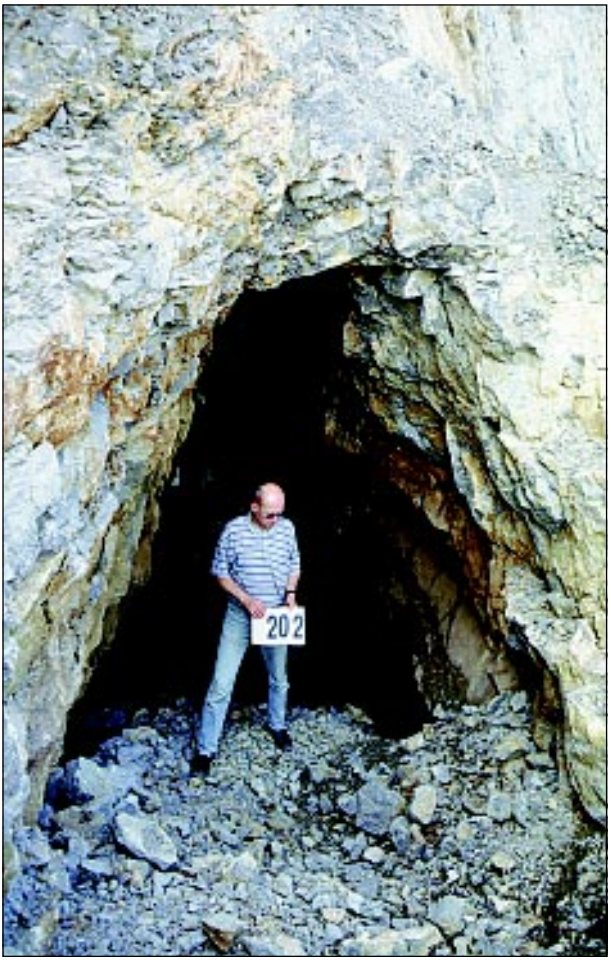

Fig. 3: An old cave in road-cutting.
Sl. 3: Stara jama v vseku avtoceste.

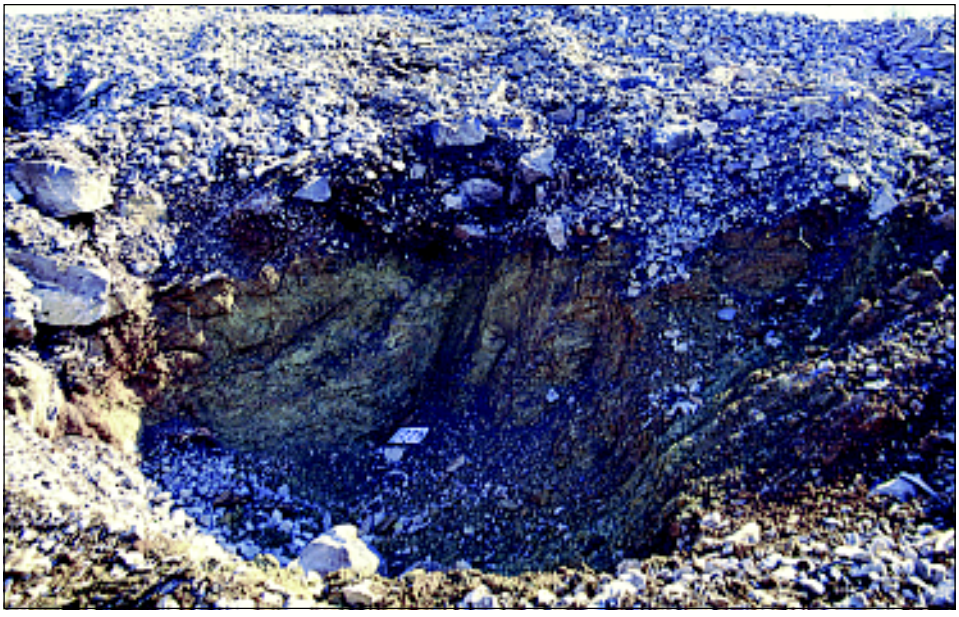

Fig. 4: Cross section of an old cave with fine-grained sediments.
Sl. 4: Prerez stare jame, ki je zapolnjena z drobnozrnato naplavino.

Fig. 5: Roofless cave.
Sl. 5: Jama brez stropa.

I divided the caves (Fig. 2) into old (Fig. 3), mostly horizontal or inclined passages and to shafts shaped by water percolating from the surface. In former times water flowed through old caves and only later they remained dry due to lowering of underground water. Even some shafts are old, being either shaped by percolation water or being a part of bigger cave systems. The latter are listed among old, hollow caves in the map showing the distribution of typical caves found in a roadway.

Such division and emphasizing of properties is dictated by the prevailing caves that were filled up by fine-grained clay or sand flysch sediments (Fig. 4). There were no flysch pebbles here such as we found in the roadway near Divača. Speleothems and flowstones were found below the sediments or above them in these passages, some of them being 6 m in diameter but most of them being smaller. There were 41 such caves, and 9 of them were void. Two thirds of the caves filled with fine-grained sediments were already without a roof (Fig. 5). According to experiences obtained during motorway construction elsewhere over karst Šebela (1996) noticed two roofless caves during the karstological study. Often the road cut a part of the same passage or cave system. These caves, filled with fine-grained sediments which filled up all the cracks and percolation water did not remove them when the karst surface lowered for several tens of metres, are seen as elongated, winding indentations or as peculiar dolines on the karst surface. With collaborators Dr. Pavel Bosak and Petr Prunner of the Geological Institute of the Czech Academy of Sciences we sampled these sediments for various paleomagnetic researches. Well studied fossil caves and their content will undoubtedly tell us a lot about early phases of this part of karst development.

Andrej Mihevc and Franjo Drole explored and made a map of a smaller coal mine. Coal was found between layers of Paleogene limestone. Similar lenses of coal were found elsewhere along the roadway.

MOTORWAY CONSTRUCTION AND KARST PHENOMENA

During the motorway construction several, some of them large dolines had to be filled up as they were located in the future road; some of them lying nearby were used as a dumping ground for surplus rocks and soil. Before the dolines were covered in the soil and sediments were removed.

The road passes above the horizontal passage at the bottom of Škrinjarica cave. This passage lies 100 m below the roadway and traffic will not influence it. Caves that opened during the construction were mostly smaller and they were covered in and sealed by a concrete cover. Such covers are also above narrow shafts. The roadway was surveyed by Geo-radar in order to detect any unknown caves below it.

Under a big dike at cross-section 103 an interesting old cave opened, 14 m deep. In its bottom is a chamber, 12 m long, 10 m wide and 5 m high in the ceiling of which there are several chimneys. The bottom is covered by rocks and loam. The influences of blasting, such as crushed rock, are seen in the first metre of the cave below the surface. We suggested that this cave be preserved. Concrete tubes were installed in it and they reach the lip of the underpass. They are covered by a concrete lid.

The high permeability of the karst aquifer means that underground water is highly threatened. The waste waters flowing from the road may pollute it or some accidental spillage of hazardous substances during construction or later when the road is in use. As a result, the roads are designed to be impermeable, the runoff beingbe collected in oil reservoirs. Only treated waters are allowed to gain access to the underground karst systems.

CONCLUSION

During the construction of this part of the motorway similar characteristics of the aquifer development were revealed to those between Čebulovica and Fernetiči.

Water flowed through the caves as long as underground water level reached them. The aquifer was surrounded and partly buried by flysch. Water flowed from the flysch and transported loam and sand into the caves. In one of the last development phases of the caves after they had been dry for some time and flowstone was deposited in them, flood waters filled them with fine-grained sediments. This filled the cracks and remained for long periods of the aquifer development while its surface lowered for several tens of metres. Old roofless caves are thus an important constituent part of the karst surface showing the development of the aquifer (Mihevc, Slabe, Šebela 1997). Today the underground water level is 200 m and more below the surface and traces of past water flow through the aquifer are preserved only in caves and their sediments. Traces of superficial water flows that would reshape the aquifer's surface (Melik 1960, 201; Radinja 1972, 13) were not found.

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KRAŠKE OBLIKE, ODKRITE PRI GRADNJI AVTOCESTE MED DIVAČO IN KOZINO (SLOVENIJA)

Povzetek

Kraški pojavi nam ob gradnji tega dela avtoceste razkrivajo podobne značilnosti razvoja vodonosnika kot smo jih lahko opazovali tudi na trasah med Čebulovico in Fernetiči (Slabe 1996, 1997b).

Skozi opisane stare jame so se, dokler je do njih segala gladina podzemeljske vode, prekali vodni tokovi. Vodonosnik je bil še visoko obdan, pa tudi prekrit s flišem. Vode so se stekale z njega in prinašale v jame ilovico in pesek. V enem zadnjih obdobjih izrazitega razvoja jam, pred tem so bile že suhe in v njih se je odlagala siga, so jih poplavne vode zapolnile z drobnozrnato naplavino. Ta je zatesnila špranje in se ohranila v dolgih obdobjih razvoja vodonosnika, ko se je njegovo površje znižalo za več deset metrov. Stare jame brez stropa so torej pomemben sestavni del kraškega površja kot sled razvoja vodonosnika (Mihevc, Slabe, Šebela; 1998). Sledi nekdanjega pretakanja vode skozi vodonosnik, danes je gladina podzemeljske vode že 200 m in več globoko pod površjem, so ohranjene le v jamah in njihovih naplavinah. Sledi površinskih vodnih tokov, ki naj bi oblikovali površje vodonosnika (Melik 1960, 201; Radinja 1972, 13), nismo našli.