

## Geologically interesting localities along the Slovenian part of Istria and the Adriatic Sea

Rajko Pavlovec<sup>1</sup>, Vida Pohar<sup>1</sup>, Branka Hlad<sup>2</sup>

<sup>1</sup> Chair of Geology and Palaeontology, University of Ljubljana, Aškerčeva 2, 61000 Ljubljana

<sup>2</sup> Institute of the Slovenian Republic for Conservation of the Natural and Cultural Heritage. Plečnikov trg 2, 61000 Ljubljana

Р. Павловец, В. Похар, Б. Хлад — Интересные геологические объекты вдоль словенской части Истрии и адриатического побережья. Вдоль словенской части Истрии и адриатического побережья обнажаются многие геологические объекты, которые должны быть включены в Балканском списке геологического наследства. Следует отметить: 1) флишевые осадочные породы между Пиран и Изола, 2) известняки с альвеолинами и нуммулитами в чешуях Чичария, 3) тектонические чешуйчатые структуры Чичария, 4) палеолитические стоянки, 5) пещеры Скоцянская яма, 6) палеоценовые пласты Козина, 7) верхнемеловые пласты Време, и 8) базальные палеогеновые флишевые отложения под Времшчицей восточнее Пивки.

Abstract. Many geological sites of interest that should be included in the Balkan Geological Heritage List crop out in the Slovenian part of Istria and the Adriatic coast. The following geosites should be noted: 1) flysch sedimentary rocks between Piran and Isola; 2) limestone with *Alveolina* sp. and nummulites in the imbricated structures of Čičarija; 3) the tectonic imbricated Čičarija structures; 4) Palaeolithic sites; 5) caves of Skocjanska Jama; 6) the Paleocene Kozina Beds; 7) Upper Cretaceous Vreme Beds; 8) the basal Paleogene flysch beds under Vremaščica east of Pivka.

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### Introduction

Slovenia, occupying the westernmost part of the Balkan Peninsula and being the westernmost republic of former Yugoslavia, has the advantage of possessing a series of geologically engaging places of interest which are worth of being pointed out and appropriately protected. For the moment being, only the caves Skocjanske jame have been put under the UNESCO custody, as a unique karstic phenomenon. A few other sites are put under the safeguard and indication of some other institutions. Slovenia lies at the juncture of important geotectonic units (the Dinarides and the Alpides) which has resulted not only in a complicated tectonic structure, but has given rise to various developments, a variety of fossils, etc., all that occurring in spite of a really small size of the area.

By the present protection of geological places of interest on the Balkan Peninsula, some particular items are being preserved (such as, Pikermian fauna near Athens) or a more important site comprising a somewhat larger area, emphasizing only one phenomenon or a connected complex of phenomena (e. g., the lakes of Plitvice in Croatia). We hereby suggest a somehow different way of treating this territory of great geological interest. More or less separated phenomena and independent objects as well as minor spaces should be united in a geologically interesting complex. We also try to put forward the idea pursuing the aim focusing attention to the geologically interesting places along the Istria and the Adriatic Sea which should enjoy the protection of some environmental regime. The area under treatment consists of individual parts or even points. Beside



Fig. 1. Sketch map of points treated (localities)

1. (Point 1): Flysch beds, cliff, lagoon along the Adriatic Sea; 2. (Points 2, 3, 4): Limestone with alveolinas and nummulites, schuppen structure, paleolithic station Črni Kal; 3. (Points 4, 5): Paleolithic station Roška Špilja, Škocjanske jame; 4. (Points 6, 7): Kozina and Vreme beds; 5. (Point 8): Basal flysch beds

the protection, there will be also warning boards needed and particularly a multilingual publication. Such an area will be interesting not only for the experts but for the amateurs, too, functioning as an object of observation and research, as well as a kind of instructional geological trip.

Owing to the fact that the part of Slovenian Istria together with its Adriatic zone represents an interesting tourist area, the following must be taken into account: geological places of interest should be easily accessible, not too far from the main tourist routes, while the mode of protection should be in accordance with the municipal and state interests as well as the development scheme.

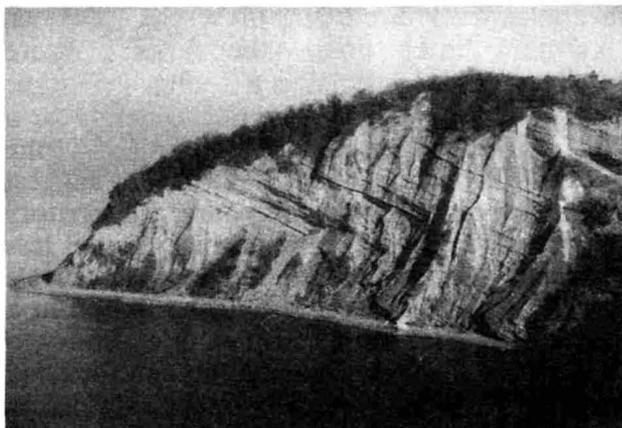


Fig. 2. Flysch beds on the Adriatic coast near Strunjan (point 1)

## 1. Flysch beds, fossil traces, fossils, cliff, lagoon

Along the Slovenian coast of the Adriatic Sea, especially between Piran and Izola, high steep cliffs of flysch beds prevail, with a predominantly turbiditic flysch, comprising a minor olistostrom insert. The underlying parts of the calcarenite are rather rich with nummulites, whilst marl beds abound with microforaminifers and nannoplankton. There is plenty of fossil traces (*Palaeodictyon*, *Palaeobullion* and others). Tectonic phenomena are visible, too.

The flysch peninsula and the lagoon near Strunjan are the only subsisting unspoiled natural section of the Slovenian coast serving for expert research purposes of geology, geomorphology, botany and zoology. Consequently, this locality offers appropriate possibilities for studying as well as for educational and instructional purposes aiming at nearly all the fields of natural sciences.

The cliff is protected as a natural reservation, lagoon as a natural monument, both of them figuring as an integral part of Strunjan landscape park. Nevertheless this stretch of land is being menaced by an eventual expansion of tourist resort and seaport activities (Pavlovec, 1963; Pavšič, 1977; Pleničar et al., 1973).

## 2. Limestone with alveolinas and nummulites in the schuppen structure of Čičarija (tract of land between Osp, Hrastovlje and Dol)

These limestones abound in foraminifers belonging to nummilites and alveoline groups, as well as red algae and some other fossils. Near Dol, not far away from Hrastovlje, a new species



Fig. 3. Nummulites in the limestone in the schuppen structure of Čičarija (point 2)



Fig. 4. The schuppen structure near Črnotiče; younger flysch lying beneath an older limestone (point 2)



Fig. 5. Tectonized marls in the schuppen structure of Čičarija (point 2)

*Assilina istrana* (= *Assilina spira abrardi*, Schaub, 1981) has been dealt with. It is known elsewhere in the Mediterranean, as well.

The existence of limestones with alveolinas and nummulites is not endangered, though, as they cover a substantial extent of land. On the other hand, the locality of *Assilina istrana* species should be protected. In the abandoned sections of the Črni Kal quarry, however, these layers comprising fossils could be more closely observed (Drobne, Pavlovec, 1991; Pavlovec, 1963; Pleničar et al., 1973).

### 3. The schuppen structure of Čičarija

It is particularly evident between Črni Kal and Črnotice or to the north of Hrastovlje. The schuppen of limestones with alveolinas and nummulites alternate with those of flysch. The limestone frequently builds steep precipitous edges, while the flysch stretches, covered with green surfaces, lend themselves to diverse cultivation. Schuppen are mostly due to the process of folding, subsequently the folds were sheared and got somehow shoved. There is no major threaten to the existence of the schuppen structure as it is exposed on a larger stretch of land (Pavlovec, 1992; Pleničar et al., 1973).

### 4. Paleolithic stations Črni Kal and Roška Špilja

The Črni Kal quarry disclosed a cave system, filled with autochthonous cave sediments belonging to Riss-Würm glacial and Riss-Würm interglacial. The remains of the cave bear are to be found in nearly all the strata, the remains of the cave lion and hyaena being rather sporadic, though. In the sediments from the Riss-Würm interglacial, fireplaces, burnt bones and silex

were discovered. A sidescraper, as well as char chips spotted in the rubble prove the presence of the Neanderthal man who used to visit the cave in the Early Würm. The Middle Würm clays shelter the remains of roe deer, red deer, wisent, aurochs, ibex, kirchberg rhinoceros, cave hyaena

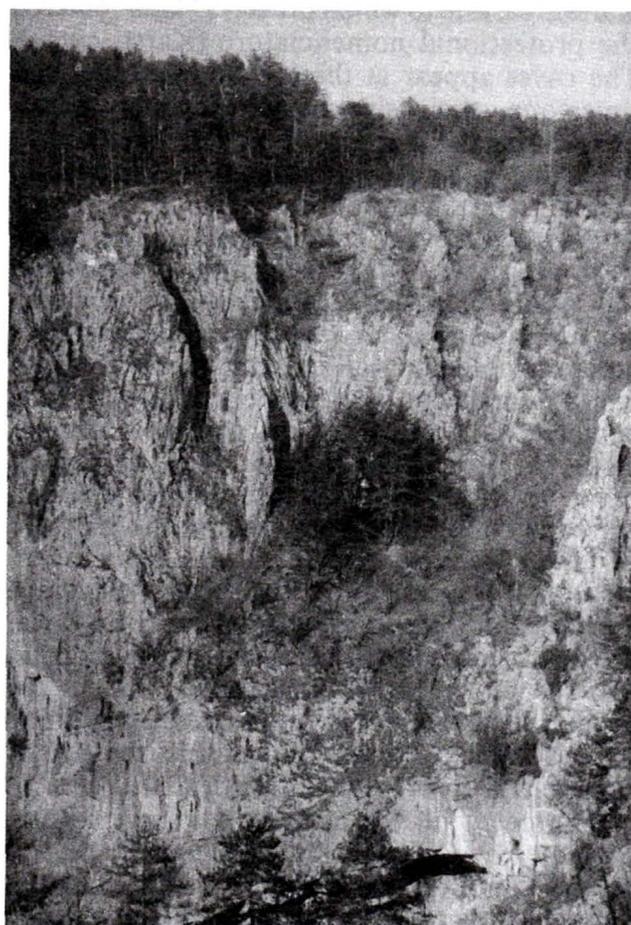


Fig. 6. Karst system of the caves Skocjanske jame. In the middle of the wall there is the paleolithic station Roška špilja (points 4 and 5)  
Photography by Gregor Stante

and cave bear. In the central parts of Europe the kirchberg rhinoceros became extinct during the Riss-Würm interglacial period. In the vicinity of Črni Kal, however, it was still existent in the Middle Würm: at that time it was still existing in the southern parts of Europe.

Roška špilja within the cave system of Škocjanske jame served as a cave bear den. In the late glacial rubble, the remains of roe deer, red deer, fallow deer and alpine marmot were found together with an atypic Gravettian point belonging to the Epigravettian.

Due to the unfortunate location of the Paleolithic station of Črni Kal, i. e. the quarry, it has been partly destroyed (having been previously fully investigated). Roška špilja, on the other hand, figures in the complex of the caves of Škocjanske jame, which are already under protection (Brodar, Osole, 1979; Brodar, 1958; Pohar, 1992; Rakovec, 1958).

## 5. The caves of Škocjanske jame near Divača

They represent the greatest, the most profound and unique natural phenomenon of the classic Karst area, due to which the term "kras" entered the professional nomenclature (Karst, carso). The caves appear at the contact of flysch and limestone, their size being extremely great, considering the fact that they represent only the beginning of a subterranean system. The entire system stretches out to the sources of the Timavo River near Tržič (Monfalcone), to the west of Trieste, i. e. at a distance of nearly 40 km. Additionally to the grandiose subterranean spaces (dry and water caves), disappearing river streams, collapse dolines, etc. there is also a world famous curiosity, namely, a two-km-long subterranean canyon of extraordinary dimensions, having a height of up to 144 m and a width of up to 80 m. The collapse dolines offer an extremely developed ecosystem at the juncture of the Mediterranean, sub-Mediterranean, Central European, Iliric and Alpine elements. In the subterranean system of the river Reka, the rare fauna is preserved as well as the endemic *Proteus anguinus*. In the cave system the archaeological findings were discovered pertaining to Mesolithic, Neolithic, Eneolithic, the Age of Bronze and Iron, Antique and Middle Ages.

The caves of Škocjanske jame are legally protected by a municipal decree and are placed on the UNESCO list of world heritage. As the municipal decree does not meet the importance of safeguarding of such a monument, a special law on the caves of Škocjanske jame is under way (Gospodarič, 1984).

## 6. Kozina beds

They are named by the place of Kozina, their age being that of the Paleocene. Rather bituminous limestones prevail, interlaced with coal strata which used to be exploited. Of special interest in the Kozina beds, besides the molluscs and comparatively rare corals, are the Characea algae. In some parts, we come across undamaged plants (as for ex.: in the vicinity of Divača), elsewhere only oogonia are to be found, which points, at least, to a shorter transport. The sedimentation was quickly changing from a terrestrial phase of short duration passing probably through brackish to truly marine beds. The development of the Kozina layers is clearly seen along the regional road Postojna — Koper, yet the observation is rather difficult due to a heavy traffic. The oogonia rich beds are between Divača and Vremški Britof (Drobne, Pavlovec, 1991; Stache, 1889).

## 7. Vreme beds

Named by the place Vremški Britof, lying to the east of Divača. They originate from the Upper Cretaceous (Maastrichtian). The dark bituminous limestones include coal which used to be exploited in the past. At least a part of the Vreme beds originate from the lagoons with a rather agitated sea water. Therefore, some horizons abound in shells of *Gyropleura*, *Apricardia* order and others. Lots of shells are damaged and crushed. In some horizons there are plenty of foraminifers of the *Rhaphydionina liburnica* order which was first dealt with not far from Vremški Britof. The road cut near Vremški Britof should be protected and the gathering of the fossil material allowed exclusively for scientific purposes. (Pavlovec, Drobne, 1991).

## 8. Basal flysch beds

They are situated below Vremščica, east of Pivka. In the base, there is limestone with alveolinas and nummulites. Basal flysch beds are interesting due to the presence of olistostroms with a clearly perceptible graded sedimentation. In the lower part, there are olistolites measuring up to one meter, in the upper parts, however, where the force of the submarine slide has already diminished, the rocky parts appear more and more minute. These layers are extremely abundant in nummulites, other fossils making themselves rarer, though. (Pavlovec et al., 1991).

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