VREME BEDS AND THE GENESIS OF THE KARST CAVES IN THEM IN WIDER SURROUNDINGS OF ŠKOCJANSKE JAME (ŠKOCJANSKE JAME CAVES, SLOVENIA)

VREMSKE PLASTI IN RAZVOJ KRAŠKIH JAM V TEH PLASTEH V ŠIRŠI OKOLICI ŠKOCJANSKIH JAM

MARTIN KNEZ

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Knez, Martin: Vremske plasti in razvoj kraških jam v teh plasteh v širši okolici Škocjanskih jam

Vremske plasti (maastrichtij) sestavljajo predvsem drobnoplastnati temni apnenci, ki so ponekod močno bituminozni, redkeje laporni apnenci in premogovi skrilavci ter ponekod vložki premoga. Po strukturi je apnenec biomikrit tipa wackstone-packstone. Med omenjenimi plastmi se pojavljajo tudi breče, ki so najverjetneje singenetskega nastanka. Fosilni ostanki kažejo, da se je večji del vremskih plasti sedimentiral v plitvem morju. Na obravnavanem ozemlju je v vremskih plasteh samo 6,2% vseh jam oziroma komaj 0,3 jame/km^2, kar je dve tretjini pod povprečjem.

Ključne besede: krasoslovje, geologija, paleoekologija, litostratigrafija, vremske plasti, Škocjanske jame, Slovenija

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Knez, Martin: Vreme beds and the genesis of the karst caves in them in wider surroundings of Škocjanske jame (Škocjanske jame caves, Slovenia)

The Vreme beds (Maastrichtian) are composed mainly of dark thin bedded, sometimes strongly bituminous limestones and rarely marly limestones and coal shales and inliers of the coal. According to structure the limestone is biomicrite of wackstone-packstone type. Among the mentioned beds there are the most probably the syngenetic breccias too. Fossil remains and sedimentological data show that the major part of the Vreme beds was deposited in a shallow sea. On the treated area there are in Vreme beds 6,2% of all the caves only, or 0,3 cave/km^2 respectively, which means two thirds below the average.

Key words: Karstology, Geology, Paleoecology, Litostratigraphy, Vreme beds, Škocjanske jame (Škocjanske jame caves), Slovenia

Naslov - Address
mag. Martin Knez, dipl. ing. geol., raziskovalni sodelavec
Inštitut za raziskovanje krasa ZRC SAZU
66230 Postojna, Titov trg 2
Slovenija

INTRODUCTION

Out of 6000 karst caves registered on the Slovenian karst which covers about 40% (8800 km2) of the country we have chosen the area of the wider surroundings of Škocjanske jame (102 km2) where 113 speleological objects are registered. The region is built by Cretaceous and Paleogene rocks which are the most common in the area of the Classical Karst of southwestern Slovenia. The statistical data processing was done in order to find out the given regularities in the appearance of the karst caves. As already inferred by M. Garašić (1986; 1989; 1991) the geological conditions dominantly control the karst objects formation. The influence of temperature or altitude, for example could be considered after thought for both paleoclimatic and paleogeographic influences on the formation of the cave objects during their genesis which have not yet been studied in detail.

Before the karst caves statistical processing on the mentioned area we anticipated from the Cave Register that the Liburnian beds are poor regarding the speleological objects. It is known that the Cretaceous beds are generally much richer. This is why I tried to establish in which conditions the Vreme beds, the beds of Liburnian formation respectively, have been deposited.

PALEOECOLOGICAL AND LITHOSTRATIGRAPHICAL PROPERTIES OF THE LIBURNIAN FORMATION AND OF VREME BEDS IN THE WIDER VICINITY OF ŠKOCJANSKE JAME WHERE ONLY FEW SPELEOLOGICAL OBJECTS DEVELOPED

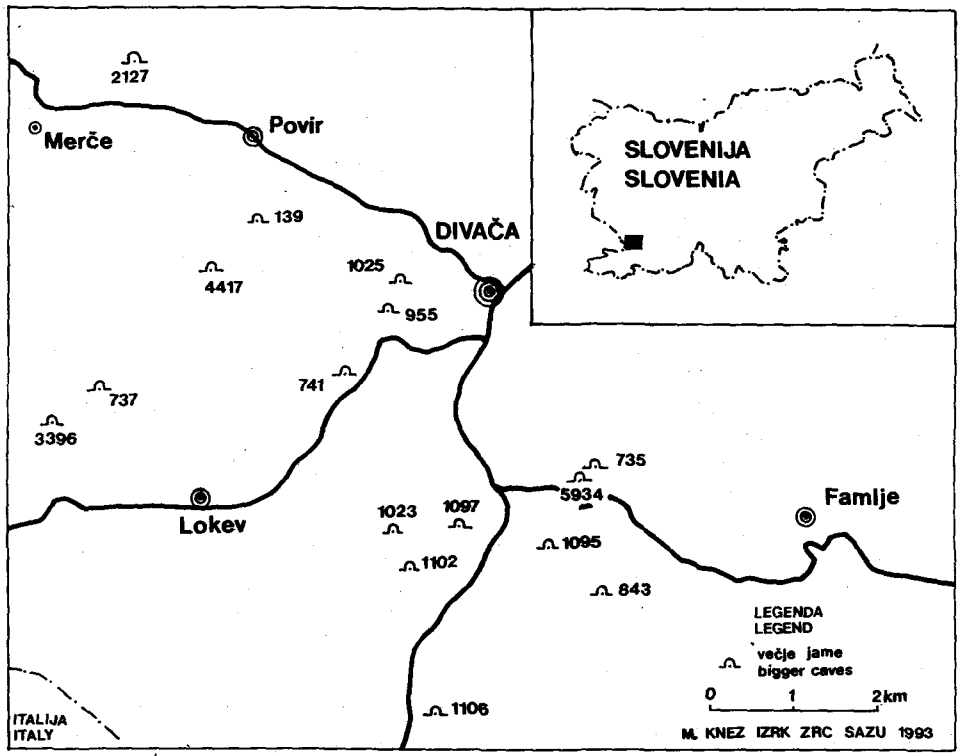
The least number of all speleological objects were identified in the upper part of the Liburnian formation, in the Vreme beds (upper part of the Upper Cretaceous - Maastrichtian). A lot of stratigraphic, biostratigraphic, lithological, sedimentological and other researches were carried out in the Vreme beds. Most of them were done from one aspect only. Just a few of them offer a conclusion in form of synthesis from various points of view. None of them includes the karstological or speleological viewpoint. Therefore the connection of lithological, petrological, stratigraphical and biostratigraphical statements with speleological findings and speleological development in past is surely interesting.

Lithostratigraphical properties of the rock where the speleological object could potentially develop (M. Garašić, 1986) are undoubtedly the most important for the origin and development of the speleological objects. The karstification of the rock is a relatively regular process and according to stratigraphy and lithology the beds, where the speleological objects developed, could be defined.

In 1872 G. Stache denominated the Liburnian formation or Protocene as prevailingly carbonate sediment occuring in southwestern Slovenia and Istria among Rudist limestones and limestones with Alveolina and Nummulites.

Today the lower part of the Liburnian formation is called the Vreme beds; they are of Maastrichtian age, the central part are Danian Kozina beds and the upper part limestones with Milliolidae of Thanetian age (R. Pavlovec & K. Drobne, 1991).

M. Pleničar, A. Polšak and D. Šikić (1973) wrote that the region of the

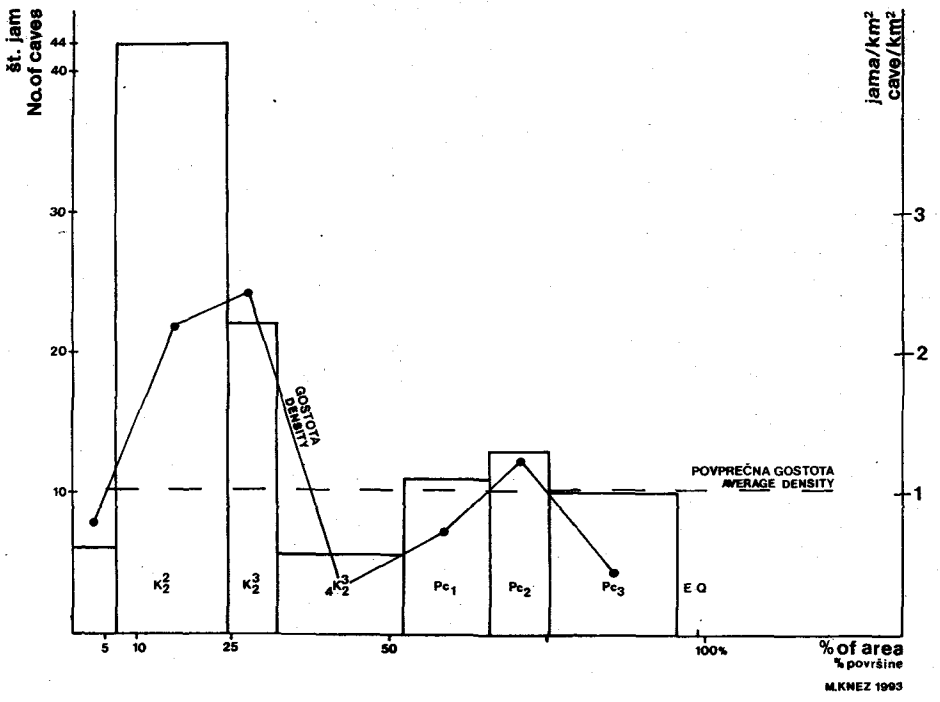


Slika 1. Skica ozemlja med Merčami in Lipico na vzhodu, Senožečami in Barko na zahodu ter Kačičami na jugu, z označenimi večjimi jamami.
Fig.1. The sketch of the region between Merče and Lipica on the east, Senožeče and Barka on the west and Kačiče on the south with bigger caves drawn in.

Slovenian Littoral was taken by Laramian folding at the end of the Cretaceous. In Danian and in Paleocene the sea transgressed into formed sinklines. According to D. Šikić and M. Pleničar (1975) there are the signs of general uplifting of the territory at the end of Cretaceous. On the passage of Cretaceous to Tertiary the sea bottom oscillated several times.

Similar is the description of the history of this part given by S. Buser (1973). In upper Senonian some parts of the Trieste Komen plateau were uplifted out of the sea. In Senonian and Paleocene the marine, brackish and fresh water conditions of sedimentation alternated frequently.

The breccias and bauxites of the Liburnian formation found on many places in Primorska indicate the then sea regression which is supposed to be shallow with local patches of land. In the sea lagoons and partly in the fresh water lakes the Liburnian formation sedimentation proceeded without any important intermediary tectonic movements (M. Pleničar, 1961). The uplifting



Slika 2. Grafični prikaz razporeditve jam na obravnavanem ozemlju.
Fig.2. Graphic presentation of the caves distribution on the treated area.

occured at the end of Cretaceous but it had the character of epirogenetic and not orogenetic process (M. Pleničar, 1970).

After the sedimentation of the beds with rudists the regression followed to which the Vreme beds are owed (R. Pavlovec & M. Pleničar, 1981).

In Slovenia the Maastrichtian beds developed in limestone and marly facies. Within the marly development they occur as the marine sediments, while in the limestone one as marine, brackish and fresh water beds. J. Pavšič (1976, 1979) wrote about the marly development of the Maastrichtian and about the marly sandstone development (flysch). In southwestern Slovenia the limestone development was defined only (M. Pleničar & R. Pavlovec, 1981).

The Vreme beds are composed mainly dark thin bedded, sometimes strongly bituminous limestones and rarely marly limestones and coal shales and inliers of the coal (M. Pleničar, 1956; M. Hamrla, 1959, 1960; R. Pavlovec, 1965). According to structure the limestone is biomicrite of wackstone-packstone type. Among the mentioned beds there are most probably the syngenetic breccias too (K. Drobne & R. Pavlovec, 1991), where Burnonians are found on some places (K. Drobne et al., 1989). On some places thin gastropoda and thin shelled shells and small micritic plasticlasts appear. Micritic base indicates frequent signs of bioturbation and is washed out in places. In some horizons there are numerous shells (M. Pleničar, 1961) of Gyropleura and Apricardia genus (M. Pleničar, 1993), Rhapydionina liburnica foraminifera, Montcharmontia appenninica and milliolids (K. Drobne, 1981; R. Pavlovec & K. Drobne, 1991). The Rudists and Gyropleura shells were subdued to intensive activity of endolites (K. Drobne et al., 1988).

Fossil remains and sedimentological data show that the major part of the Vreme beds was deposited in a shallow sea (M. Hötzl & R. Pavlovec, 1981; R. Pavlovec, 1981) on a quiet and leeward shelf with the energy index 1-2 (K. Drobne et al., 1989), near the coast and partly in shallow lagoons (K. Drobne & R. Pavlovec, 1991) which were the most probably seasonally bordered by the rudist bioherms (R. Pavlovec & M. Pleničar, 1983). Such environment should exist uniformly on wider region of the Slovenian part of the Outer Dinarides (K. Drobne et al., 1989).

KARST PHENOMENA IN SLOVENIA AND IN WIDER VICINTY OF ŠKOCJANSKE JAME

In Slovenia karst phenomena developed in the Paleozoic limestones, in the limestones and dolomites of the Mesozoic and in the Tertiary limestones, in the limestone sandstones, in the marly limestones and in the conglomerates. The karstification extent and depth depend on thickness, extension and frequency of appearance of porous and permeable carbonate rocks on a given area. The biostratigraphical age of the rocks influences to the origin of the karst phenomena too. Till now it is not yet explained why there is on the

Classical Karst the best developed superficial and underground karst just in the Upper Cretaceous rocks (R. Gospodarič, 1986). It is possible that these rocks are more subdued to karstification as they are primary and secondary more permeable as the mantle Paleocene limestones are; maybe they were tectonically deformed at the passage from Cretaceous to Tertiary already and exposed on temporary land to the first effects of karstification.

From the point of view of karstification the lithologic-petrological setting of the Cretaceous beds is interesting as well. In micritic and sparitic limestones there are included dolomitized and silicified limestones which impede the karstification on the surface and in the undergroubnd due to weak solubility. In the same manner different bedding and connected different fissures within the limestone blocks are interesting, influencing the morphology of the underground passages and the shapes of the superficial karst.

The most widespread and at the same time the most favourable rocks for the karstification in Slovenia are Jurassic and Lower and Upper Cretaceous rocks. In these rocks Postojnska jama, Škocjanske jame, Planinska jama and Križna jama developed and these are our the biggest cave systems.

For a more complex review of the Škocjanske jame problematics in the wider vicinity of the cave system all 113 caves, registered in the Cave Register were statistically processed; they are situated between Merče and Lipica on the east up to the Senožeče and Barka on the west and Kačiče on the south (Fig. 1). Treated were 15 maps in the scale 1:5.000, namely Sežana from 23 to 27, 33 to 37 and 43 to 47. The surface of the entire territory amounts to 102 km^2.

To define a particular lithostratigraphic unit on the studied area I used the basic geological maps, sheets Gorica (S. Buser, 1968), Postojna (S. Buser, K. Grad & M. Pleničar, 1967), Trst (M. Pleničar, A. Polšak, & D. Šikić, 1969) and Ilirska Bistrica (D. Šikić, M. Pleničar, & M. Šparica, 1972). I set apart the following units: Lower Cretaceous and Cenomanian, Turonian, Senonian, Maastrichtian, Danian, Thanetian, Illerdian, Eocene (flysch) and Quaternary.

Cretaceous

In the Lower Cretaceous and Cenomanian limestones and dolomites, covering 7.08 km^2, there are 6 caves or 5.31% of all the caves of the treated area (Fig. 2). One km^2 only is of limestones and 6.08 km^2 of dolomites; in dark grey bituminous limestones of this unit there are no caves.

Dark grey and sometimes snow white fine grained Turonian limestones alternating with grey rudist limestone cover 18.20 km^2, which is 17.84% of the surface. In this unit there are 44 or more than one third of all cave objects included into the study.

On 8.20 km^2 (8.04%) built by Senonian pale grey limestone with numerous rudists 22 caves (19.47%) are registered.

In grey to dark grey bedded Maastrichtian limestones (Vreme beds) there are on the treated area 7 caves, which is 6.20%. Maastrichtian beds cover

about 19.72 km^2 or 19.33%.

Tertiary

Characteristic compact, black or brown, sometimes silicified, sometimes crystalline and bituminous Danian limestones cover 13.99 km^2 (13.72%). 11 cave objects or 9.73% were discovered in them.

Thanetian milliolid limestones (the upper part of the Liburnian formation) with 13 caves cover a bit less of the territory (9.52 km^2 or 9.33%).

In spite the fact that the rather compact, mostly granular alveoline-nummulitic limestone covers the biggest amount of the territory 20.89 km^2 or 20.48%) only 10 caves (8.85%) were registered in it.

In flysch rocks (2.88 km^2 or 2.83%) there are no caves.

Quaternary

Quaternary deposits cover altogether 1.52 km^2 (1.49%). No karst caves have yet been found in them.

CONCLUSION

I have calculated from the cited data that the average cave density on the entire area amounts to 1.01 cave/km^2 (Fig. 2). For Lower Cretaceous and Cenomanian this factor is 0.77, for Turonian 2.18, for Senonian 2.42, for Maastrichtian 0.32, for Danian 0.71, for Thanetian 1.23 and for Illerdian 0.43 For Maastrichtian, Danian and Thanetian together, for the Liburnian formation respectively it is 0.75 which is for one quarter below the average.

Summing up the cited lithostratigraphical data of the treated territory where the speleological objects developed I can conclude that the most objects are formed in the Cretaceous rocks, with the greates density in the Senonian limestones. In the area including lithostratigraphic links from Lower Cretaceous to Quaternary there are only no cave objects found in Eocene flysch and Quaternary sediments.

According to the previous knowledge of the Vreme beds the answer to question why there are the least caves in the Maastrichtian Vreme beds, which is without doubt an interesting date by itself, the answer must be probably searched in rather specific conditions in the basin during the sedimentation of the Liburnian formation. By the manner and by the in the introduction mentioned starting points this problematics was not yet studied in detail this is why it is without doubt necessary to continue with petrological, sedimentological and chemical researches beside the paleoecological and lithological ones.

LITERATURE

Arhiv IZRK ZRC SAZU, Postojna. Jamski kataster (Cave Register).

Buser, S. 1968, Osnovna geološka karta SFRJ Gorica 1:100 000.- Zvezni geološki zavod Beograd, Beograd.

Buser, S., 1973, Tolmač lista Gorica. Osnovna geološka karta SFRJ 1:100 000.- Zvezni geološki zavod Beograd, 50 str., Beograd.

Buser, S., Grad, K. & Pleničar, M. 1967, Osnovna geološka karta SFRJ Postojna 1:100 000.- Zvezni geološki zavod Beograd, Beograd.

Drobne, K. 1981, Značilne foraminifere in njih združbe v podlagi danijskih plasti.- Simpozij o problemih danija v Jugoslaviji, Zbornik referatov, Proceedings, 2, 85-97, Ljubljana.

Drobne, K. & Pavlovec, R. 1991, Paleocene and Eocene Beds in Slovenia and Istria.- Introduction to the Paleogene, SW Slovenia and Istria, Field-Trip Guidebook, IGCP Project 286-Early Paleogene Benthos 7-17, Ljubljana.

Drobne, K., Ogorelec, B., Pleničar, Barattolo, F., Turnšek, D. & M., Zucchi-Stolfa, M. L., 1989, The Dolenja vas Section, a Transition from Cretaceous to Paleocene in the NW Dinarides, Yugoslavia), Mem. Soc. Geol. It., 40, (1987), 73-84, 2 ff., 6 tavv. n. t., Roma.

Garašić, M., 1986, Dominantan utjecaj geoloških uvjeta na morfološke i hidrogeološke tipove speleoloških objekata u hrvatskom kršu.- Naš Krš, 12, 21, 57-63, Sarajevo.

Garašić, M. 1989, New concept of the morfogenesis and hydrogeology of the speleological objects in karst area in Croatia (Yugoslavia).- Proceedings, 10th International Congres of Speleology, 1, 234-236, Budapest.

Garašić, M. 1991, Morphological and hydrogeological classification of speleological structures (caves and pits) in the Croatian karst area.- Geol. vjesnik, 44, 298-300, Zagreb.

Gospodarič, R., 1986, O geološkem razvoju klasičnega krasa.- Acta carsologica, 14/15, 19-29, Ljubljana.

Hamrla, M. 1959, O pogojih nastanka premogišč na krasu.- Geologija, 5, 180-264, tab. 1-6, Ljubljana.

Hamrla M. 1960, K razvoju in stratigrafiji produktivnih liburnijskih plasti Primorskega krasa.- Rudar. - metal. zbornik, 3, 203 - 216, Ljubljana.

Hötzl M. & Pavlovec R., 1981, Vremske plasti kot podlaga danijskim plastem v Zahodnih Dinaridih.- Simpozij o problemih danija v Jugoslaviji, Zbornik referatov, 133-136, Ljubljana.

Pavlovec, R. 1965, Regionalni obseg liburnijskih plasti.- Geologija, 8, 135-138, Ljubljana.

Pavlovec R., 1981, Nekaj primerjav s plastmi liburnijske formacije izven jugoslovanskega ozemlja.- Simpozij o problemih danija v Jugoslaviji, Zbornik referatov, Proceedings, 2, 167-174, Ljubljana.

Pavlovec, R. & Drobne, K., 1991, The Vremski Britof Profile, Upper

Maastrichtian.- Introduction to the Paleogene, SW Slovenia and Istria, Field-Trip Guidebook, IGCP Project 286-Early Paleogene Benthos 43-45, Ljubljana.

Pavlovec R. & Pleničar M., 1981, The boundary between Cretaceous and Tertiary in the limestone beds of the West Dinarides.- Rudar.-metal. zbornik, 28/1, 25-31, Ljubljana.

Pavlovec R. & Pleničar, M., 1983, Der ältere Teil der Liburnischen Formation in den NW-Dinariden.- Zitteliana, 10, 195-199, München.

Pavšič, J., 1976, Zgornjekredne in paleocenske foraminifere ter nanoplankton Slovenije.- 8. jugoslovanski geološki kongres, 2, 249-262, Ljubljana.

Pavšič, j., 1979, Zgornjekredni in paleocenski nanoplankton v Posočju.- Geologija, 22, 225-276, Ljubljana.

Pleničar, M. 1956, Razvoj paleocena in eocena v Sloveniji.- Prvi jugosl. geol. kongres, Bled, Predavanja in poročila, 45-46, Ljubljana.

Pleničar, M., 1961, Startigrafski razvoj krednih plasti na južnem Primorskem in Notranjskem.- Geologija, 6, 22-145, Ljubljana.

Pleničar, M., 1970: Tolmač lista Postojna. Osnovna geološka karta SFRJ 1 : 100.000.- Zvezni geološki zavod Beograd, 62 str., Beograd.

Pleničar, M. 1993, Apricardia pachiniana Sirna from lower part of Liburnian beds at Divača (Triest-Komen Plateau).- Geologija 35, 65-68, Ljubljana.

Pleničar, M. & Pavlovec, R., 1981, Novi pogledi na razvoj maastrichtija pri nas.- Rudar.-metal. zbornik, 28/4, 383-386, Ljubljana.

Pleničar, M., Polšak, A. & Šikić, D. 1969, Osnovna geološka karta SFRJ Trst 1:100 000.- Zvezni geološki zavod Beograd, Beograd.

Pleničar, M., Polšak, A. & Šikić, D., 1973: Tolmač lista Trst. Osnovna geološka karta SFRJ 1:100 000.- Zvezni geološki zavod Beograd, 68 str., Beograd.

Stache, G., 1872, Geologische Reisenotizen aus Istrien.- Verh. geol. R. A., 215-223, Wien.

Šikić, D. & Pleničar, M., 1975, Tolmač lista Ilirska Bistrica. Osnovna geološka karta SFRJ 1 : 100.000.- Zvezni geološki zavod Beograd, 51 str., Beograd.

Šikić, D., Pleničar, M. & Šparica, M. 1972, Osnovna geološka karta SFRJ Ilirska Bistrica 1 : 100 000.- Zvezni geološki zavod Beograd, Beograd.

VREMSKE PLASTI IN RAZVOJ KRAŠKIH JAM V TEH PLASTEH V ŠIRŠI OKOLICI ŠKOCJANSKIH JAM

Povzetek

Veliko stratigrafskih, biostratigrafskih, litoloških, sedimentoloških in drugih raziskav je bilo opravljenih v vremskih plasteh. Nobena od njih pa ne vključuje krasoslovnega oziroma speleološkega vidika. Zato je nedvomno zanimiva povezava litoloških, petroloških, stratigrafskih in biostratigrafskih ugotovitev s speleološkimi raziskavami.

Že pred statistično obdelavo kraških jam na omenjenem področju, se je glede na podatke Katastra jam dalo slutiti, da so plasti liburnijske formacije revne s speleološkimi objekti. Da so kredne plasti v splošnem z njimi mnogo bogatejše je znano že dalj časa.

Za kompleksnejši pogled v problematiko Škocjanskih jam je bilo na širšem območju Škocjanskega jamskega sistema, med Merčami in Lipico na vzhodu do Senožeč in Barke na zahodu in Kačičami na jugu (slika 1), statistično obdelanih 113 v Katastru jam identificiranih kraških jam. V obdelavo je bilo tako zajetih 15 kart v merilu 1:5000.

Najmanj jamskih objektov je identificiranih v zgornjem delu liburnijske formacije oziroma v vremskih plasteh (vrhnji del zgornje krede - maastrichtij).

Izračunal sem, da je povprečna gostota jam na celotnem ozemlju 1,01 jame/ km^2. Za spodnjo kredo in cenomanij je ta faktor 0,77, za turonij 2,18, za senonij 2,42, za maastrichtij 0,32, za danij 0,71, za thanetij 1,23, ter za ilerdij 0,43 (slika 2). Za maastrichtij, danij in thanetij skupaj, oziroma za liburnijsko formacijo pa 0,75, kar je za četrtino pod povprečjem.