SLOVENIAN NATIONAL COMMISSION FOR UNESCO
SPELEOLOGICAL ASSOCIATION OF SLOVENIA
and
KARST RESEARCH INSTITUTE ZRC SAZU

11th INTERNATIONAL KARSTOLOGICAL SCHOOL

"CLASSICAL KARST"

KARST TERMINOLOGY

GUIDE BOOKLET OF THE EXCURSIONS AND ABSTRACTS OF LECTURE OR POSTER PRESENTATIONS

POSTOJNA, JULY 2003

Petelinjsko jezero periodical lake in dry season (Photo: N. Ravbar).

Organizer:
Karst Research Institute
Scientific Research Center of the
Slovenian Academy of Sciences and Arts

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CONTENTS

Page:

PROGRAM OF THE KARSTOLOGICAL SCHOOL

Tuesday, July 1, 2003

19.00-21.00 Registration of participants

Wednesday, July 2, 2003

8.00–12.00 Registration

8.30–8.40 Opening
T. SLABE, Head of the Karst Research Institute ZRC SAZU

8.40–10.30 Lectures (Chairman: P. Bosak)
A. KRANJC: Acad. Prof. Ivan Gams and his Karst Researches (at his 80th anniversary),
J. KUNAVER: The contribution of Ivan Gams to the development of the Slovene karst terminology,
J. NICOD: The contribution of Professor Ivan GAMS to the knowledge on the Geography of Slovenia and Karst problems among the French geographers,
H. TRIMMEL: Remarks concerning the development of the Karst terminology from the past up to today.

10.30–11.00 Break

11.00–13.00 Lectures (Chairman: D.J. Lowe)
K. MAIS: Development, advantage and enlargement of speleological terminology,
A. GINÉS: Terminology as a useful tool of karst research: the case of karren features,
A. MIHEVC: Karst terminology on the International Karstological schools "Classical Karst"
A. TYC: Contribution of experiences from Classical Karst to karst evolution of Cracow-Czestochowa Upland in Poland,
U. SAURO: Dolines and sinkholes: aspects of evolution and problems of classification,
F. ŠUŠTERŠIČ: What is karst channel.

13.00-15.00 Break and lunch

15.00-19.00 Afternoon excursion:
Pivka basin

Thursday, July 3, 2003

8.30-10.30 Lectures (Chairman: A. Tyc)

M. PARISE, M. DELLE ROSE: A review of karst terminology in the Apulian karst (southern Italy),

M. CHIRIENCO: The nomenclature of crystals morphology composing calcite moonmilk: example from Humpleu Cave (Romania),

J. BRUTHANS: Karst or pseudokarst? Case study from the Czech Republic,

C. SELF: The Problem with Speleothems,

V. MANGHISI: International lexical elements in the karstic geomorphological terminology related to Apulia (south Italy),

S. ŠEBELA: The use of structural, geological terms and their importance for karst caves.

10.30-11.00 Break

11.00-13.00 Lectures (Chairman: U. Sauro)

B. MADER: Observations on historical terminology,

P. BOSÁK ET AL.: Preliminary report on palaeomagnetic research on Račiška pečina Cave, SW Slovenia

ILONA BÁRÁNY-KEVEI: Human impact on Hungarian karst terrains, with special regard to sylviculture,

MEHMET EKMEKCI: Change in Perception of Karst From Morphology to Morpho-Hydrology,Turkish Experience in Comprehension of Karst,

M. NECDET: Overview of the karst occurances in Northern Cyprus,

M. AHMADIPOUR: Karst springs of Alashtar, Iran,

I. ATALAY: Effects of the tectonic movements on the karstification in Anatolia, Turkey.

13.00-15.00 Break and lunch

15.00-17.00 Poster presentations (Chairwomen: N. Ravbar & S. Šebela)

B. MRAK: Comparison of French and Slovene Karstic and Speleological Terminology,

S. POPIT: Karst terminology in education,

B. ANIČIĆ, I. RECHNER, D. PERICA: Karst structures as a structural vocabulary of cultural landscape on the Krk Island,

J. MULAOMEROVIĆ: About some karst terms in Bosnia and Herzegovina,

C. A. SELF, G. J. MULLAN: Karst and Pseudokarst,

A. MARSICO, G. SELLERI, G. MASTRONUZZI, P. SANSÒ, N. WALSH: Kriptokarst, The case study of the Quaternary landforms of Southern Apulia (Southern Italy),

G. KOVAČIČ, N. RAVBAR: Karst aquifer vulnerability or sensitivity?,
N. BOČIĆ, D. PERICA, S. TRAJBAR: Relation Between Karst and Fluviokarst Relief, On the Example of the Slunj Plateau (Croatia),
G. SZUNYOGH: High-accuracy graphic representation of the underground karst features and formations during cave mapping,
U. STEPIŠNIK: Origin of loamy sediment levels inside collapse dolines,
N. LONČAR: Speleogenesis of the Crveno jezero (Red Lake) near Imotski,
M. FILIPPONI, K. THURO: The stability of large halls in karst caves - a case study on the Abisso di Trebiciano (Trieste; Italy),
R. KASZALA: Investigation of the heavy metal content on the soil and vegetation of Aggtelek Karsts (Hungary),
L. KÜRTI: The effects of landscape use on the hydrogeographical system of The Bükk karst,
N. RAVBAR: Drinking water supply from karst water resources (The example of Kras plateau, SW Slovenia),
D. ANGELOVA ET AL.: Karst and cave systems in Bosnek Region (Vitosha Mountain, Bulgaria) and in Wintimdoine (High Atlas Mountain, Morocco),

S. POPIT: "Kraševci".

17.00-17.30 Break

17.30-19.30 Round table about Karst Terminology
Led by **A. KRANJC,** Participants: **A. TYC, J. NICOD, U. SAURO, A. GINÉS, P. BOSÁK, H. TRIMMEL, A. MIHEVC.**

20.0- Reception

Jernej Verbič-mayor of Commune of Postojna
Zofija Klemen Krek-Slovenian National Commission for UNESCO
Jordan Guštin-Speleological Association of Slovenia

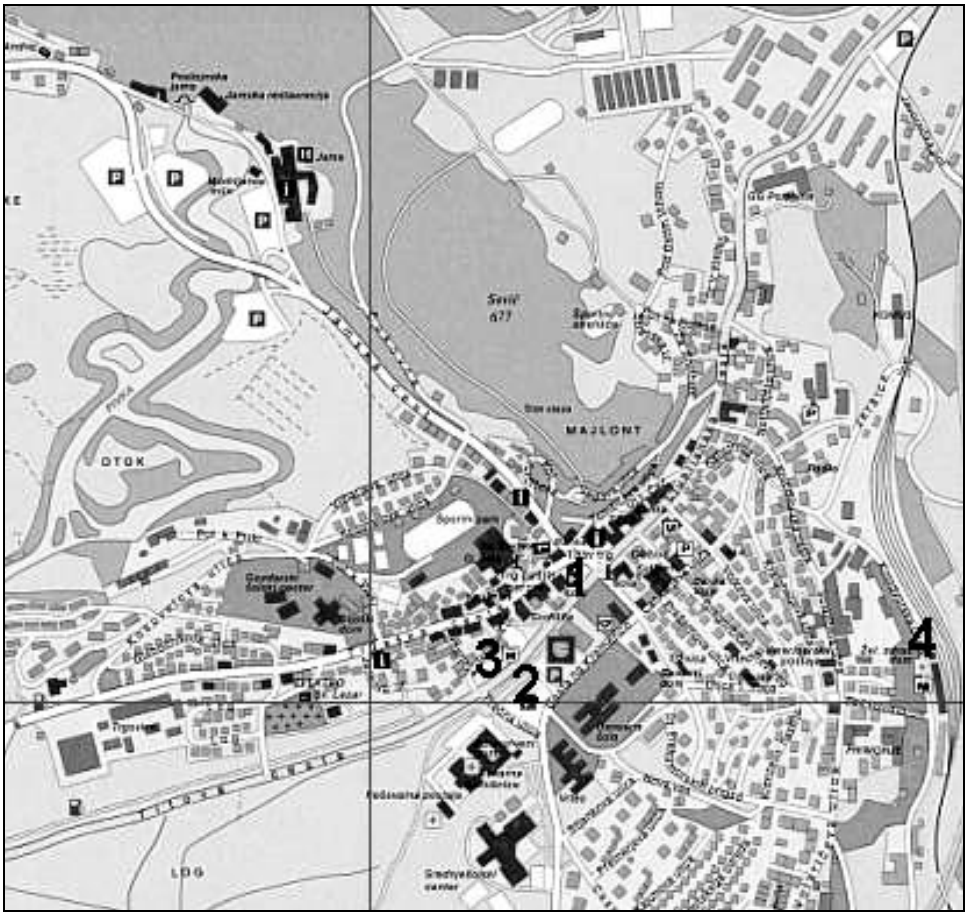
Friday, July 4, 2003

8.30-18.00 Whole day excursion:
Temenica River valley and karst of SE Slovenia

Saturday, July 5, 2003

Departure

POSTOJNA WITH SOME PLACES YOU MIGHT NEED



1-Karst Research Institute ZRC SAZU
2-Parking Place: Meeting Point for the Excursions
3-Bus Station
4-Train Station

NOTES AND HINTS FOR THE PARTICIPANTS

- There is a possibility to have evening slide–show presentations in the Institute's hall. Those of you who are interested, let the organizers know as soon as possible at the registration desk. The slide–show presentations will be announced during regular lecture programme.

- **Departures for field trips:** meeting point for the excursions is at the parking place in front of the Business center Primorka – PTC Primorka (No. 2 on the map, page 7). **PLEASE BE ON TIME!**

- For the field trips suitable field shoes and clothes are needed.

- Organizer will supply some beverages for the field trips. Take some additional beverages with you as well as some food.

- For the whole day trip on 4th July lunch, which is paid by your own, is organized. If you do not want to take organized lunch, prepare your own, because in the village there are no big shops. Please inform the organizers, whether you take meat or vegetarian meal. **In the restaurant they take only cash (Slovene Tolars) !!!**

- **IMPORTANT**! Infected ticks populate the areas of field trips. Use repellent. Do not forget to check yourself carefully for the presence of ticks after the excursions!

- If you have any questions or needs, do not hesitate to ask the organizers for more information. You can recognize them by the badge they wear.

- We wish you a pleasant stay in Postojna.

EXCURSION TO THE PIVKA BASIN

Fig. 1.: Plan for the excursion on Wednesday, July 2, 2003.

Excursion route: 1. Šilen tabor, 2. Kalški izviri springs, 3. Palško jezero lake, 4. Petelinjsko jezero lake.

Overview (S. Šebela, N. Ravbar)

Valley of the Pivka River is situated in the southwestern Slovenia. Numerous Karst plateaus surround it. In the north Nanos and Hrušica steeply raise, in the east, southeast and south Javorniki and Snežnik are taking place, and in the west Slavenski ravnik, that descends into Košana valley, is situated.

Periodical lakes of Pivka valley are developed in Upper Cretaceous limestone that traverses into Eocene and Paleocene limestones in the direction towards W (Fig. 2).

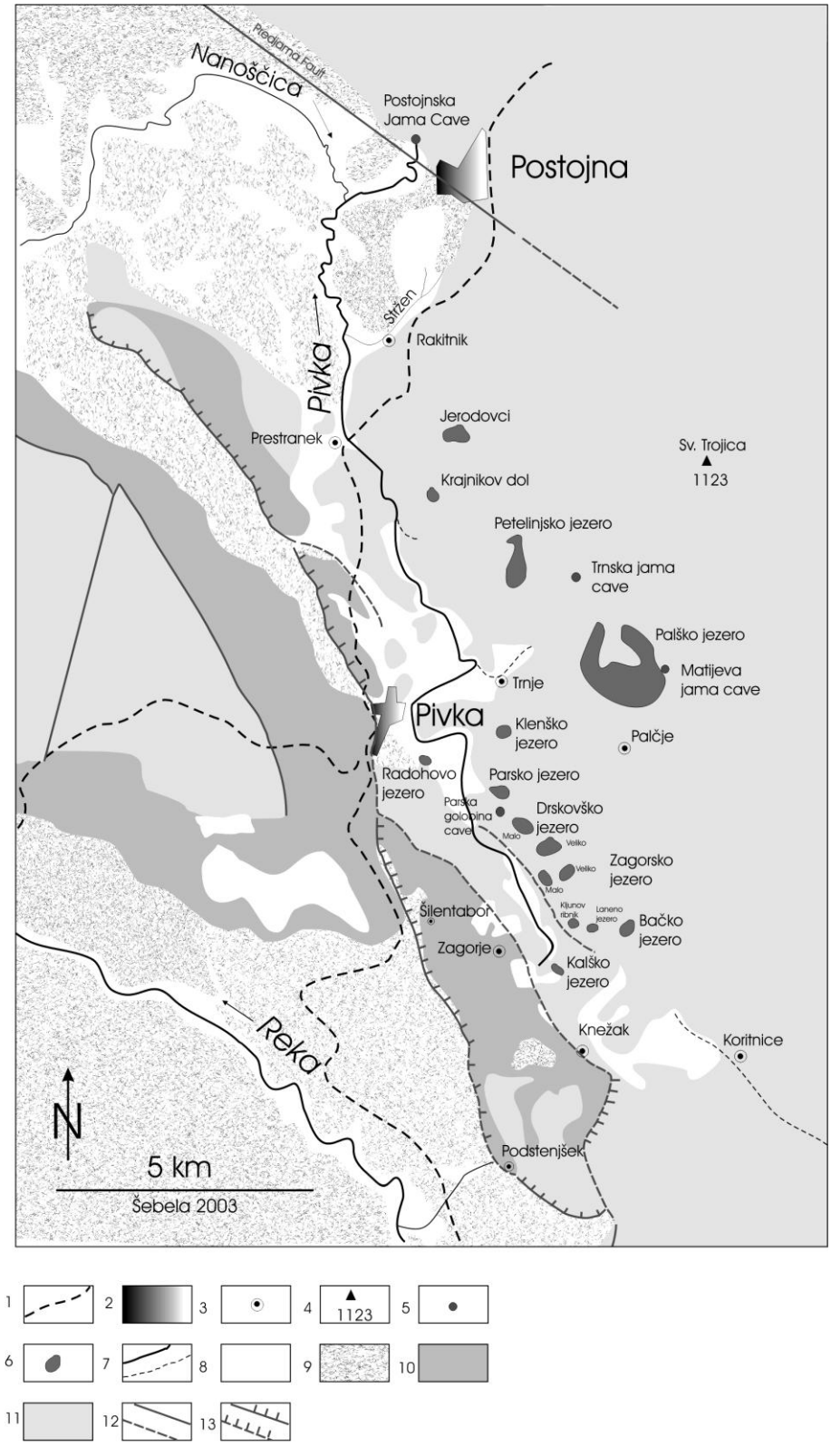


Fig. 2.: Geological map of Pivka valley with periodical lakes, compiled by S. Šebela (after Buser et al. 1967, Šikić et al. 1972, Gospodarič et al. 1970, Placer 1981).

1-railroad, 2-town, 3-smaller town, 4-hill with above sea altitude, 5-karst cave, 6-periodical lake, 7-river; periodical stream, 8-alluvium (Quaternary), 9-flysch (Eocene), 10-limestone (Paleogene), 11-limestone (Cretaceous), 12-fault: established and covered, 13- thrust fault: established and covered.

According to Placer (1999) the area belongs to External Dinarides. Snežnik thrust sheet is overthrusted over Komen thrust sheet.

Between Zagorje and Knežak there is a tectonic window (Pleničar, 1959), where flysch rocks lying under Paleogene limestone are visible. Pleničar (1959) described two tectonic windows, one is situated W from Zagorje, the other is near Knežak.

According to geological structure the flysch base of Pivka valley is close to the surface, what influences the development of shallow karst. In dry season the underground karst waters are 10 m bellow the valley bottom of periodical river Pivka. Low karst waters are passing Postojna flysch valley and flow directly under Javorniki Mountains into Malni springs. This is so-called Javorniki underground flow. High waters pour over the surface and fill stream valley of river Pivka, which runs continually from Zagorje to the ponor of Postojnska jama cave (Habič 1968). The principal Pivka spring is near Zagorje. At high waters the discharge of springs at Pivšce is about 1500 l/s, and in the whole valley near Zagorje 3500 l/s (Habič, 1975). The gradient of Pivka from springs towards the ponor at Postojnska jama cave is just 2.5‰. At high waters karst depressions or uvalas transform into periodical karst lakes (Habič, 1975).

Surficial Pivka had probably once risen in Žlebovi near Koritnice. The biggest part of that water today flows underground into Podstenjšek spring near Šembije (Habič, 1975).

At dry season Pivka appears on the surface between Prestranek and Rakitnik (Pleničar 1959). The duration of surficial Pivka flow through Prestranek is in accordance with average floods duration on Petelinjsko and Palško jezero lakes, what is 3-6 months per year (Kranjc, 1985).

Pivka has special hydrological characteristics that are similar to water conditions on Cerknica polje. The similarities and differences between hydrology of Pivka and Cerknica polje are influenced by geological structure and development of karst. It is obvious that the karstification along Pivka is more developed, the outflow channels are more deepened and also the surficial stream is more deeply cut into the primary surface of Pivka polje, which spreaded from Koritnice to Ravbarkomanda and from Palčje to Bukovje. Along Pivka the traces of gradual displacements of surficial streams into the underground are well visible (Habič, 1975).

Region is generally divided into Upper (Zgornja) and Lower (Spodnja) Pivka basin, where in the central part characteristics of karst and fluvial relief alternate due to different lithology of the basis (Fig. 3). Some people are calling Spodnja Pivka (N from Prestranek) karst **polje**, but most people think it is a depression surrounded by karst; it is a depression with nonpermeable flysch bottom surrounded by permeable karst rocks (limestone and dolomite) (Kranjc, 1985). According with geological structure there are two types of underground water on Pivka: groundwater and karst water.

Upper (Zgornja) Pivka (S from Prestranek) is built mostly of limestone. Bottom of the Pivka valley is partly covered with river sediments. The alluvium covers also the bottoms of bigger karst depressions-periodical lakes (Kranjc, 1985).

Waters in this area are flowing into different directions. When there is high groundwater level, it appears above the surface and fills up the riverbed of the Pivka River, which then continuously flows from Zagorje until it sinks into Postojnska jama cave. Smaller part of the Pivka River already disappears underground into small sinkholes in its riverbed, but mainly continues towards Postojnska jama cave and flows underground towards Planinsko polje. If the water level is low, underground waters flow under Javorniki Mountains towards Cerkniško polje. Javorniki Mountains are constantly draining into springs of the Vipava and Timavo, however, smaller amounts also into springs of the Unica on Planinsko polje (Habe, 1963; Habič, 1989). Waters of the Lokva and Belščica streams that disappear near Predjama flow into spring of the Vipava (Habe, 1970).

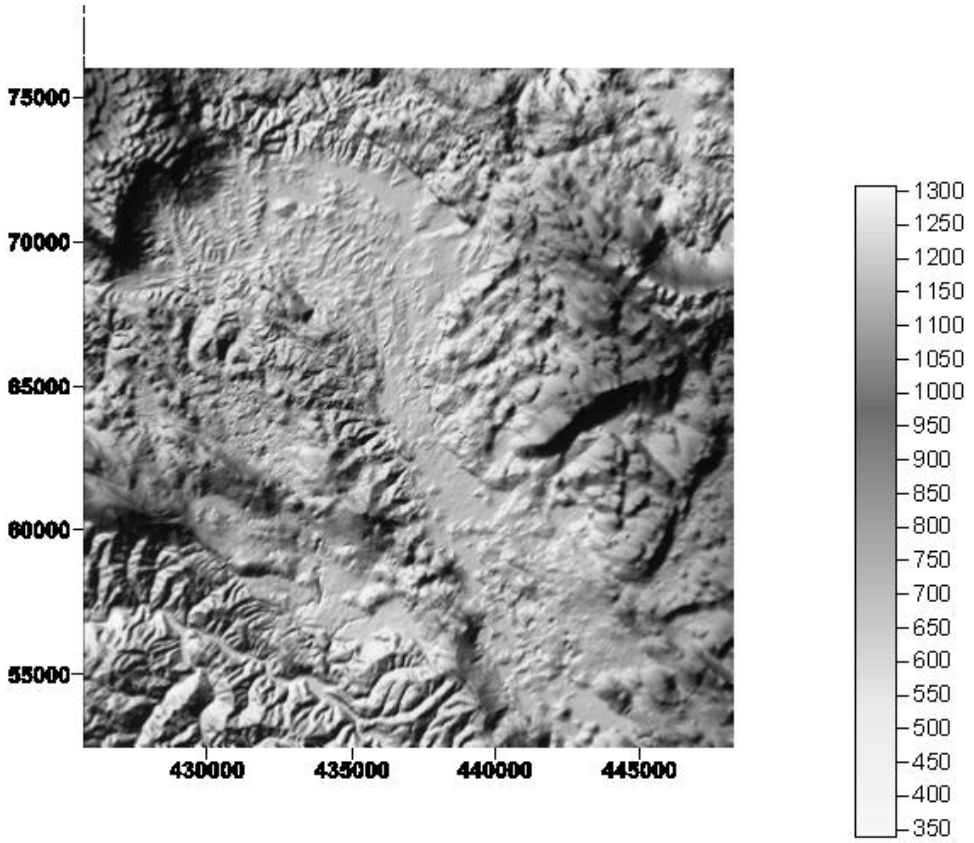


Fig. 3.: DMR of Pivka valley.

Dye injection from Poček (Fig. 4) appeared uncertainly at Žeje springs and in Pivka river near Žeje. Main direction was into Vipava springs and Malni springs near Planina, secondary direction was into Rakov Škocjan (low water level, spring 1997). Through Malenščica and Vipava we detected about 80 % of injected dye (Kogovšek 1999).

At low water level, the waters bellow Javorniki Mountains do not reach the surface on Pivka, but are flowing underground into Planina polje. Part of waters from Upper Pivka flows underground into the Podstenjšek spring and river Reka. That means that on Pivka we have underground karst **bifurcation** between Adriatic and Black sea.

When the level of the underground water rises, shallow karst hollows are flooded and changed into seasonal karst lakes. The list of Pivka periodical lakes with water levels:

Jeredovci 537-538 m

Petelinsko jezero 532-545 m

Palško jezero 543-557 m

Klenško jezero 544-545 m

Parsko jezero 538-540 m

Malo Drskovško jezero 539-540 m

Veliko Drskovško jezero 542-545 m

Malo Zagorsko jezero 549-550 m

Veliko Zagorsko jezero 544-548 m

Jezero za gradom Kalc or Laneno jezero 553-558 m

Bačko jezero 561-563 m

Kalško jezero 554-555 m

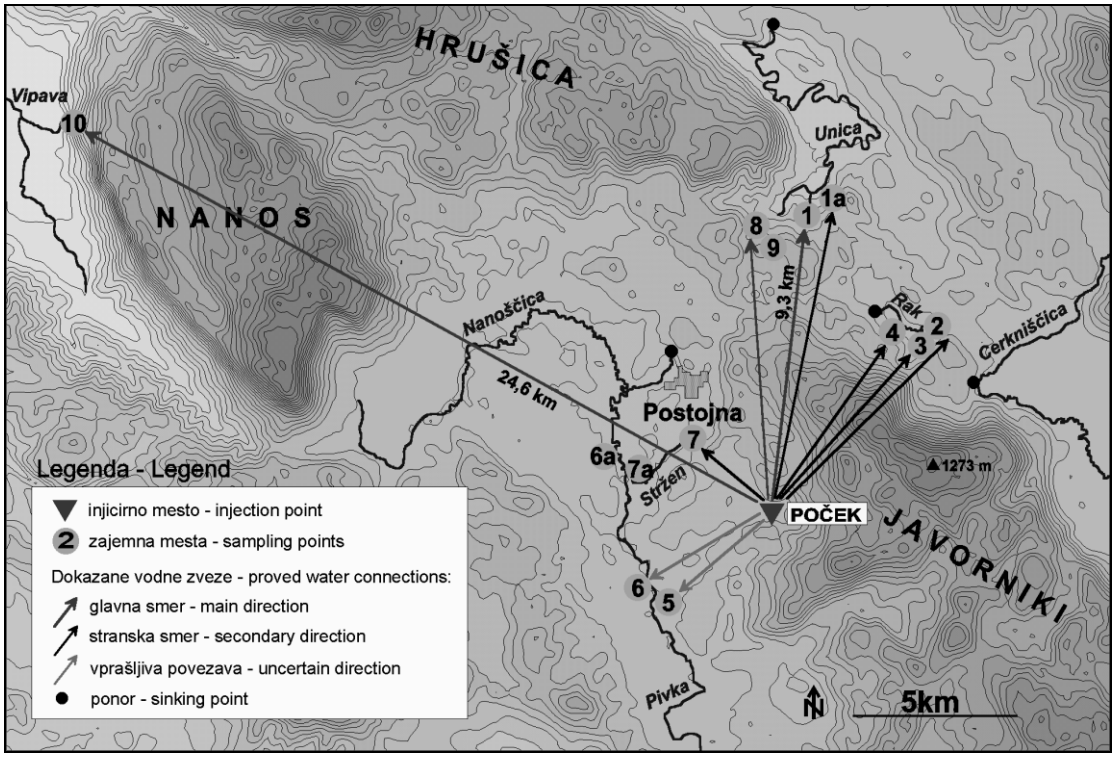


Fig. 4.: Hydrology of Pivka valley (Kogovšek, 1999).

Excursion route:

1. Šilen tabor (751 m) is the hill where in prehistoric time the ancient fort was situated. In mediaeval time there was a castle and the settlement Tabor above Knežak developed bellow the top of the hill. It looks that the ancient fort was the biggest in Pivka valley. The remains show that top of the hill was inhabited also in Roman time. In 1471 the castle on the top was an encampment against invasions. There is an early-christian church of St. Martin (Bavdek, 1999).

2. The temperature and water hardness of karst springs Kalški izviri near Kljunov ribnik lake are different from Pivka springs, that is why we are assuming they have different hydrographical recharge area. At high waters Kalški izviri springs have the discharge about 2000 l/s.

In Parska golobina cave the remains of ice age humans were found. The cave is situated about 10 m above the actual river Pivka. Srečko Brodar described that the cave was part of primarily underground Pivka channels (Habič, 1975).

Because the permeability of Javorniki Mountains in the direction towards Malni springs is bounded, the high waters resurge from underground channels on the surface and fill Pivka riverbed. That is the period when in Upper Pivka numerous karst springs and karst **uvalas** at bottom of Javorniki Mountains are transformed into karst lakes (Habič, 1968).

3. Palško jezero lake is dry 3/4 per year, other karst depressions are filled with water just in very wet periods (Habič 1968). Palško jezero lake is the biggest periodical lake in Pivka valley, it exceeds 1,5 x 1,3 km.

Matijeva Jama cave (Fig. 5) near Palško Jezero is a typical **estavelle** with a considerable oscillation of water level and till now the only larger water cave in which we can reach the karstic waters under the Javorniki mountains in drought periods. After heavy falls of rain it emits up to 6 m^3/s, while the decreasing waters are swallowed by it, and the water level in the cave sinks beneath the altitude of the Pivka riverbed, from which we infer that the waters of Matijeva

Jama also flow directly towards the springs of Malni near Planina. The lowest water level in Matijeva Jama is almost 40 m bellow surface (Habič, 1968). The cave is 36 m deep and 50 m long.

4. The longest floods are in Petelinjsko jezero lake (half of the year), which is situated at the lowest altitude (Habič, 1968).

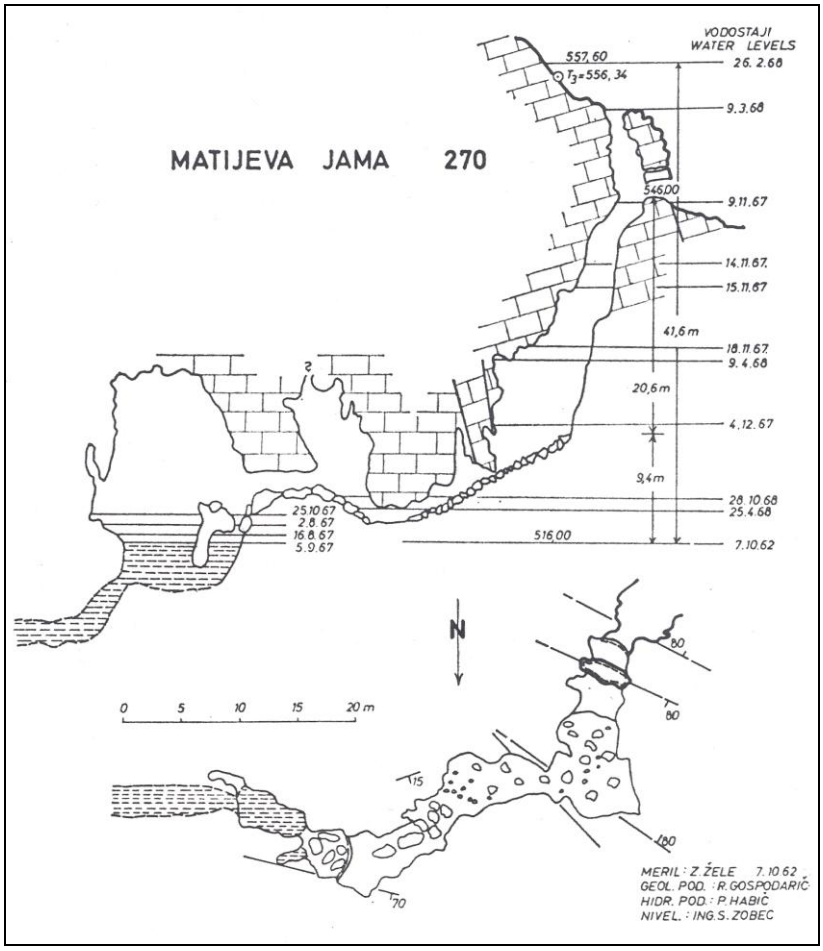


Fig. 5.: The plan of Matijeva Jama cave (Habič, 1968).

Dictionary:

Uvala: A multi-coned closed depression. The term was introduced to describe features assumed to be the second step in a 3-stage process of **polje** development, in which dolines were supposed to coalesce into uvalas. This mechanism is no longer accepted and the term uvala has fallen into discuse (Lowe & Waltham 1995).

Polje: A Large flat-floored closed karst depression, with sharp slope breaks between commonly alluviated floor and the marginal limestone. The form of some poljes is related to the geological structure, but others are purely the products of lateral dissolution and plantation. The word is Slovene (common also to other Slav languages) for a field, reflecting the agricultural value of the alluvial polje floor soils (Lowe & Waltham 1995).

A polje is an extensive (closed) basin with a flat bottom, karstic drainage and steep slope, at least on one side. If the slopes are mostly steep, with a break at the transition bottom, and a sinking

river, the flat bottom is 400 m wide at least. The poljes can be classified from different aspects (Gams, 1973).

Estavelle: Cave opening that acts as either a sinkhole or a spring, depending upon groundwater level (Lowe & Waltham 1995).

Bifurcation: The surficial and underground waters on karst from the same area, or at different water levels flow into different areas and belong to different watershed. The main reason of each karst bifurcation is permeability and karstificability of rocks on different watershed. From hydrological point of view two types of karst bifurcation can be distinguished: water flow in vadoze zone and water flow in epiphreatic and phreatic karst zone (Habič, 1989).

Surficial or underground rive that belongs to two different drainage basins.

References:

Bavdek, A., 1999: Šilen tabor.- Enciklopedija Slovenije št. 13, Mladinska knjiga, 36, Ljubljana.

Buser, S., Grad, K. & Pleničar, M., 1967: Osnovna geološka karta SFRJ, list Postojna 1:100.000.- Zvezni geološki zavod, Beograd.

Habe, F., 1963: Hidrološki problemi severnega roba Pivške kotline. Treći jugoslovanski speleološki kongres, 77-84. Sarajevo.

Habe, F., 1970: Predjamski podzemeljski svet. Die Höhlenwelt von Predjama. Acta Carsologica, 5, 5-94. Ljubljana.

Habič, P. 1968: The underground stream of Javorniki and the water supply of Postojna.- Naše jame 10, 47-54, Ljubljana.

Habič, P. 1975: Pivka in njena kraška jezera.- Ljudje in kraji ob Pivki, 41-54, Kulturna skupnost Postojna.

Habič, P. 1989: Pivka Karst Bifurcation on Adriatic – Black Sea Watershed.- Acta carsologica SAZU XVIII, 233-264, Ljubljana.

Gams, I. 1973: Slovene Karst Terminology.-Ljubljana.

Gospodarič, R., Habe, F. & Habič, P. 1970: The karst of Orehek and the source of the Korentan.- Acta carsologica V/2, 97-108, Ljubljana.

Kogovšek, J. 1999: New knowledge about the underground water drainage in the Northern part of Javorniki Mountains (High Karst).- Acta carsologica 28/1, 161-200, Ljubljana.

Kranjc, A. 1985: Poplavni svet na Pivki.- Ljudje in kraji ob Pivki, druga knjiga, 155-172, Kulturna skupnost Postojna.

Lowe D.J. & Waltham T. 1995: A Dictionary of Karst and Caves.- Cave Studies Series Number 6, British Cave Research Association, 40 p.

Placer, L. 1981: Geologic structure of southwestern Slovenia.- Geologija 24/1, 27-60, Ljubljana.

Placer, L., 1999: Contribution to the macrotectonic subdivision of the border region between Southern Alps and External Dinarides.- Geologija 41, 223-255 (1998), Ljubljana.

Pleničar, M. 1959: Two tectonic windows at Knežaku.- Geologija 5, 5-10, Ljubljana.

Šikić, D., Pleničar, M. & Šparica, M. 1972: Osnovna geološka karta SFRJ, list Ilirska Bistrica 1:100.000.- Zvezni geološki zavod, Beograd.

EXCURSION TO THE TEMENICA RIVER VALLEY AND KARST OF SE SLOVENIA

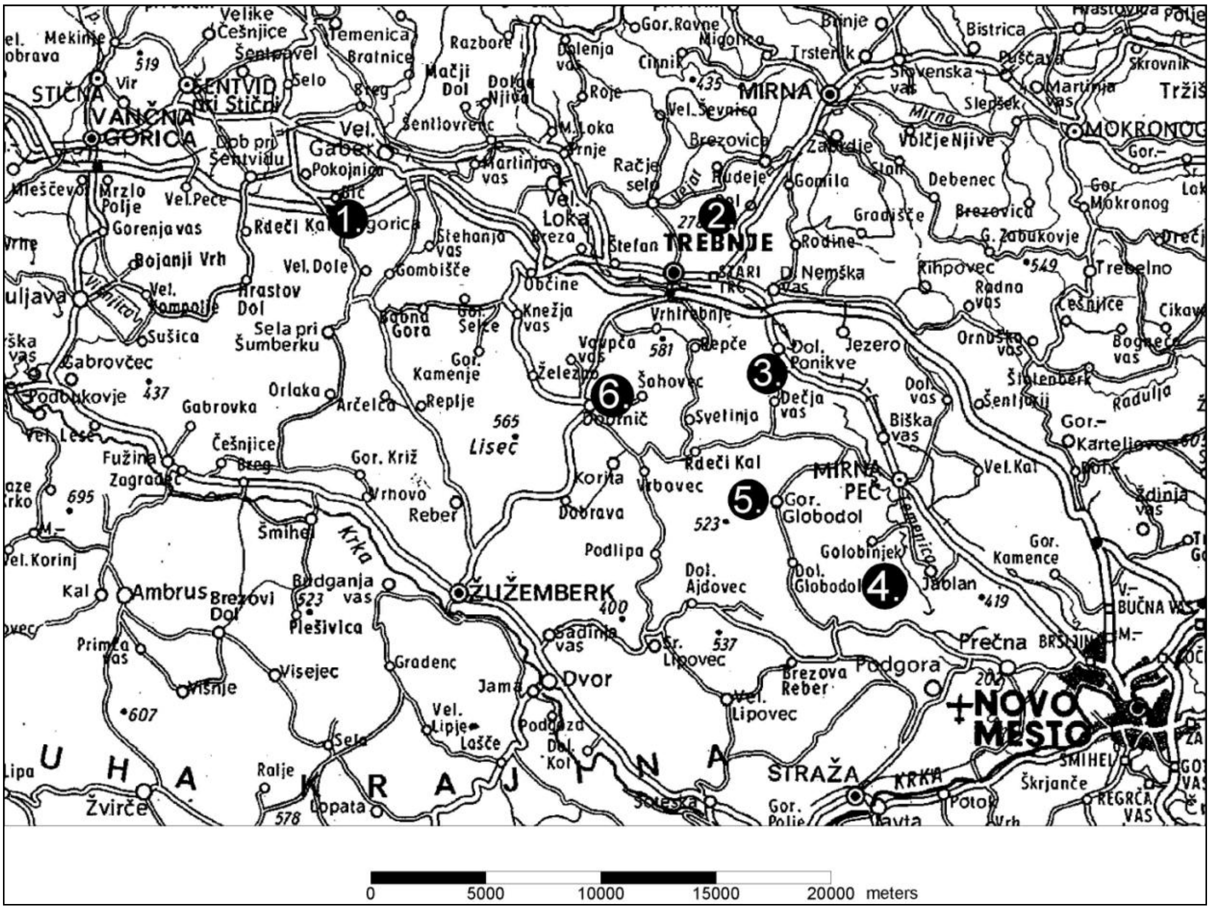


Fig. 6.: Plan for the excursion on Friday, July 4, 2003.

Excursion route:

1. Local geology on the Korenitka highway construction, 2. Stone forest near Trebnje, 3. The Temenica River spring, 4. The Temenica River ponor, 5. Globodol Karst polje, 6. Dobrnič Karst polje.

General regional and morphological overview (by B. Otoničar)

The territory between Ljubljana moor, Krško depression, Dobrepolje, Želimlje depression and Gorjanci range is considered as so-called low-land covered karst of Dolenjska (Gams 1974; Kranjc 1990).

On the Triassic dolomites of Dolenjsko Podolje (Dolenjska lowland) such type of karst has been developed, where the surface drainage prevails, although the significant part of precipitation is also drained vertically into the fissured and porous rock (Habič 1982). Although the surface as well as subsurface karst phenomena are generally rare, they are still typical and for that reason we may classified the dolomite karst as a special type of fluvio-karst.

The evident sign of karstification are sinkholes, which are opening into the thicker layers of the weathered dolomite material at the bottom of the depressions. Horizontal caves are practically absent in this area.

Pliocene-Quarternary fluvial sediments and thick layer of soil cover relatively large part of the rocky basement of Dolenjsko Podolje.

1. Geology of the Medvedjek area (by B. Otoničar)

Researchers from the Karst Research Institute ZRC SAZU have been performing the kastological supervision in the frame of the Slovenian motorway construction program for the last few years, but only few months ago geological supervision projects were acquired as well. In the frame of these geological projects we work preferentially on conservation and documentation of the geological and paleontological heritage, but at the same time geological mapping and profiling as well as stratigraphical and sedimentological investigations of the carbonate rocks has been carried out. Here some preliminary results from Medvedjek (central Slovenia) are presented.

The area along the motorway section Bič - Korenitka (Medvedjek) is composed of Late Triassic and Jurassic shallow marine carbonate rocks, mostly limestone. Highly fractured limestones are overlain by up to few metres thick soil cover, which could penetrate up to 10 m deep into widened fissures and shafts.

Tectonically the area corresponds to the eastern part of the Hrušica nappes of the Dinaric fold and thrust belt, which comprises a part of NE External Dinarides. Paleogeographically the area correspond to the NE part of the Mesozoic Adriatic-Dinaric carbonate platform. After tectonically active period at the Late Triassic – Early Jurassic boundary, more marginal platform carbonate sediments were deposited over formerly relatively monotonous Late Triassic inner shelf sedimentary facies.

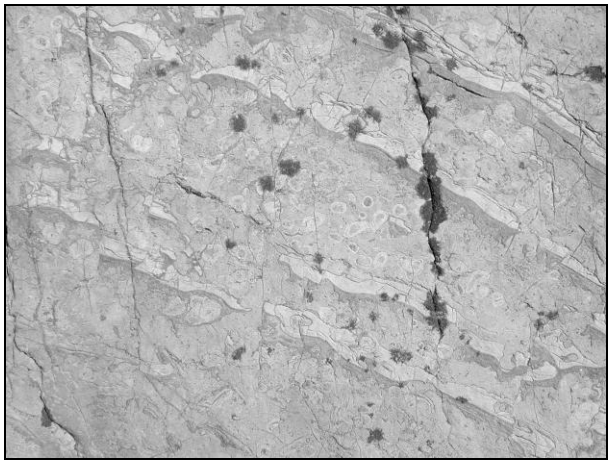


Fig. 7.: Syngenetic karst – "Dachstein limestone" with oncoids (Late Triassic/Lower Jurassic): dissolutional voids geopetaly infilled with micrite and isopachous fringes of fibrous calcite (long axis of the picture: 20 cm), (Photo: B. Otoničar).

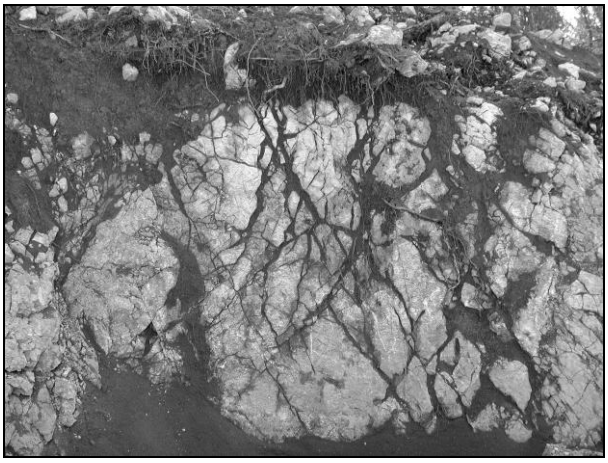


Fig. 8.: "Root karst" – Subcutaneous root related solutionally widened fissures (Photo: B. Otoničar).

In the outcrop at Medvedjek, a stratigraphically lower part of the profile is composed of Late Triassic-Lower Jurassic(?) bedded "Dachstein limestone" which mainly consists of inner-platform shallowing-upward peritidal "Lofer cycles" characterised by subtidal light grey to dark grey mudstone/wackestone and intratidal to supratidal middle grey to black, locally brownish and reddish stained, often pedogenically modified limestone. Oncoids and up to 15 cm large megalodontide shells are the most distinctive clasts of the subtidal part of the cycle, while black pebbles and peloids/pisoids are characteristic for pedogenically modified limestone. Up to few dm large "corrosion" voids geopetally infilled with micrite and isopachous fringes of fibrous

calcite are frequent diagenetic/karstic features in the subtidal part of the limestone. In places root related phenomena (rhizolithes) are preserved in pedogenically modified upper part of the cycles.

"Dachstein limestone" which was periodically subaerially exposed (syngenetic karst) is overlain by more open marine peloidal packstone and grainstone which passes to inner shelf dark gray mudstone probably Early Jurassic in age. The youngest carbonate rocks of the area, which are in tectonic contact with older rocks, belong to the Late Jurassic intraclastic/bioclastic grainstone, rudstone and boundstone with corrals and hydrozoans deposited in the vicinity of the barrier reef.

All four major stratigraphic units are dissected by fissures, in places solutionally widened and infilled by ochre, ochre reddish and reddish stained highly calcareous fine grained sediment and clast- to matrix-supported breccia/conglomerate with matrix of similar composition to above mentioned fine grained sediment. The fissures are not related to present day karstic surface or the infilling sediments are similar to the soil material related to the surface related fissures and shafts. Although the fissure infilling material has not been dated yet it probably corresponds to some event of the past karstic phase or even period.

Rocks are overlain by up to few metres thick soil cover, which displays characteristics of cambisols. In some karst related infilled fissures pedogenically unmodified clastic siliceous deposits, which presumably overlie carbonate host rock in the adjacent areas, have been found.

2. Subcutaneous stone forest (Trebnje, central Slovenia), (after Knez et al. 2003)

The subcutaneous stone forest has been discovered during the construction of the industrial facilities at the NE edge of Trebnje town and represents the first phenomenon of this type in Slovenia. Individual columns attain the height of up to 8 m and they display typical subcutaneous karst. Prior to the building interventions this stone forest has not been revealed on the surface, since there were only peaks of columns that were protruding for several meters out of the thick soil, which could at first sight be considered and classified as smaller karren.

The subcutaneous stone forest represents a significant karst feature, which reveals the subsoil processes on carbonate rocks as well as the development of the covered karst areas.

Fig. 9.: Subcutaneous stone forest (Photo: B. Otoničar).

Geology of the site

The Trebnje area is composed of Triassic and Jurassic shallow marine carbonate rocks, in places overlain by up to few metres thick Pliocene-Quaternary deposits and soil (Pleničar & Premru

1977). Scattered erosional patches of the Late Cretaceous deeper marine marl and sandy deposits disconformably overlay Triassic and Jurassic carbonate successions.

In the outcrop at Trebnje, a host rock is composed of two lithologies, light grey massive internally stratified dolomitised limestone and grey coarse grained dolomitic breccia which occupies a major part of the outcrop. Locally, the upper part of the pinnacles beneath the soil is slightly silicified.

Both, breccia and stratified dolomitised limestone are overlain by up to few metres thick soil cover, which displays characteristics of cambisols.

Shapes of the stone forest and its columns and their rocky relief

Only 1000 m^2 of the above-mentioned stone forest has been uncovered, however its principal formal characteristics could be determined.

Regarding their shape the subcutaneous columns may be divided into two types. The predominant are those large-sized. In their lower part, they occupy up to several square metres large area. They are further carved out in the forms of subterraneous rocky features. The second type of the columns is represented by individual, pointed and less bulky structures.

The most pronounced rocky features, which are carved into the columns, are the funnel-like incisions (karren) and subcutaneous flutelets.

In the lower part of columns there are larger pan-like karren, which came into being due to the weathering of the rock.

Prior to this recent "non-natural" unveiling of the columns, it was only their pinnacles that were protruding by 50 cm to one meter out of the ground, which covered the rock. On the most bulky columns there occurred also kamenitzas.

The rock surface may be distinguished between the surface that was positioned below the soil and the other one, which was formed above on the soil. The upper part of the former is a carved boxwork, whereas the latter, the lower part, is weathered up to several centimetres deep, it is soft and is rapidly disintegrating.

Although the rock is heterogeneous, this fact is not reflected in the shape of the columns. They are of regular forms and are attenuating towards their tops. The rock itself, however, affects the rocky relief of these stone columns. On their surface thus occur only larger rocky features, funnel-like karren, subcutaneous runnels and on the surface also the kamenitzas. The flutes on such type of rock are not likely to be found.

These features may, namely, occur also elsewhere, that is, where the described conditions are fulfilled - i.e. the compact rock, interlaced with a network of vertical fissures and a thick cover of fluvial sediments or the soil above them. Furthermore, we may point out that a large part of the karst in the south-east Slovenia belongs exactly to such type.

References:

Gams, I, 1974, Kras (Karst).- Slovenska matica, 358 str., Ljubljana.

Habič, P. 1982, Pregledna speleološka karta Slovenije (Speleological map of Slovenia) .- Acta carsologica 10, 5-22, Ljubljana.

Knez, M., Slabe, T. 2001a: Oblika in skalni relief stebrov v Naigu kamnitem gozdu (JZ Kitajska) (The Shape and the Rocky Relief of Columns in Naigu's Stone Forest (SW China)).- Acta carsologica 30/1, 13-24, Ljubljana.

Knez, M., Slabe, T. 2001b: The lithology, shape and rock relief of the pillars in the Pu Chao Chun stone forest (Lunan stone forests, SW China).- Acta carsologica 30/2, 129-139, Ljubljana

Knez, M., Slabe, T. 2002: Lithological and morphological properties and rock relief of the Lunan stone forests.- In: Evolution of karst: from prekarst to cessation, edited by F. Gabrovšek, 259-266, Postojna-Ljubljana.

Knez, M., Otoničar, B. & Slabe, T. 2003: Subcutaneous stone forest (Trebnje, central Slovenia).- Acta carsologica 32/1, 29-38, Ljubljana

Kranjc, A. 1990, Dolenjski kraški svet (The Karst World of Dolenjska).- Dolenjska založba, 240 str., Novo mesto.

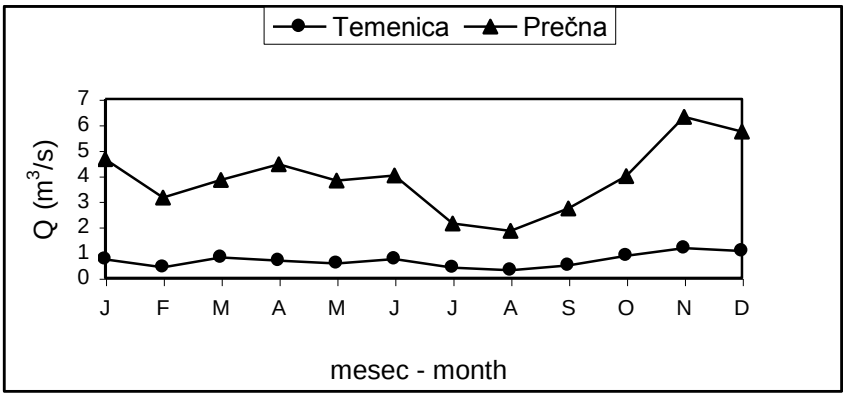
Pleničar, M., Premru, U. & Herak, M. 1977, Osnovna geološka karta SFRJ (Basic Geological Map of SFRJ) 1 : 100 000, Beograd.

3. The Temenica River (by N. Ravbar)

The river Temenica is a typical karst river that has a superficial and underground river flow. The source of the Temenica River lies in the fluvial relief of Posavsko hribovje (north of karst of Dolenjsko) and it flows along the border between non-carbonate Posavsko hribovje and karst plateau of Suha Krajina.

Unpermeable paleozioc clastites and poorly permeable Triasic dolomite enable surface collection of water in the upper Temenica River stream (Buser, 1968). When it reaches karst, it sinks underground two times. First **ponors** are at the end of Slovene longest **blind valley** (Gams, 1974) near Ponikve village, where Jurassic limestone outcrops. After 1,5 km it reapers in the pocket valley near Mirna Peč. It springs in Zijalo and flows towards south. The last spring is in the Luknja cave, where the river has two names: Temenica and Prečna (after the village). After 6 km it flows out into the Krka River.

In august 1994 a tracing test has been done in the Temenica River underground flow. On this basis study of influence of the planned highway sector Trebnje – Hrastje on karst waters has been done in 1998 (Kogovšek, Petrič, 1998).



Fig, 10.: Average monthly discharges of the Temenica River in the years 1990-1995 (Kogovšek, Petrič, 1998).

The chemical analyses have shown, that the water hardness in ponors Rupa I., Rupa II. and in Zijalo spring are similar, but the discharges extremely increase in the spring (Ladišič, 1994). This means that Lukovški, Dobravski potok stream and rainwater additionally supply the spring. Underground water flow from the Lukovški potok stream to the Zijalo spring with average velocity 0.45 cm/s and further on to the Luknja spring with velocity 4.1 cm/s was proved. Tracer appeared also in Bršljinski potok stream. The second part of the underground Temenica River is

significantly enlarged by recharge from the Karst aquifer of Suha Krajina. Inflow is evidenced also by chemical composition (Novak, 1994; Hudoklin, 1995; Kogovšek, Petrič, 1998).

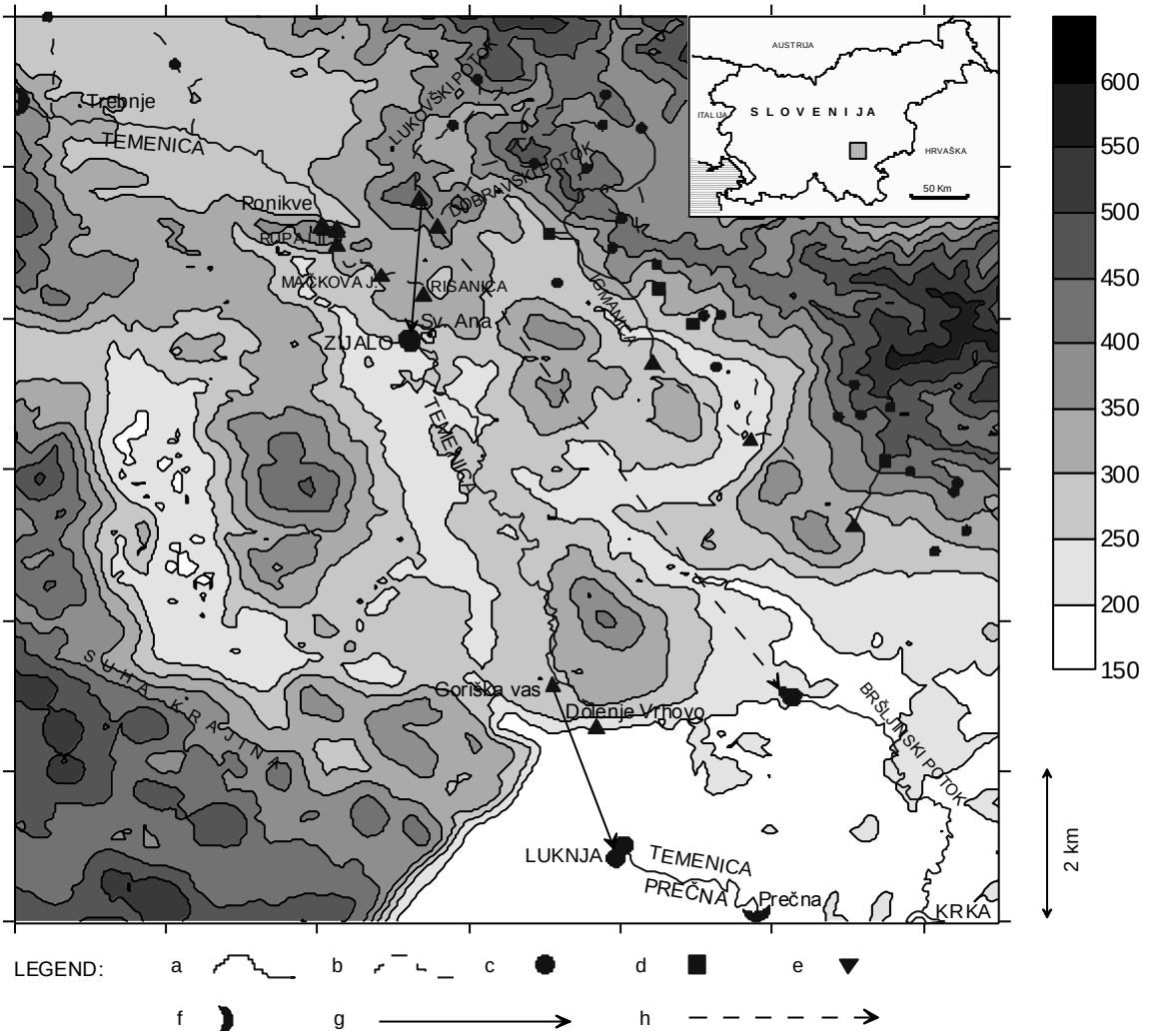


Fig. 11.: Hydrological map of the area (Kogovšek, Petrič, 1998).

Legend: a-permanent superficial flow, b-temporary superficial flow, c-spring, d-captured spring, e-ponor, f-gauging station, g-proved underground water connection, h-supposed underground water connection.

At high waters faster flow can be expected, which would potentially cause fast spreading of eventual pollution, eventhough dilution is an important factor. In karst recharge area of the Temenica River precipitation infiltrates directly from surface into the underground and at the same time possibly also pollution as a result of different human activities in the hinterland (Kogovšek, Petrič, 1998).

References:

Buser, S., 1968: Osnovna geološka karta 1:100.000. list Ribnica. Zvezni geološki zavod, Beograd.

Gams, I., 1973: *Slovenska kraška terminologija*.- Katedra za Fizično geografijo, Univerza v Ljubljani, 76, Ljubljana

Gams, I., 1974: *Kras*.- Slovenska matica, 358, Ljubljana

Habič, P. 1988: Tektonska pogojenost kraškega reliefa zahodne Suhe Krajine. Acta carsologica, 17, 33 – 64.

Hudoklin, A., 1995: Poročilo o barvanju Temenice. Bilten '94 Dolenjskega krasa, 16-17, Novo mesto.

Kogovšek, J., Petrič, M. 1998: Characteristics of water flow in the karst hinterland of the Temenica river. Acta carsologica, 27 (2), 221 – 233.

Novak, D., 1994: Raziskave na Temenici leta 1994. Naše jame, 36, 109-110, Ljubljana.

Šušteršič, F. & M. Knez, 1995: Prispevek k slovenskemu speleološkemu pojmovniku. Naše jame, 37, 153-169, Ljubljana

4. Suha krajina (by A. Kranjc)

The name means »dry land« or »Dry Carniola« and it is part of Dolenjsko (Lower Kranjska or Carniola) covering about 430 km^2. It is plateau at the altitude of 300-700m a.s.l., divided by the valley of the river Krka into two parts: western and eastern Suha krajina. It lies between the Valley of Temenica River on NE and polje Dobrepolje on SW. On the NW there are hills around the polje of Grosuplje and on SE there is karst massif of Kočevski Rog (1099 m). Geological base are Mesozoic (Jurassic and Cretaceous) limestone and dolomite. On many places thick layer of loam covers the surface with the iron ore in the form of "ironstone" (Bohnenerz in German or "broad bean ore") – iron hydroxides – and of limonite.

Suha krajina receives about 1300 mm of precipitation per year. Today it is sparsely inhabited (25 inhabitants/km^2) but due to the mentioned iron ore specially the culture of Older Iron Age (Halstatt) flourished, including numerous oppida and ironworks.

The main characteristics of the surface are depressions, i.e. numerous dolines, uvalas, dry valleys and few small poljes. The depressions are N-S oriented and usually connected to each other by low gaps or morphological steps. They are often of irregular shape and look more like fossil, strongly remodelled dry valleys.

Eastern Suha krajina is a plateau approximately at 300 m of altitude where the top of the hills (the remains of the higher level plateau of cone karst, according to Habič 1981, 1988) reach or even rise over 500 m. The lowest point is 200 m a.s.l. at the bottom of the polje of Globodol. The main characteristics of Eastern Suha krajina are the same as of Suha krajina in general. There are four main depressions oriented N-S, going eastward (from the highest lying): Hrastov dol, depression of Dobrnič, Globodol, and the closed valley of Temenica (near Mirna Peč).

They give the impression that they were formed by the no more existent streams running from the hills (partly normal relief) North of Suha krajina towards the river of Krka. The biggest, where the village of Dobrnič lies, evokes the idea of "Palaeotemenica" river being the surface tributary of recent Krka River. Nowadays the Temenica River is flowing along the NE foot of Suha krajina plateau and forming, before sinking underground, a sort of large **closed valley** or a sort of polje. I call it closed valley because in fact it is combined feature of steep-head valley upstream and blind valley downstream.

The "***dry valley of Dobrnič***"consists of few closed depressions in line. The largest is ***Dobrniško polje*** (Polje of Dobrnič), which has characteristics of karst polje, although the Slovene authors usually do not count it between the poljes. The bottom is over 2 km long and up to 1,5 km large at 230 m a.s.l. The flat bottom is covered by recent alluvium. Apart of the permanent running sinking stream Žibrščica crossing the polje, there are some perennial karst springs too. After longer period of rain the lower parts of the polje can remain flooded up to 3 weeks. To reduce inundation the channel was made to drain the water into "**katavotra**" (enlarged ponor, strengthen by masonry) Mišnica. In the group of ponors called Velike Rupe (**rupa**, pl. **rupe** is local term of

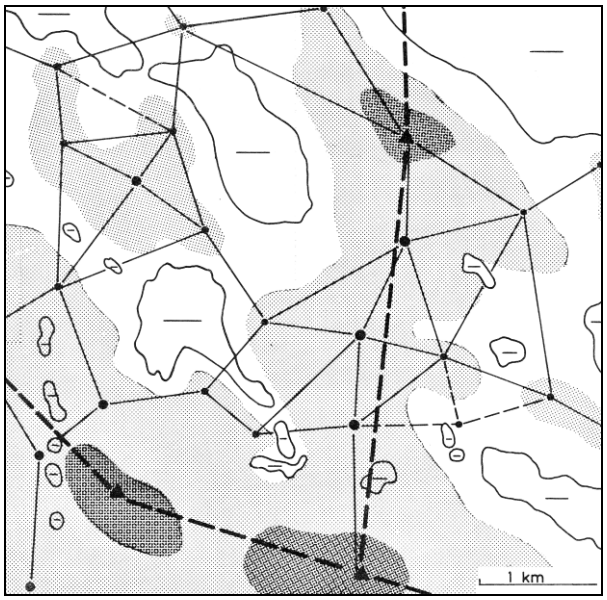


Fig. 12.: Hill (=cone) and dale surface in Suha krajina (Habič 1981).

Dolenjsko meaning smaller absorbing holes, mainly in the sediment) there is also one "**katavotra**". From Dobrniško polje waters drain towards lower lying polje of Globodol. Dobrniško polje is nearly open towards the depression NW of it, where there is the village called Železno. The name comes from "železo" = iron, which evokes the iron ore and the activities connected to it in the past.

Eastwards and lower lying of Dobrniško polje is the polje of ***Globodol*** (vaguely meaning deep depression, from "globok" = deep, and "dol" = depression, doline, uvala).

It lies just over 200 m a.s.l. measuring 4 x 0.75 km. The flat bottom with fertile soil on alluvium is sometimes (but not regularly) flooded by the perennial springs, or better by the water rising up from the dolines and **rupas**. Gams published comprehensive study of Globodol (1959) and according to his classification (1973) Globodol is **polje in the piezometric level** or **baselevel polje** (Ford & Williams 1989). Floodwater is absorbed by **rupas** and a small shaft in the southern part of the polje and drained underground towards the Prečna River. Prečna River is the last – the third – surface section of the sinking river Temenica, running into Krka River upstream of the town Novo mesto.

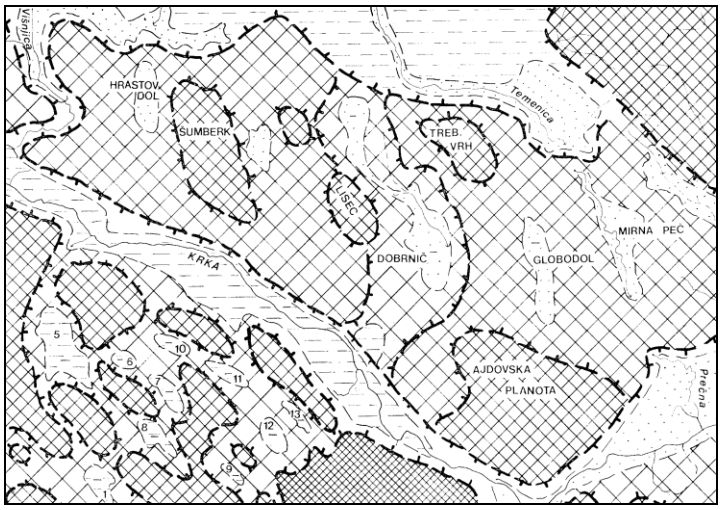


Fig. 13.: Geomorphological sketch of Eastern Suha krajina (fluvial surface, low and medium karst plateau) (Habič 1988).

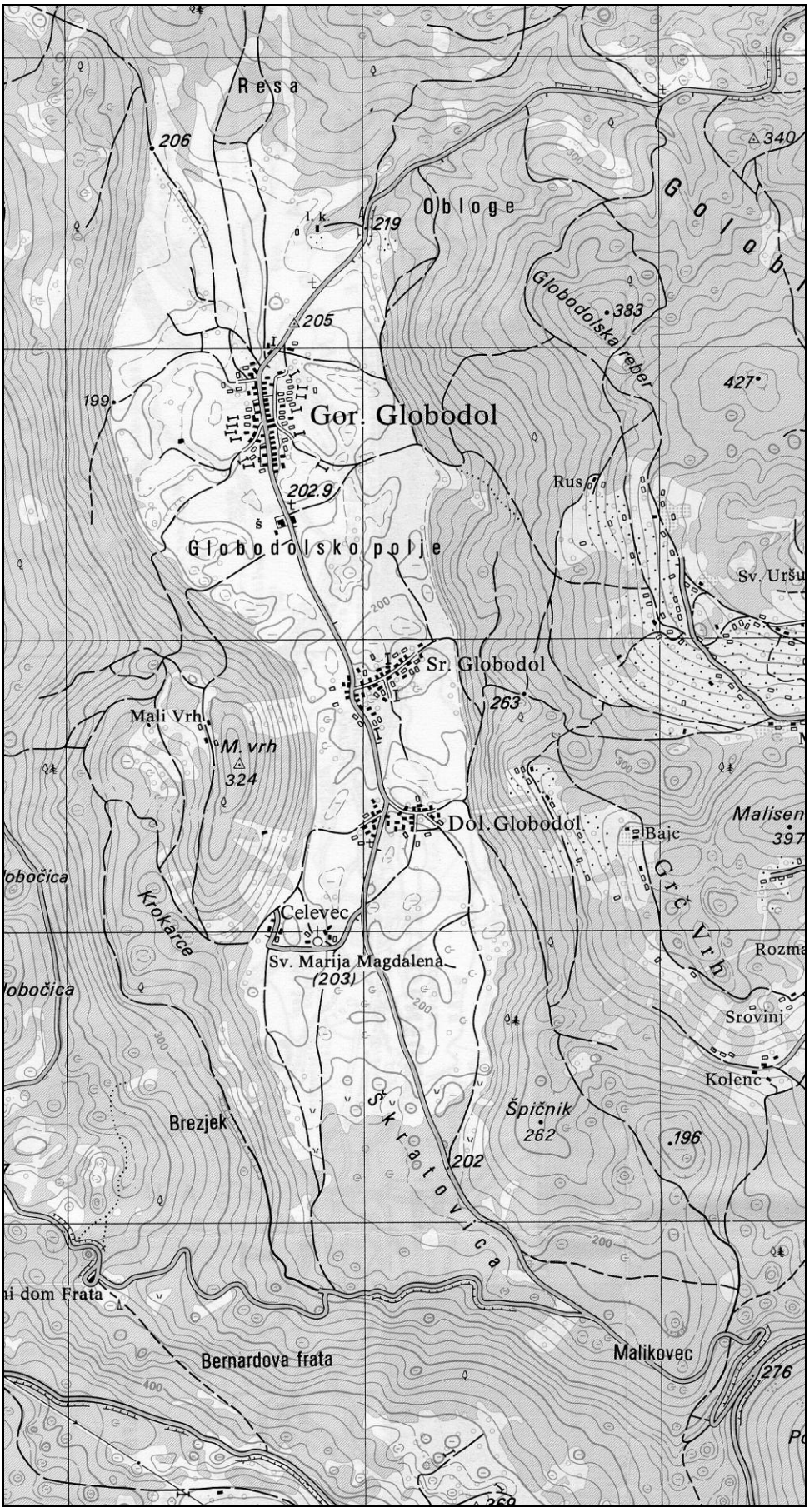


Fig. 14.: Polje of Globodol (1:25.000 map, Dolenjske Toplice, 157, Geodetska uprava RS, 1998).

The morphogenesis of depressions of Eastern Suha krajina can be supposed as follows:

- the surface tributaries of "Palaeokrka" river crossed the plateau from N towards S, cutting relatively shallow valleys (Gams 1994 presumed that Paleo-Temenica flew through Globodol);
- the drain turned eastwards and underground, valleys changed into dry valleys;
- remaining local surface streams (from the patches of dolomite or less karstified limestone) and the meteoric water formed shallow closed depressions in the bottoms of dry valleys (dolines in the depressions prove that the depressions are older and not the result or recent karstification process);
- the largest of these depressions developed into Dobrniško polje.

This hypothesis can be checked by detailed morphological analyses, by the sediments study, study of roofless caves, etc.

References and further reading:

Ford, D.C. & P.W. Williams, 1989: Karst Geomorphology and Hydrology. Pp. 601, London etc.

Gams, I., 1959: H geomorfologiji kraškega polja Globodola in okolice. Acta carsologica, 2, 29-65, Ljubljana

Gams, I., 1973: Terminologija tipov kraških polj – The Terminology of the types of poljes. In: Slovenska kraška terminologija – Slovene Karst Terminology, 55-67, Ljubljana

Gams, I., 1994: Types of the poljes in Slovenia, their inundations and land use. Acta carsologica, 23, 285-302, Ljubljana

Habič, P., 1978: Razporeditev kraških globeli v dinarskem krasu – Distribution of karst depressions in NW part of Dinaric karst. Geografski vestnik, 50, 31, Ljubljana

Habič, P., 1981: Nekatere značilnosti kopastega krasa v Sloveniji – Some characteristics of cone karst in Slovenia. Acta carsologica, 9, 5-25, Ljubljana

Habič, P., 1988: Tektonska pogojenost kraškega reliefa zahodne Suhe krajine – Tectonically controlled karst relief in western Suha krajina. Acta carsologica, 17, 33-64, Ljubljana

Kranjc, A., 2002: The history of karst resources exploitation: an example of iron industry in Kranjska (Slovenia). Theoretical and Applied Karstology, 15/2002, 117-123, Bucureşti

ABSTRACTS OF LECTURE AND POSTER PRESENTATIONS

ACAD. PROF. IVAN GAMS AND HIS KARST RESEARCHES (AT HIS 80TH ANNIVERSARY)

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Ivan Gams (1923) studied geography at Ljubljana University and worked at first at the institutes (of geography and karst research) and since 1966 at Geography department of the University. He was the first representative of the young generation in the board of Slovene speleological society (1951) and his first scientific publications (Karst spring Mitoščica, 1955; about karst research, 1957) are dealing with karst. More than 330 of his publications altogether are dedicated only or mainly to karst. In more fields of karstology I. Gams is the pioneer in the Slovene karstology. Such are measurements of corrosion activity, corrosion intensity and its role in evolution of the surface and underground, flowstone deposition and forms of speleothems, complex speleological research, speleogenesis, subcutaneous forms, and climate. Internationally recognised is his research on classification and definition of karst poljes, all round the world researchers are using his method of limestone tablets and an international project to compare the corrosion according to "Gams' method" is proposed. Beside his ample publishing opus his work in editing must be also mentioned. I. Gams is very active in scientific and professional societies at home and abroad; let me mention his positions as the chairman of commissions at International Speleological Union and International Geographical Union, Slovene speleological society and Geographical society. 50 years of Gams' work in karstology and speleology essentially mark these sciences in the second half of the 20th century; his contribution is essential for the Slovene karstology and its recognition in the international sphere.

THE CONTRIBUTION OF IVAN GAMS TO THE DEVELOPMENT OF THE SLOVENE KARST TERMINOLOGY

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The state of the scientific terminology is by all means one of the indicators of the development of the scientific branch, to which it belongs.
Therefore the publishing of the Slovene karst terminology in 1973 was an important event for further development of Slovene and international karstology. Still more, the efforts for comparative national karst terminologies of former common state Yugoslavia were successfully achieved in publishing the Serbian and Croatian karst terminology also, a year later.
In fact, this efforts begin in October 1969, when the former Association of the geographical societies of Yugoslavia decided to give full support to its subcommission in preparing the project Karst terminology of the Yugoslav nations, in that time guided by prof. Ivan Gams, who was also the original initiator of this idea. The important foundation stone of implementation of this idea was also a joint Yugoslav symposium on Karst terminology, held in Ljubljana from 22-23rd October 1971, organized by Ivan Gams, as well. All this efforts were nevertheless combined and connected with the international work of that time to find most appropriate terms and definitions for the karst phenomena and to make them comparable in terms of national terminologies. Ivan Gams was therefore not only a most important promoter of the Slovene karst terminology and one of the leading persons of the scientific karstology in the former common state but was due to his global ideas also one of the central persons in the international karstology.

THE UNDERSTANDING OF THE ENVIRONMENTAL PROBLEMS IN THE DINARIC KARST

MAINLY FROM THE WORKS OF PROFESSOR IVAN GAMS

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Main regions of the Dinaric karst, the *Kras*, the islands and low plateaus of Dalmatian littoral present the classical types of land use and agrarian management in the Mediterranean countries, that change the karst surface:
-the deforestation and adaptation of the karst surface for agriculture, the stone clearing effects,
-the use of extracted stones for dry-stone walls and hillslopes terraces,
-the land reclamation and management in the dolines, uvalas and karstic dales.
This landscape evolution and system of adapting agriculture to karstic terrains in *Kras* and Dalmatian countries make possible many comparisons with other karstic countries, i. e. Provence, Causses, Puglia…
Many studies show that the management phases have been in relation with the historical conditions, and recently with the new changes of agriculture and the decay of the pastoralism.
In the nearby-forested mountains, particularly in SW Slovenia, the historical impacts of deforestation and cultivation are recognised by the studies on sediments in caves and dripstones mineralogy.
The managements in the large Dinaric poljes pose very intricate and hard problems, depending on the structural and hydrogeological conditions, and they have been studied in many works. After the field-work of the Study Group on Man's Impact in Dinaric Karst (1987), two new spectacular examples are presented:
-the problem of watertightness of artificial lakes in the polje of Nikšić ;
-the agrarian management in the Popovo polje, as a result of hydrosystem change (suppression of the seasonal flow) in relation to hydro-electric power plant.
These environmental problems, on which many factors interfere, interest various and multidisciplinary researches. In contrast, this research give better knowledge on the view and working of the Dinaric karst : particularly the landscape evolution, the growing of karren-fields, the geomorphological and hydrological changes in the poljes.

REMARKS CONCERNING THE DEVELOPMENT OF THE KARST TERMINOLOGY FROM THE PAST UP TO TODAY

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History and development of the karstological terminology are very complicated and many problems can be understood only with knowledge of the historic backgrounds.
The first important steps for a terminology of karst and cave sciences have been made in the period between 1860 and 1890 in the today so-called classical karst. It was the time of the economic engagement and the enlargement of the Austro-Hungarian Empire to the Balkans including Bosnia and Hercegovina, and the German language was the bass for scientific discussions and publications.
A great number of publications at this time show the development of specific terms in karstology and speleology. A good example is the term "karst" itself, originally employed only as a topographic expression for the relatively small region in the surroundings of Trieste. The change to a generally accepted geo-scientific expression can be documented since 1860. In a note from 1686, the karstification of the tertiary gypsum formation in the Western Ukraine (the formerly

Galicia) is described, and in a book from 1891, a list of karst regions in the world including the South of Brazil, Australia and many parts of the United States, can be found.
Between 1880 and 1890, the definitions of many terms - by exemple "Karrenfelde", "Einsturzkessel", "Dolinen", "Karsttrichter", "Grötten", "Hohlen" - have been discussed. Including unfortunately this time supposed genetic conditions. Great problems - in many cases up today - were also on the one side the scientific employment of words in a complete other sense than the linguistic usage, and on the other side misunderstanding observations or descriptions of local or regional phenomena.
The book of Jovan Cvijic "Des Karstphänomen", published in Vienna (Austria) in German in 1893, indicates - common with the books of Franz Kraus ("Hohlenkunde") also in German and Edouard Alfred Martel ("Les abimes") in French in 1894 - more or less the end of this "pioneer period" of the karst terminology. Only one year later, Robert Sieger proposed to utilize the well-known karst terms for the description of glacier forms.
Outside of Central Europe, the French karst terminology is influenced mostly by Martel, who had many contacts with Austrian karst researchers up to the first years of the twenty-century, but the collaboration ended by political reasons many years before the First World War.
Since this time up to the Fifties of the 20th century, we can observe a more or less independent development of karstology as well as related terms in the different countries. On the other side, the then dominant hypothesis of one cycle of karst development provoked the transfer of the terms from the classical karst with its very special conditions to regions - like in the tropical zone - with completely different geological, hydrological and climatological conditions of past and present evolution.
In my opinion, the First International Congress of Speleology in Paris (1953) was the initial point for an international collaboration and for a systematic comparison of terms in different languages. A first great difficulty was the standardisation of terms inside of each language. When I prepared the speleological dictionary in German ("Speleologisches Fachwörterbuch"), I received comments with proposals to modifications to a preliminary manuscript by 40 colleagues. This dictionary has been distributed 1965 in Germany and Austria. Comparable dictionaries have been published for example in English (1970), French (1965) and Italian (1960).
During the 5th International Congress of Speleology (Stuttgart 1969) a sub commission of terminology as a part of the Commission of Documentation has been founded (Chairman- Max Fink). This Sub commission was very active in the following years to create a first multilingual dictionary and glossary. An international Conference in Obertraun (Austria) from 13 to 17 September 1971 decided descriptions of the most important terms in the main languages of the speleological world and presented his work on the International Congress of Speleology in Olomouc (Czech Republic) in 1973. It is regrettable that it was impossible to print this work because of financial problems.
Nevertheless, this work has certainly encouraged many authors to elaborate glossaries, for example in Slovene (1973), Croatian (1974) and Serbian (1974), but also in Portuguese (1981) and other languages, In the last years, the number of such dictionaries - published by official institutions or by private researchers – increased.
The newest publication in English, the Lexicon of Cave and Karst Terminology edited in February 2002 by the United States Environmental Protection Agency give the source of the descriptions and many terms in other languages, but shows also the existence of problems by exact translation in different languages up today.

DEVELOPMENT, ADVANTAGE AND ENLARGEMENT OF SPELEOLOGICAL TERMINOLOGY

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In every field of research terminology is a pillar of scientific work, and so it is for speleology. Terminology is the basis of systematics by determining conceptions. Definitions are fundamental for mutual understanding as well as for comparing scientific results. Thus connections may be established to neighbouring scientific fields, which hardly deal with speleological problems. Clear conceptions further contribute to international and supra-regional understanding.
Terminology may origin from acquired scientific findings. It may define and assess phenomena through practical work, but it may also rise from purely theoretical considerations where it aims at characterizing systematic order. Such conceptions sometimes are of less value than seems necessary for a general understanding. Especially in speleology, there exist some terms neither used in practical work, by fellow scientists nor in geomorphology or biology.
This paper evaluates publications important for the development of the German speleological terminology. They were of general importance during the 19th and 20th centuries. A few examples of practical and theoretical terminology from various scientific fields are selected and examined as to their domains of application – e.g. for a geomorphological and biological characterization of subterranean – subaquarian cave systems. New terms, which may be helpful for speleological investigations, are also evaluated, such as the term "consequence cave", suggested by Jean Paul VAN DER PASS a few years ago.

TERMINOLOGY AS A USEFUL TOOL OF KARST RESEARCH: THE CASE OF KARREN FEATURES

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Terminology is a substantial background for science research because many of the scientific terms must be used in a highly specific manner in order to avoid misunderstandings and ambiguity.
In the case of karst research, two main facts introduce some peculiar problems regarding terminology: 1) the majority of karst phenomena started to be known after careful exploration of particular (and often remote) regions, which means that a certain amount of exotic new terms tend to be incorporated; and 2) the richness in landforms and transitional shapes constitute one of the most fundamental aspects of karst, which necessarily implies that so great array of forms are very difficult to grasp precisely with unequivocal words.
International karren terminology is based today in the classification developed by Bögli during the second half of the 20th century. The former German terms were taken as neologisms in English literature after the seventies. The existing small differences in what concerns karren terminologies are frequently biased towards definite classification criteria, but some satisfactory international agreement has been achieved during the last decades.

KARST TERMINOLOGY ON THE INTERNATIONAL KARSTOLOGICAL SCHOOLS "CLASSICAL KARST"

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Karst sciences faced fast development in the past years of the 20th century. It was caused by new research methods and new fields of sciences introduced, by new karst areas studied and by increase of the number of the researchers. All this has a strong influence on the karst terminology.

By organising the Karstological schools »Classical karst« our intention was, among others, to contribute to improvement of the terminology too. For each year a new theme was chosen and different features on classical karst were visited. It was our intention to focus the attention to a set of karst features, to see them on the field and to confront different experiences of the karstologists on the field. We were limited by the karst phenomena of Slovene classical karst and by always too short time.

The first school presented the Slovene classical karst areas, landscapes that gave the name to term karst. The most known features of the Kras, caves of Ljubljanica and Reka rivers and karst poljes were visited.

The second school was devoted to the karst poljes. These are well-defined and distinctive large karst features. Characteristic hydrology and corrosion processes were first described on them. They are important relief features of Dinaric karst and important from the point of land use and water meliorations. They are easy to be defined because they are large closed depressions but new knowledge on the role of tectonics, impervious rocks, hydrology, shape of the rim makes some terminological problems too.

More problems were opened on the next school devoted to dolines. The term indicates features that vary significantly in dimensions, shape and also in genesis. On the field such instances were presented: a dolines that originate from collapsing, suffusion, denudation of caves or locally enhanced solution. We have seen different karst surfaces with hundreds of small dolines and dolines that have several hundreds of m in diameter.

The fourth school was about shafts. Term can mean vertical entrance to underground, vertical cave galleries or caves, which depth is larger than horizontal length or simply very deep caves. Shaft is not a genetic or entirely morphologic term. They can be formed by percolating water or waters mowing upward or by collapses of other types of pre-existing caverns.

Some of the shafts were visited, and the lowest point reached by the participants was the bottom of the Labodnica or Abisso di Trebiciano cave at -329 m.

The topic of the fifth karstological school were the caves and cave systems. In Slovenia 8000 caves are known. The term cave means a cavity that is larger than 10 m. They are segments of different past or present draining systems. The participants visited Škocjanske jame, caves of underground Ljubljanica River and caves on the edge of the Kras plateau.

Karst developed in high Alpine mountains was the subject of the sixth karstological school. Participants visited the high Alpine plateau Kanin. There are several deep shafts. Trough that massive the water is drained into deep alpine valleys with numerous karst springs. The mountains and the valleys were glaciated and karst surfaces and some features like kettles and pavements show the development in specific conditions.

Roofless caves, the caves of different origin or shape exposed to the surface by denudation were the subjects of the seventh school. They developed due to the surface denudation lowering which re-shaped caves into the surface relief forms. Transformation depends on many factors, shape and position of the cave and the dip of the surface, existence of cave sediments, are being very important.

The term and the idea, that these features are important part of the surface morphology were on the school presented for the first time. Several km long unroofed caves were visited and features like dolines, cave entrances and evidences of the karst denudation processes were seen on the field.
The following school was dealing with collapse dolines, which occur when ceilings above underground caves collapsed. Slovenian expert literature understands collapse dolines as those with exceptional dimensions, and steep or vertical walls. Smaller collapse forms are frequently left aside because of lack of signs of collapse processes.
We have visited the areas where the collapse dolines as the dominant surface relief form and has volumes to 9 million m^3. Because the rooms as big are not usual in the Karst, we must assume that development of that large collapse dolines is controlled also by other, mostly speleogenetic processes. So the collapse dolines are polygenetic and polyphase forms which make the term disputable.
Next school was about the contact karst. This is the karst where the contact of the surface and the underground drainage occurs. Contact karst is a special geomorphic system where factors of fluvial surface, geological structure and the properties of the karst drainage system meet. The relief forms and the phenomena are the result of the interaction of all of them.
The term grew familiar in Slovenia on the Classical Karst where such karst essentially differs from the very large karst areas which surface and underground features were formed without such contact influence. In the international karstological literature these forms and phenomena are usually named as karst influenced by allogenic inputs. The participants have visited several contact karst areas and descent into numerous blind valleys, ponors and caves.
The previous karst school was devoted to different karst types, and some of the different Slovene karst areas were presented on the field trips.
There were many questions concerning karst terms discussed on the schools. No final answers were given. But discussions pointed out that all terms are not well grounded and that there is a constant need to discuss the terminological problems.

CONTRIBUTION OF EXPERIENCES FROM CLASSICAL KARST TO KARST EVOLUTION OF CRACOW-CZESTOCHOWA UPLAND IN POLAND

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Direct comparison of two karst areas, developed in particular geologic and climatic settings is difficult, even impossible. Therefore paper does not deal with direct comparison of Cracow-Czestochowa Upland and Karst but with introduction of new ideas and experiences coming from Classical Karst in last decade to improve our knowledge on karst evolution in south-polish uplands.
Cracow-Czestochowa Upland, with about 2500 km^2 area and more than 1500 known caves, is the largest individual karst region in whole Central Europe. Karst phenomena developed in Upper Jurassic limestone are very peculiar relict karst, even palaeokarst, sometimes classified as result of selective erosion within different types of limestone. Several phases of karstification are distinguished in the evolution of the region. These phases cover hydrothermal, cold meteoric and tectonic stage. Denudation is as an important geomorphic process in karst, which exposes underground features on the surface. Features that have been formed deep in phreatic, sometimes hyrothermal conditions undergo through the epikarst and are present among superficial forms. This unusual morphology of residual hills present in contemporary relief of Cracow-Czestochowa Upland was a subject of many studies since 50-ties of twenty century but never was

explained as speleogenetic features. Applying knowledge and ideas on speleodestruction processes and denuded caves as their results in morphology author explains some morphogenetic aspects of the karst evolution in the area of Cracow Czestochowa Upland.

DOLINES AND SINKHOLES: ASPECTS OF EVOLUTION AND PROBLEMS OF CLASSIFICATION

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In the international scientific literature the terms "doline" and "sinkhole" are both utilised in a very wide sense to indicate medium-sized closed depressions, normally not holding water, in karst areas. Anyway, while the word doline is used mostly in Europe with a mainly "morphographic" significance, the term sinkhole is utilised mainly in North America with a predominantly "morphogenetic" meaning.
The mental picture of the word doline is a subcircular bowl or funnel-like depression. That of "sinkhole" is a form originated by a gradual or sudden lowering of a portion of the topographical surface. In particular, in the engineering geology, a sinkhole is a steep-sided, closed depression resulting from a sudden collapse downward of the hard rock or soft material staying at the surface.
These different ways to denominate closed karst forms are often cause of ambiguity.
Probably the most correct way to define a form is to associate to a term bearing a morphographical meaning, as "doline", an adjective with a morphogenetical significance. But if we try to utilise this criterion we also find many problems linked with both the difficulty to get information about the real history and structure of a doline and the different nature of the processes involved in its genesis, which often coexist. An overview of some of the main known types of dolines and of the possible morphogenetical adjectives is briefly outlined.

WHAT IS KARST CHANNEL

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In some other word, the title might be written: "What makes an underground void to be a karst channel?" From the point of view of the speleogensis a true cave is any underground karst feature resulting from mass removal, larger than half millimeter or so. The crucial condition is that the trajectory of the formative water passes through the cave and that the mass is removed in liquid phase (solution) (F. Šušteršič, 1984, 61) The infinitesimally small element of a cave that still holds its basic properties is defined as a ring of phase boundaries perpendicular to the trajectory direction. Such infinitesimally small element is termed Differential Speleogene Element (DSE). Consequently, a cave channel is a continuous string of DSEs. The length (along the trajectory) of a single DSE is negligible, though its diameter may be as large as the widest cavern. In reality, however, the length of a "channel" (string of DESes) is its best-expressed dimension. Among various possible outcomes one must make clear difference between structural segments formed along a single geological structure, and topological links, joining two nodes, no respect of how many structural segments they consist of.

A REVIEW OF KARST TERMINOLOGY IN THE APULIAN KARST (SOUTHERN ITALY)

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Apulia region, in southern Italy, is one of the classical karst areas of the Italian peninsula, being underlain for most of its extension by intensely karstified carbonate rocks. The resulting landscape of Apulia presents therefore essentially landforms of karstic origin, which have been the object of specific studies since a long time.
The three main geographical sub-regions in which Apulia is generally divided (namely, from north to south, the Gargano Promontory, the Murge plateau, and the Salento peninsula) have been characterized in the past centuries by complex and different social and historical events. These resulted in the development, from a linguistically point of view, of very distinct dialects in different areas. The terms used to describe the karst landforms, both at the surface and underground, had subsequently been, and still are, extremely variable throughout the region.
This paper illustrates the main terms used in Apulia to designate and describe the principal geomorphological manifestations of the karst landscape, starting from the critical analysis of some of the oldest works on the topic, which date back to the XVIII and XIX centuries. An attempt is made to subdivide the terms on the basis of: i) geographical distribution; ii) etymology, with reference to the local dialects; iii) morphological features and genesis of described landforms. Some cases of misuse of terms in the Apulian karst, and the deriving confusion, even in recent times, in the related terminology, are also pointed out.

THE NOMENCLATURE OF CRYSTALS MORPHOLOGY COMPOSING CALCITE MOONMILK: EXAMPLE FROM HUMPLEU CAVE (ROMANIA)

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This presentation deals with the nomenclature of calcite crystals composing moonmilk deposits and also with the terminology of moonmilk itself based on some examples from Humpleu Cave (Bihor Mountains, Romania).
Calcite moonmilk is a common cave deposit throughout most of the passages in the Humpleu Cave System. The monmilk deposits are in the form of large massive flowstones, delicate draperies, and patches of mould-like accumulations. Except for one moonmilk sample (secondary in origin), all the others were precipitated directly from low supersaturated, calcium-rich solutions. Scanning electron microscope observations revealed that the moonmilk consists of nanofibers, acicular microfibres, composite fibres, rhomb chains, and calcified filaments. These morphologies seem to have been developed under specific cave topoclimatic conditions and at variable rates of dripping and CO_2 outgassing. Microbial activity apparently did play an active role in the formation of some of the calcite moonmilk.

KARST OR PSEUDOKARST? CASE STUDY FROM THE CZECH REPUBLIC

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Where is the boundary among karst and pseudokarst? There are many different ideas how to define the boundary. Beside clear examples, there are some areas in the Czech Republic, which could not be easily classified. One of such areas is a northern surroundings of Turnov town. The

blind and half-blind valley, several ponors and large sinkholes are presented here. Up to date, two caves traversed by small streams are known. The current development of small collapse dolines shows the recent dissolution activity. Solution forms are developed in marlstones of Jizera Formation, containing admixture of fine quartz sand and $CaCO_3$ content about 60%. Ponors are located mostly at points, where small superficial streams originated from springs draining upper sandstone aquifer (Teplice Formation) enter the area build by Jizera Formation. Bartošova pec Cave is the example of ideal water table cave, probably modelled by paragenesis, presumably late Quaternary in origin. Several tracer tests were performed in the area. Diving exploration in Bartošova pec Cave and new investigations in the surrounding area proved the karst origin of surface and underground forms, which were formerly described as the result of pseudo-karst processes, such as close-to-surface weathering. Bartošova pec Cave is an excellent example how primarily negligible fractures became by dissolution into large conduit, which nowadays transmits water from catchment area of several square kilometers.

THE PROBLEM WITH SPELEOTHEMS

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Speleothems are secondary mineral deposits that form in caves. The overwhelming majority are composed of only three mineral species (calcite, aragonite and gypsum), but there is a great variety in the physical forms that these minerals can take. However, the terminology used to describe speleothems is almost entirely based on their physical appearance, i.e. their morphology. A problem arises when morphologically similar speleothems are shown to have different crystal structures and textures when examined under a microscope. This implies a different genetic history.

Ontogeny of minerals is the branch of genetic mineralogy which studies individual crystals and aggregates of individuals as physical bodies, rather than as mineral species. This scientific subject has been developed in Russia since the 1950s, but is barely known elsewhere. The potential value of the Russian approach to mineralogy is that it offers a systematic conceptual framework for the internal organization of speleothems, complete with an established terminology system.

INTERNATIONAL LEXICAL ELEMENTS IN THE KARSTIC GEOMORPHOLOGICAL TERMINOLOGY RELATED TO APULIA (SOUTH ITALY)

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In Apulia, southern region of Italy, some dialect terms reported to karstic superficial phenomenons show a clear analogy with foreign terms used in the karstic international terminology.

Typical examples are the terms: »grave« that it points out an ample and deep abyss consequential from the German »graben« and the term »pulo« that points out a doline of sinking that has comparison in the Slavic term »polje«, that point out a vaste depression displaced by normal faults. The same terms have numerous variations (gravina, gravoglione, pulicchio, puro, etc.....).

This points out a common matrix in the denomination of similar karstic phenomenons from the north to the south of Europe.

THE USE OF STRUCTURAL GEOLOGICAL TERMS AND THEIR IMPORTANCE FOR KARST CAVES

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Structural geological studies on karst areas operate with the same structural geological terms as on other geological regions. But because of special geomorphologic terms characterized for karst areas, some structural geological elements, which are in a special way connected with particular karst forms, are used as a special terms, different from those used on non-karstic areas.
For Slovene karst we need to divide two most important structural elements that are important for development of cave passages, bedding planes and faults. And between bedding planes the ones that are tectonically disrupted are very favorable for development of initial cave passages.
In principal Slovene karst caves (Postojnska jama caves, Predjama and Škocjanske jame caves) interbedded movements, thrusting and folding deformations, and tectonically crushed zones (fissured, broken and crushed zones) are very important for initial, and also for younger stages of passage development.

OBSERVATIONS ON HISTORICAL TERMINOLOGY

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The author is treating the historical terminology for caves (Grotte, Höhle) used by German speaking authors and explorers in the austro-hungarian period with special view on the various descriptions of caves in the Mediterranean Karst-area written by the Austrian archduke and scientist Ludwig Salvator (1847-1915), who is not only using the historical speleological terminology but also citating the names of caves in their original form and language.

PRELIMINARY REPORT ON PALAEOMAGNETIC RESEARCH ON RAČIŠKA PEČINA CAVE, SW SLOVENIA

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Račiška pečina Cave is situated in the SE part of the Matarsko podolje, SW Slovenia, near the Croatian border. Its mean altitude is 590 m a.s.l. Cave is developed in Lower Cretaceous thick-bedded limestones, breccias and dolomitised limestones. The cave represents relic of old cave system, which was opened by denudation to the recent surface. On the S side, the cave terminates with the collapse choke and sediment fill. The development of the cave is most likely connected to the sink of allogenic streams from non-karst Eocene flysch area that occurs only 2.5 km to the N of the cave. Recent streams sink at elevation of only about 500 m, i.e. 90 m lower than the cave altitude.
Cave is 304 m long. It consists of simple southwards dipping gallery, which is mostly over 10 wide and 5–10 m high. Flood clays of unknown thickness covered by massive flowstone form the bottom of the cave. Several phases of the development of the cave can be seen. The main gallery was formed in paragenetic or epiphreatic conditions. Phreatic features like large cupolas and scallops can be seen on the walls, ceiling and also on the remains of an old flowstone mounds and stalactites. Later the cave become dry and large flowstone and stalagmites were formed on some places on the allogenic clays. There are remains of the extinct *Ursus spelaeus* on the cave floor. Remains of Prehistoric pottery were found at cave entrance.

In the first half of 20th Century the cave was used as a military magazine. The floor was leveled and some large cuts were made through the old massive flowstones. The largest cut through the banded flowstones is situated in the S part of the cave, about 200 m from present entrance. The cut through the flowstone is more than 3 m high and about 20 m long.

Section. The studied section was about 13 m long. The composite thickness of sampled profile reached 484 cm, nevertheless the real thickness is somewhat higher. The section was vertically composed of 3 principal parts. The lower part, 140 cm thick, was built of massive speleothems representing bottom part of huge stalagmite. Most of speleothem layers were highly porous. The middle part of the profile, 344 cm thick, overlaid the lower part with angular unconformity. It was composed of layers of flowstone interrupted with layers of flowstone with gours and several intercalations of red clays of variable thickness. Three clay layers were 15 to 30 cm thick. Some flowstone layers were massive nevertheless most of them were highly porous. Intercalations of thin calcitised siltstones with flowstone fragments and iron-rich sphaerulas occurred in places, too. The top part consisted of huge stalagmites, which were not studied.

Palaeomagnetic and magnetostratigraphic investigation. Laboratory procedures were selected to allow the separation of the respective components of remanent magnetisation (RM) and to determine their geological origin. Oriented field samples were taken to small plastic cubes (20x20x20 mm) from unconsolidated sediments and as oriented hand samples from cemented sediments and speleothems. These hand samples were cut to cubes (20x20x20 mm) in the laboratory. Samples were measured on the spinner magnetometers JR-5A and JR-6A.

Laboratory specimens were either thermally demagnetised or subjected to alternating field (AF). A MAVACS (Magnetic Vacuum Control System) apparatus was used for thermal demagnetisation (TD; 10 samples). The MAVACS creates a high magnetic vacuum in which the samples are demagnetised. Either a LDA-3 was employed for the AF demagnetisation (83 samples).

Phase or mineralogical changes of magnetically active (mostly Fe-oxides) minerals frequently occur during the TD, especially at low temperature intervals. To monitor these changes, magnetic susceptibility (MS) was measured after each thermal step and plotted normalised to the initial MS measurement as a function of temperature. The MS were measured on a kappa-bridge KLY-2.

Multi-component analysis of Kirschvink was applied to separate respective RM components. The statistics of Fisher were employed for calculation of mean directions of the pertinent RM components derived by the multi-component analysis.

All samples collected were subjected to detailed AF demagnetisation in 14 steps and/or TD method in 12–14 fields. The multi-component analysis was applied to separate respective RM component for each sample. Three components were isolated after TD (10 samples) or AF (88 samples) demagnetisation. The A-component is undoubtedly of viscous origin and can be demagnetised in the AF field (0–2 to 5 mT) and at temperature range of 20 to 60 (120) °C. The B low-field component (LFC) and/or low-temperature component (LTC) are also secondary; they show harder magnetic properties and can be demagnetised in the AF field (5–10 to15 mT) or at temperature range of 120 to (300) 400 °C. The characteristic C high-field component (HFC) and/or high-temperature (HTC) are stable. They can be demagnetised or isolated in the AF field (ca. 15–80 to 100 mT) or at temperature range of 300 to 520 (550) °C. The unblocking temperatures (520 to 550 °C) determined for all studied samples indicate that magnetite represents the principal carrier of RM.

Systematic acquisition of palaeomagnetic data within the studied section allowed the construction of a detailed magnetostratigraphic profile having high-resolution character.

The top and middle parts (0–3.25 m) of the profile showed normal (N) palaeomagnetic direction. Mean values of NRM are 72±301 $mA.m^{-1}$ and respective of MS value $230\pm307x10^{-6}$ SI units. Mean palaeomagnetic directions of of C-components for this parts are D = 343° and I = 59°.

The age of the lower part (3.25–4.81 m) of the profile is older then Brunhes/Matuyama boundary (0.78 Ma). There are alternating two longer reverse (R) polarised zones and two N magnetozones. Mean values of NRM are 10.6 ±18.5 $mA.m^{-1}$ and respektive MS value reaches 86.2 ±60.6x10^{-6} SI units. Mean palaeomagnetic directions of of C-components for this parts are D = 19° and I = 68°.

Table 1 NRM and MS mean values

	0.03–3.25 m (54 samples)		3.25–4.81 m (36 samples)	
	NRM [$mA.m^{-1}$]	MS [10^{-6} SI]	NRM [$mA.m^{-1}$]	MS [10^{-6} SI]
Mean value	72	230	10.6	86.2
Standard deviation	301	307	18.5	60.6

Table 2 Mean palaeomagnetic directions of C-components

Site	Polarity	Mean palaeomagnetic directions		α *95* [°]	k	n
		D [°]	I [°]			
Pečina	N (0.03-3.25)	343.0	59.2	5.2	16.3	49
Profile	N+R (3.25-4.81)	19.4	68.2	4.5	30.9	34

Note: Mean directions were calculated for samples with normal polarity, reverse polarised samples were transformed into normally polarized samples

Discussion. The profile consists of two parts. The lower one represents lower part of huge stalagmite form. The overlying flowstone formation intercalated by red clays. The character of speleothems, internal textures and structures and high porosity can indicate very rapid growth in warm and humid climate. High porosity, on other hand, can also indicate post-depositional corrosion of speleothems. Alternation of normal and reverse polarised magnetozones indicate, that the age of lower sequence is clearly older that Brunhes/Matuyama boundary (0.78 Ma), most probably older than 1.77 Ma. Upper sequence shows only normal polarisation of remanent magnetisation. The age of this part cannot be stated by palaeomagnetic method. Table 2 proves, that declinations in upper and lower sequences differ in about 36°. This fact can indicate, that the break between both sequences could be long-lasting and that the age of the fill could be very ancient, formed in the period of intensive block movements and rotations.

HUMAN IMPACT ON HUNGARIAN KARST TERRAINS, WITH SPECIAL REGARD TO SYLVICULTURE

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This study represents the changes of Hungarian karst terrains due to human impact paying special attention to sylviculture. The functioning of the karst geo-ecosystem is considerably determined by the climate-soil-vegetation system, which will influence the dynamism of karst development. Most of the Hungarian karst terrains are the scene of sylviculture. The plantation of non-adequate forest associations resulted the alteration of climate and soils, which resulted in the change of the intensity of karst corrosion. This paper focuses on the change of sylviculture in the Aggtelek National Park, a World Heritage site, and makes suggestions for optimal landuse.

CHANGE IN PERCEPTION OF KARST FROM MORPHOLOGY TO MORPHO-HYDROLOGY: TURKISH EXPERIENCE IN COMPREHENSION OF KARST

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Although it is possible to find some notes on karst phenomena in Turkey in reports as early as 1866, they cannot be considered as research on the phenomena until the work of C. Alagoz who wrote a paper documenting the karst phenomena in Turkey in 1943. Regarding this work as a start of systematic research on karst, it is possible to think about four phases in which perception of karst evolves from descriptive morphology to quantitative morpho-hydrology although clear-cut distinctions cannot be established between phases. Following the period of "excursion notes" between 1866-1940, the first phase (1940-1950) is devoted to documentation of karst features and thus to understand the phenomena by geographers. From 1950, karst became also a focal point for geologists and geomorphologists who had an interest in caves and caving. This interest brought morphology and speleology together which consequently a link has been established between surface and subsurface morphology and tectonic elements. Hydrologic behaviour stayed behind in these studies until the years 1960-1965 when Turkey had some failures in reservoir/dam construction in limestone terrains. Morphology and especially speleology included in dam feasibility studies. T. Aygen demonstrated the role of morphological-speleological surveys in engineering practices in his excellent works between 1965 and 1973. The mission of A. Burdon in 1970 as a FAO consultant to Turkey has been a triggering event to change the Turkish perception of karst. Upon the mission report by Burdon (1970) who has stressed on the need of developing coastal and submarine springs located at western and southern Anatolia, the State Hydraulics Works has invited an expert on karst hydrogeology, namely J. Karanjac who started a new phase in comprehension of karst in Turkey. Karst turned out to be a topic of water resources development following Karanjac's activities in Turkey. During this phase, geomorphological studies by geographers have been dominated by the hydrogeological studies carried out by geologists who ignored the vital link between morphology and hydrology. This phase having an "engineering perception" was represented by the expression "no matter where water originates and how it circulates underground. I have it here so I will develop it". Apparently, this type of perception had also adverse effects on the advance of the Turkish karst science at least in two ways. Firstly, geomorphology could not re-establish its importance in practical hydrogeology and therefore could not change its direction to quantitative karst morphology. And secondly, Turkish karstologists, almost all geologists/hydrogeologists dealing with water resources development have never felt that they had to conduct research on the factors governing the chemical and physical processes in karstification. There has been therefore, very poor Turkish contribution to innovative studies and the advance of investigation techniques. Nevertheless, it is worthy to note that Turkish engineers accomplished construction of large dams in karstic terrains. The world of karst became thus, acquainted with Turkish large-scale karst and the relevant large scale hydrotechnical structures. However, the last decade has been another stage of re-discovery of morphology in comprehension of nature of karst. This fact is today practiced in two ways: first morphology as the major factor controlling the recharge regime and contamination of karst aquifers and second, the value of karstic features as archives keeping records about the past.

OVERVIEW OF THE KARST OCCURENCES IN NORTHERN CYPRUS

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Cyprus is located at the eastern most Mediterranean and encountered to the intersected zone among Eurasia, Africa and Arabic Plates. Karstification is occurring as travertine or caves in Northern Cyprus through to the different ages of formations. Those formations are the dolomite limestones of Kyrenia (Girne) Range of Jurassic – Upper Cretaceous; Gypsum Deposits of Messinian ages. Travertine terraces (Quaternary), which are characteristically seen at the northern edge of the Kyrenia Range. Secondary limestones of Holocene age were deposited on the older sediments and seen some sort of karst features over the island. Karstic occurrences are seen as different size of opened mouth caves or sealed and the sinkholes in these formations which mentioned above.

KARST SPRINGS OF ALASHTAR, IRAN

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Alashtar area is situated in the western part of Iran. The Jurasic Cretaceous dolomitic limestone covers most of the area. There are 5 karstic springs named as Amir, Chenare, Zaz, Honam and Papi. All the springs except the Papi emerge from the Jurassic-Cretaceous limestone. The Papi Spring discharges at the contact of the Jurassic-Cretaceous and the Marly limestone of Eocene age. The springs show variation of discharge during the different periods. Faults and the lineaments are the main avenues for the emergence of the springs. The springs are responsible for the rivers in the plain. The fractures are classified as thrust and normal faults. The faults are mostly formed at the junction of the surrounding carbonate rocks, which give a graben structure to the plain. The springs have an important role in recharging the plain. It is due to the fractures and the springs that the plain aquifer has a high potential of water. The discharge of some of the wells is more than 60 l/s. The discharge of the springs varies consideraby during the year. Out of these, the Amir, Chenare and Honam springs are considered as permanent springs. The annual discharge of the springs is 111 MCM. The hydrochemical analyses of the springs show that all of them are of carbonate type.

EFFECTS OF THE TECTONIC MOVEMENTS ON THE KARSTIFICATION IN ANATOLIA, TURKEY

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Turkey has several types of karstic landforms containing lapies (kkarens), caves, dolines, uvalas and poljes and ground river valleys. Karstification is related not only to the thickness and purity of limestone, climate, altitude but also tectonic movements. Well-developed karstic features such as wide poljes, ground water and cave system are widespread in/on the Mesozoic comprehensive limestone in the Taurus Mountains. The formation of these karstic forms have been taken long time.

Initially, karstification has been begun to develop towards the end of the Mesozoic by the uplift movements of the Taurus Mountains in general. The Neogene lakes in which limely and clayey materials accumulated occupied some large poljes, which had been formed by mostly faulting movement. The fresh water lakes such as Lake Beyşehir and Egirdir are found in the tectonic-

karstic depressions in the western part of the Taurus Mountains. Sinkholes occurring within the lakes also indicate the existence of vertical uplift process.
Ground river systems are found between the Lake Region, which is located in the western part of the Taurus Mountains, and Mediterranean coast. These river systems have been shifted towards the deeper parts of the limestone as the result of the progress of karstification and the vertical uplift of the Taurus Mountains during the upper Tertiary and Early Quaternary time.
Most of the caves, which are found different levels within the old river valleys, fault zones, formed as the result of vertical tectonic movements. It can be stated that vertical tectonic movements caused the lowering of the base level. So the karstification processes have shifted from the upper level to deeper parts of the Taurus Mountains.

COMPARISON OF FRENCH AND SLOVENE KARSTIC AND SPELEOLOGICAL TERMINOLOGY

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The article compares karstic terminology of the two world Karst forces – Slovenia and France, whose scientists have been collaborating for a very long time. From the etymological point of view, the comparison shows that the two vocabularies exerted mutual influence on each other, which in turn brought about several errors when new terms were being adapted. The article also describes some differences in terminology and deviations in the typology of more specific terms, as well as points out great similarity between general terms. The comparison also deals with different lexical abundance of the two terminologies, and concludes with a presentation of some karstic phenomena unique in both countries.

KARST TERMINOLOGY IN EDUCATION

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Unequivocally formed scientific paradigm of any science can be recognized outside the scientific circles as relatively clear terminology in different spheres of society.
For this purpose syllabuses and curriculums for primary and secondary school in Slovenia, school textbooks and teachers handbooks were analyzed regarding karst terms and explanations about karst processes and phenomena.

KARST STRUCTURES AS A STRUCTURAL VOCABULARY OF CULTURAL LANDSCAPE ON THE ISLAND KRK

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In the course of centuries a complex typology of cultural landscapes has evolved on the island Krk. An interaction of natural conditions (geology, relief, water regime, climate and soil) on the one hand and the agricultural technologies on the other has generated specific structural features in rural landscapes. Since this is a karst area, the major factors in shaping of the typological diversity were various karst phenomena, such as sinkholes, dolines, karst fields and dry valleys. It is these structures that make the basis for a morphological vocabulary of cultural landscape on Krk.
Recently, Karst areas are more and more subject to far-reaching structural changes that are triggered by socio–economic processes largely due to the globalisation. In this phenomenology,

the abandonment of agricultural land-use constitutes the core of the problem. Agriculture is no longer the main factor that articulates the manifold patterns of the cultural landscape. Rural lands are left to spontaneous afforestation or taken over by urbanisation. All this leads to a loss of invaluable cultural heritage and of both, regional and local identities. As an obvious physical deterioration, these transformations inevitably mean a loss of typical Mediterranean landscape patterns. This at the same time implies also a reduction of the structural vocabulary in karst landscapes.
The main objective of this paper is to present the landscape typology which should enable an identification of the vocabulary inherent in the cultural landscapes of the Karst region. Parallel to this procedure an effort was made towards landscape evaluation resulting in a hierarchy of cultural landscapes. The latter can be used as an important instrument for protection and revitalisation of valuable landscape areas on the island.

ABOUT SOME KARST TERMS IN BOSNIA NAD HERZEGOVINA

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The mingling of different people over the centuries in what is now Bosnia and Herzegovina has left its mark on the various terms used to describe the karst landscape and its components, particularly since more than 50% of the country's territory consists of karst. The most usual term for karst is krš, but it is also to be encountered in the derivative form kras. Peć and pećina (as an augmentative) are the most common terms for caves, in the sense of horizontal speleological features. This work will analyse the possibility that, from the cultural and historical perspective, the evolution was from peć (pećina) to furnus, and not the reverse, as P. Skok believed. The Greek word spila or špilja is also used for the same natural feature, particularly in some parts of Herzegovina, and even appears in the old ecclesiastical Slav language as pest (pešt). The influence of oriental languages is to be seen in use of the words megara and kuhija for cave. In Bosnia these words too, have certain specific features differing from their use in Serbia and Montenegro, where they are also encountered in toponymy. Most of the terms used for karst features are referring to in the work that has been taken from the topographical terminology used on the 1:25,000 maps published by VGI and from available reference works.

KARST AND PSEUDOKARST

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The term karst has traditionally been used by geographers to describe a set of surface and/ or underground landforms found in limestone terrains. The assumption has always been that the main genetic mechanism for these landforms was chemical solution of the bedrock. For this reason, similar landforms in other soluble rocks were also included into karst, e.g. gypsum karst. Similar landforms in poorly soluble rocks such as quartzite were relegated to pseudokarst, a term used when the main genetic mechanism was assumed to be physical erosion.
These genetic assumptions are simplistic and hinder our understanding of the processes involved. The importance of physical erosion is increasingly being recognised in limestone terrains, as is solution in arenaceous terrains. Also, the balance between chemical and physical erosion changes with time as landforms develop. The term karst should be used to signify a set of landforms, without regard for the rock type or the dominant genetic process. Pseudokarst can then be used for landforms that are similar but distinctly different from karst, such as mass movement caves, lava tubes, thermokarst etc. The contributors to UIS Pseudokarst Symposia have used such an interpretation of pseudokarst for many years.

This poster contrasts two minor English caving regions: the quartzite karst of Northumberland and the limestone gull (mass movement) caves of the Cotswolds.

KRIPTOKARST: THE CASE STUDY OF THE QUATERNARY LANDFORMS OF SOUTHERN APULIA (SOUTHERN ITALY)

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Apulia is the emerged part of a plate stretching between the Ionian Sea and the Adriatic Sea, which constitutes the foreland of both Apenninic and Dinaric orogens. It comprises a Variscan basement covered by a 3-5 km thick Mesozoic carbonate sequence and overlain by thin deposits of Neogene and Quaternary age. The landscape of the costal area is characterized by a staircase of marine terraces produced by superimposition of glacioeustatic sea level changes to the general uplift of the region, which started since the Middle Pleistocene. A number of karstic morphogenetic phases developed under different climates during the continental periods, which followed since the end of Cretaceous to the present. Several areas of southern Apulia, where kriptokast forms are present, have been studied in this paper. They occur in Quaternary marine terraces, which have been overlaid by continental sands.
Kriptokarst is a karst developed beneath a permeable and not karstifiable formation by percolating waters. The permeable rock acts as storage of water which feeds slow seepage and infiltration. This action induces the alteration of bedrock. The resulting forms consist in depressions and pipes filled by the covering sediments. In the surface, sinking of the permeable cover can make closed depressions. The erosion of the soil cover exposes a landscape characterized by pinnacles, ruinforms and dolines.
The studied landforms are mainly pipes of 4-5 meters deep and with variables width (from some centimeters to about one meter). The continental sands are only found in these depressions. The kriptokarst alteration ended before the erosion of this cover because a calcrete is stored in to the pipes under the sands.

KARST AQUIFER VULNERABILITY OR SENSITIVITY?

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Karst aquifers are due to their specific structure particularly sensible to pollution. Hence the protection of karst groundwater, which forms an important drinkable water resource in many countries around the world and specially in Europe, is becoming an essential part of the environmental managing. Since the karst areas are often very large it is thus impossible to demand the maximum protection for the entire hydrogeological background of the source or the pumping well. This leads to the concept of groundwater vulnerability mapping, where different degrees of vulnerability (sensitivity) are symbolised by different colours. Such maps are practical tool for land-use managing and protection zoning. But the term karst groundwater vulnerability has different meanings for different researches and up to now there has been no generally accepted definition and methodology for the construction of vulnerability maps. The definition can be limited to the intrinsic geological and hydrogeological characteristics of an area or can also include land-use and management practices. Still other find that vulnerability depends on the properties of individual contaminant or group of contaminant, but is independent of specific

land-use (Gogu, Dassargues, 2001; COST 65, 1995). Because of the variations in the definitions the term "vulnerability" should be clearly defined.

The aim of this paper is to discus about the differences in the meaning of the terms "vulnerability" and "sensitivity" of karst aquifers based on the Slovenian Environment Protection Act established in 1993. According to the aforementioned act our country statutory specified the making of Environmental vulnerability studies, which are a direct response to the recommendations for sustainable development that were ratified by all the signers of the Agenda 21. According to the methodological scheme of the environmental vulnerability study, devised under the instruction of a research team of geographers, it is necessary to define the carrying capacity or self-cleaning capacity of the environment and its components as well as of the extent and degree of the past anthropogenic interventions which have already reduced the environmental carrying capacity and consequently limited further interventions (Špes et al., 2002).

Such methodological scheme could be easily applicable in the concept of karst groundwater vulnerability mapping, with the regard that it is necessary to distinguish between the terms sensitivity and vulnerability. The term natural sensitivity of karst aquifers to pollution is defined as the assessment of self-cleaning capacity of the karst environment, based on the measurements of different parameters (thickness of overlying layers, concentration of flow, karst network development, precipitation regime, etc). It takes into account the geological, hydrological and hydrogeological characteristics of the area and the intrinsic remediation and neutralizing capacities of the karst system, but is independent of the nature of the contaminant and the contaminant scenario. The synonym is the term intrinsic vulnerability, which was applied by the COST action 620.

Since the measurements of physical-chemical and microbiological characteristics of the captured karst sources and pumping wells show that the karst groundwater is already polluted to some degree, the natural purification capacity of karst aquifers is therefore to some extent diminished. Therefore the term vulnerability should be applied, describing both the natural sensitivity and the degree of the past human interventions, which have already reduced the natural remediation and neutralizing capacity of karst waters. Water protection zones and regimes should be established on the basis of groundwater sensitivity assessment, while the land-use managing in the highly sensitive karst environment should base on the groundwater vulnerability and not sensitivity assessment, since the former is much more complex indicator and includes beside the assessment of carrying capacity also the information on actual hazards that already contaminate karst groundwater. By applying the groundwater vulnerability assessment as discussed above in the concept of the protecting of the karst aquifers, fewer mistakes in land-use managing are to be expected (e.g. placing of the potential hazards in the karst areas of high vulnerability).

RELATION BETWEEN KARST AND FLUVIOKARST RELIEF ON THE EXAMPLE OF THE SLUNJ PLATEAU (CROATIA)

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The Slunj plateau is part of the shallow Kordun karst. It extends from the westernmost part of river Una towards the northwest to the confluence of the Slunjčica and Korana, on the average height of 300 - 350 m of above sea level. It is 40 km long, and averagely about 10 km wide. A larger part of the plateau built of Jurassic and Cretaceous carbonate rocks has characteristics of the karst relief with numerous dolines. On the smaller part built of the Paleozoic and Tertiary clastic sediments and Triassic dolomites a surface fluvial network has been developed. The water

streams emerging on that basis regularly dissappear underground on the contact whit permeable rocks. During geomorphological evolution of this terrain the area that is being drained on surface was reduced, and the traces were left in the form of blind and dry (fossil) valleys. The water streams moved from surface to the underground where they formed the underground channels, i. e. speleological objects. This work analyses the correlation between the formation processes of (today fossil) valleys and cave channels on three examples: 1) Cave system Matešićeva špilja - Popovačka špilja, 2) Ponor pod Kremenom cave and Baričeve špilje, 3) Cave system Panjkova špilja - Muškinja.

HIGH-ACCURACY GRAPHIC REPRESENTATION OF THE UNDERGROUND KARST FEATURES AND FORMATIONS DURING CAVE MAPPING

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We attempt to develop a new method of cave mapping, which would be superior in terms of the amount and quality of the documented information, relative to the "standard" methods of cave survey. The method envisages that everything that can be seen in the cave which is being surveyed, e.g., corrosional features, cave formations, water bodies, fallen rock blocks, fractures in cave walls, artificial (engineering) structures, etc., must be represented on the map. The method employs traditional system of map symbols; the accuracy of the produced map, however, approaches accuracy of the engineering survey maps. The maps accurately render positions, shapes and dimensions of cave features: for example all stalagmites with diameters greater than ca. 10 cm, and all rock blocks with linear sizes exceeding 0.5 m are shown on the maps individually. Such maps serve not only for orientation in caves, but may also serve as a basis of karstological research (e.g., morphometric and morphogenetic studies), and for development of caves (design of engineering structures and facilities, such as paved trails, stairways, rock support structures, etc.). Employing the methodology outlined above, we have produced the 1:100-scale map of the Béke cave near Aggtelek. The map is in a form of an atlas (75 sheets in the A/1 format). Over the last 4 years, similar map of the Baradla cave is being prepared (52 sheets are ready).
In the report we will elaborate on the most important aspects of this mapping method, including stages of survey and mapping, system of drawing, map symbols. Presentation will be based on several map sheets from the Béke and Baradla atlases.

ORIGIN OF LOAMY SEDIMENT LEVELS INSIDE COLLAPSE DOLINES

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On karst surface of Slovenia several hundred collapse dolines are found. Their bottoms are covered with boulders, scree or thin soil layer. In ponor karst areas, where water transports significant amount of alochtonic material the bottoms of many collapse dolines are leveled with loamy sediment. I have made detailed study in 16 collapse dolines in the vicinity of Postojna cave system. Loamy sediment fills at the bottoms of several neighboring collapse dolines are on the same altitude. Level of sediment fills inside collapse dolines is often on the same elevation as flood loam inside nearby caves. Leveling of bottoms inside the collapse dolines is a result of flooding inside karst that had reached bottoms of the collapse dolines. It is possible to predict some dynamics of sedimentation inside karst on the basis of elevations of loamy sediment levels inside collapse dolines, and on the other hand it is possible to find out development of collapse dolines on the basis of processes inside cave system.

SPELEOGENESIS OF THE CRVENO JEZERO (RED LAKE) NEAR IMOTSKI

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Crveno jezero (Red Lake) is situated at the edge of the Imotsko polje, which belongs to external Dinatic karst belt. It was named after the red rocks of its vertical sides which have dips over 45º. Because of its geomorfological and hidrological characteristics, the lake is draging attention of many scientists for more than a hundered years. There are two main presumptions of its genesis. According to Josip Roglić (in Roglić,J., 1938) and Milivoj Petrik (in Petrik, M., 1995.) Crveno jezero (Red Lake) is a collapse doline. On the other hand according to Bahun (in Bahun, S., 1991) Crveno jezero (Red Lake) is swallow-hole through which the water flowed from the large lake existed in the area around Imotski in the Late Miocene. During the subsequent neotectonic activities it has lost that function, and under the influence of collaps processes was transformed into very deep pothole (Bahun, 1991). The newest and therefore most interesting informations related to the Crveno jezero follow from the speleohidrogeological research made in 1998. Those reaserches resulted with the theory which defines Crveno jezero (Red Lake) as a speleological feature (big shaft), which has been formed by reversed processes of karstification under the influence of vertical corrosion.

THE STABILITY OF LARGE HALLS IN KARST CAVES - A CASE STUDY ON THE ABISSO DI TREBICIANO (TRIESTE; ITALY)

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The Abisso di Trebiciano is a vertically developed limestone cave located near Trieste (length: around 700 m, depth: 329 m). The cave consists morphologically of vadose shaft zone, that lead down approximately 270 m below the surface into a big hall, the A.F.Lindner hall with an area of 130 x 80 m and a flat roof between 30 and 60 m above the ground. A river runs through the base of the big hall, belonging to the Reka-Timavo system and flooding the A.F.Lindner hall completely after high precipitation. The Abisso di Trebiciano was thoroughly studied in various spelaeological, hydrological and geological aspects and provides an excellent possibility for a case study on the stability of karst caves and breakdown mechanisms.
The aim of this work was to examine the stability of the A.F. Lindner hall and to investigate the genesis and further development of the cave. For this purpose, a research study was initiated to describe the breakdown blocks, the wall and roof surfaces as well as the discontinuities of the main hall. The Geological Strength Index (GSI, HOEK & BROWN, 1997) was used to describe the geomechanical properties and behaviour of the rock mass, supported by a couple of rock mechanical laboratory tests.
As a first step, the stress distribution around the hall with a 2D finite element program (Phase^2, ©ROCSCIENCE) was modelled to estimate the stress related failures. In the next step the discontinuities were analysed using stereographic projection and the "key block theory" (GOODMAN & SHI, 1984) for the wedge/block failure. Taking the results of these analyses into account and the concept of the "fixed beam model" (DAVIS 1951) finally a model for the genesis and development of the A.F.Lindner hall in the Abisso di Trebiciano could be proposed.

INVESTIGATION OF THE HEAVY METAL CONTENT ON THE SOIL AND VEGETATION OF AGGTELEK KARST (HUNGARY)

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The research of Aggtelek karst includes examinations of physical and chemical parameters of the soils and the microelement content of the greenery. The assessment of antropogenic influent comes to the front the last decades. The research of the heavy metal contamination becomes more significant among investigations. The poster presents the relationship between the heavy metal content of the karstic soil and the sproud of plants.

THE EFFECTS OF LANDSCAPE USE ON THE HYDROGEOGRAPHICAL SYSTEM OF THE BÜKK KARST

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The karst of the Bükk mountain is very important because more than 50 villages and towns receive the drinking water from this karst system. The wells of Kács and Sály belong to the same water system, so their cathcment area is also the same. But we have found diferences between the chemical components of their water.
During the centuries this springs have been used:
for make work the mills
for the bath of Kács and so one…
Currently the drinking water supply system of twelve villages is coming from these springs. So these springs play an important role in the life of this region.

DRINKING WATER SUPPLY FROM KARST WATER RESOURCES (THE EXAMPLE OF KRAS PLATEAU, SW SLOVENIA)

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The biggest economic problem on the Kras plateau in the past used to be drinking water supply, which has also been the reason for the scarce settling of Kras.
Today Kras water supply provides drinking water to households and industry on the plateau and its amounts are sufficient enough to supply coastal region in the summer months as well. Water supply is being founded on efficacious karst groundwater pumping near Klariči. Some water is captured from karst springs under Nanos Mountain as well. The Water Supply Company supplies more than 21,000 inhabitants. A basic question of drinking water supply on Kras is how to assure a suitable water quality and quantity and how to reduce water losses in the water supply network. Inadequate upkeep of the old pipelines causes damage and enormous losses of more and more valuable water. Therefore the Water Supply Company must invest more into maintenance and reconstruction of the system.
Karst groundwater, which is pumped, is organically polluted due to its vast recharge area. It is also endangered by contamination because of rapid urbanization, industrialization and hazardous spills of dangerous substances in its catchment area. Considerable chemical contamination is due to unsuitable transport system, and dumping in a direct recharge area. But water capacities of the spring are not yet completely exploited.
In water supply planning in future numerous other local water resources in linkage to traditional ways of water supply need to be considered. Eventual rainwater usage for garden irrigation or car

washing, purified wastewater usage for communal activity (street washing) or for the needs of farming and industry (as technological water) is not expelled.

KARST AND CAVE SYSTEMS IN BOSNEK REGION (VITOSHA MOUNTAIN, BULGARIA) AND IN WINTIMDOINE (HIGH ATLAS MOUNTAIN, MOROCCO)

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The study of both endokarstic systems Bosnek (Vitosha Mountain, Bulgaria) and Wintimdoine (High Atlas Mountain, Morocco) is presented in this work. Both regions are standard for the study of geodynamic processes in Bulgaria and Morocco, and they could be used as geodynamic polygons in the Mediterranean region. The karst is developed in Triassic and Jurassic limestones. The karst processes in both endokarstic systems occur under the conditions of active Quaternary and recent tectonics. A typical structural karst is formed. The present work shows also the results of the comprehensive studies performed in the field of geology, tectonics, geomorphology, hydrology, climatology, etc., of the karst. It is accented on the genesis and the evolution of the greatest cave systems in Bulgaria (Douhlata cave – more than 17 km) and Morocco (Wintimdoine – more than 19 km long). Both cave systems are situated in zones with high seismicity, with open surface and sub-surface paleoseismic disruptions. The karst study and monitoring of its processes has great practical value in Bulgaria and Morocco because they are related to one of the largest urbanized territories (Pernik and Sofia for Bulgaria, and Agadir for Morocco) and they are protected natural objectives as well.

"KRAŠEVCI"

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The aim of the research was to establish the relations of inhabitants of the region Kras to their living space. Consequently some dimensions of regional identity of Kras are introduced with a special emphasis on the conception of "kraševec". Results of analyses on images of the region indicate great distinction between "insider's" and "outsider's" image as well as the influence of Slovene-Italian border.

THE MAIN CONCEPTS AND TERMS OF ENGINEERING KARSTOLOGY

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One of the impacts of the multi-aspect approach to karst study for practical purposes is a growing difficulty in communication between karst researchers and the end users of final research results. The need for unification of engineering karstology terms and definitions is becoming urgent. In practice, as examples show, terminological ambiguity leads to serious economic and environmental problems. Unified terminology can be efficiently organized within the "karst-construction"geotechnical system. Three term types can be identified: nature related, technological and systemic. The most widely used are the following: karst types; karst occurrences and their parameters; karst danger; karst protection; sinkholes estimated span; sinkhole development probability; karst risk; karst terrain safety.

KARST EVOLUTION AND TECTONIC FEATURES IN ZAGROS RANGE

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Significant presences of carbonate rocks and consequently number of well developed karst aquifers are the main hydrogeological characteristic of Zagros range. Vast exposure of karst in Zagros and increasing need for fresh water has led to new investigation on karst water in Zagros. Huge discharge from springs which are feeding the alluvium aquifer, presence of surface and subsurface karst features has made Zagros range as unique region for karst phenomena as cited in this paper. In this region tectonic has an important role in karstification process in Zagros in addition to the primary porosity of limestone the tectonic activity result in the secondary porosity which include intensive fracturing which has facilitated the flow of water. In general different stages of karst geomorphologic cycle are presented in Zagros region. Also the case study shows karstification decrease with depth.
It is finally stated that study of karst tectonic and geomorphologic cycle helps and will lead to better understand of karst in this region and so there is a great need for comparison and international scientific co-operation in recognition of karst phenomena in this area.

ROUND TABLE ABOUT KARST TERMINOLOGY

A LITTLE CONTRIBUTION TO THE KARST TERMINOLOGY: SPECIAL OR ABERRANT CASES OF KARST POLJES

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According to the usual defination « a polje is defined as a great karst closed basin, with flat bottom, karstic drainage and steep peripheral slopes » (GAMS 1978). But the Dinaric karst shows a wide range of poljes, some fully in carbonatic terrains, other partly in impervious rocks or *border poljes*, (ROGLIĆ 1964) and peripheral polje.
In complement of the structural and morphoclimatic classification, are looking to the evolution of poljes, in keeping with the neotectonic stress, the activity of hydrology, changes of water-table level, and the degree of karstic evolution, particularly marked by the forms of bottom and peripheral slopes.
In some large poljes, the hydrogeological activity is in relation to the neotectonic activity, particularly with the distensional and/or transcurrent faults: classical examples of Minde (Portugal), Cerknica (Slovenia), El Yammoûné (Lebanon)….
Many poljes are in incipient stage:
- blind valley in contact karst,
- uvala in extension,
- structural basin, erosion, excavated in only impervious rocks of the bottom ; examples of the poljés of Caille and Caussols in the subalpine range of the Alpes Maritimes. The development of these forms arises mainly from the fluvial erosion from the ponor in the synclinal trough, and the episodic overflow depends only from the blocking of this ponor.
- recent filled graben, with peripheral slopes constituted by fault scarp, as the polje of Cinquemiglia (Abruzzo) ; *cf.* the south side of Cuges (Provence).
- valley or graben blocked by scoriae cone and lava flow : example of the « Rug », adjacent to the Ghor rift valley, in Syria.

In contrast, in the Mediterranean karsts, many poljes are only inherited forms:
-open poljes, partly drained by an intermittent stream ;
-fossil poljes or *paleo-poljes*.
Generally, the paleo-poljes arise from the canyon cut and drastic lowering of the piezometric level, more often correlated to the regional uplift. They have only a residual hydrographic network (ex. Grand Plan de Canjuers, Subalpine Ranges in Provence). The bottom shows old corrosion surface, with *Rundkarren.* The residual deposits and inherited fersiallitic soils (*terra rossa*) sink trough the epikarst to the deep karst; suffosion and collapse phenomena may occur in the polje bottom.
One intermediary case between active and fossil poljes is that of large uvalas and small poljes in the dolomitic areas, even most above the near canyons. The dolomitic layers give *aquitards* and overflows are possible, by important rain period in the Grand Causses (i. e. episodic lakes of Larzac) and, an even seasonal lakes, as the *daias* of the Causses of the Middle Atlas, in Morocco.