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SOME REMARKS ON THE GENESIS AND GEOGRAPHY OF STATIC ICE SHAFTS

KARAKOSTANOGLOU, Iakovos

ABSTRACT

The conditions favoring perennial ice formations in cold air traps are discussed, with some focus on the climatic ones. If surface air temperature is considered to be the decisive variable, all the other conditions being favorable but of minor importance, a two dimensional (Latitude-Altitude) distribution of the ice shafts should follow some normality. A thermodynamic study for the search of the maximum permitted energy up to the quantities could be helped by limitations and relationships between various ice shaft geometric variables which are revealed from plots of surface temperature versus these variables. Then a grouping of the ice shafts might be possible. This proposal requires adequate worldwide explorative data. Examples are given.

INTRODUCTION

Cold air trapping processes have been described by various authors (see for instance/1,p.228/). Ice shaft temperature profiles have also been published, some of which in high precision/2/. In general, the gradual freezing state as someone goes deeper in the shaft is manifested/3,p.175,Fig.82/.

Factors affecting the all over the year presence of snow, firn or ice formations in non active potholes or shafts and in steep funnel shaped dolines are more or less known. The most important of them are briefly mentioned in the followings.

The existance of the so named "Cold Air Traps" depends mainly on:

A. The cave geomorphology, that is
   i. shape and size of the entrance
   ii. depth and morphology of the cavity
B. The cave geology and hydrology, that is
   i. type of rock (e.g. volcanic or sedimentary)
   ii. state of rock (e.g. massive or fractured)
   iii. the amount of water penetrating the rock surroundings of the cave
C. The surface environment, that is
   i. type and density of vegetation (e.g. presence or absence of trees)
   ii. geomorphology of the cave surroundings (e.g. flat land or irregular karstic land)
   iii. local climate, for instance:
      a. wind dominant direction, relative to cave entrance orientation
      b. amount of snow precipitation
      c. yearly number of freezing days

In this study, all the above factors are considered to be favorable for the ice shafts. The only variable which might not be favorable is considered here to be the Mean Annual Temperature (MAT) outside the cave entrance, which is used as a parameter for static ice shafts correlation purpose. This variable was chosen because it is widely accepted that, in general, deep cave temperature is approximately equal to the MAT of the cave surface surroundings /4,p.27/. So, the temperature diversion found in a certain ice cave characterizes its own freezing ability, which may be different in another ice cave.

A distinction should be made between the MAT of the locality in which a certain cave is found and the MAT outside the cave entrance. The former depends on several factors, the most important of which are: latitude(L), altitude(A), and climatic regime(ex. continental or maritime). For the later, geomorphology and vegetation of the surroundings seem to play a role in its determination.

GEOGRAPHY

The geographic area of this study ranges from Caucasus to the East up to Pyrenees to the West, and from Atlas and Ide to the South up to Lurich Horv to the North (Fig. 1).

The information for almost 80 ice caves of any type was collected from more than 50 publications, written in 10 different languages. This was the one main difficulty, the other one being the lack of complete data most papers could offer. So, for each cave several publications had to be sought. The need of a concise computerized cave documentation was prominent.

The space of this study in an Altitude-Longitude diagram is shown in Figure 2. The snow line is also shown /5,p.169,Table 5.3; 6,p.270,Fig.9.1/as well as the glaciers of Europe/7,p.24,Table I/. The altitude data reflects the situation as it was in the fifties.

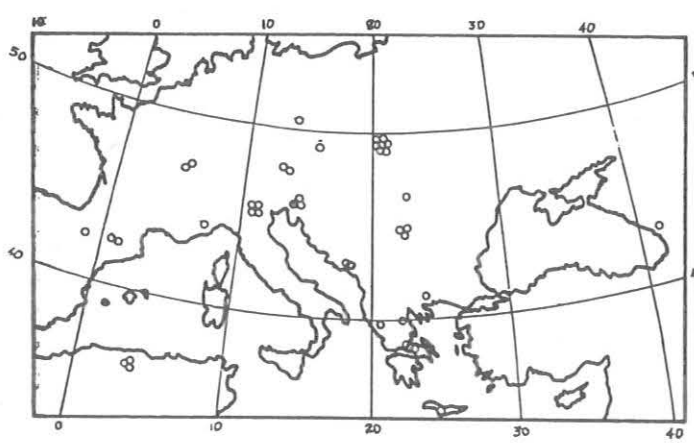

FIGURE 1

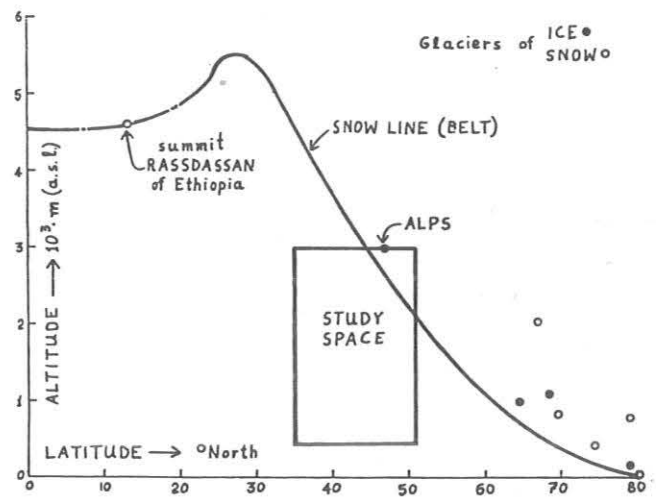

FIGURE 2

Figure 3 is an enlargement of the study space, in which any type of ice-caves found in literature have been incorporated. It includes static and dynamic ice caves or shafts, as well as ice dolines and transitional ones. The so named "transitional" doline or cavity preserves ice all over the year quite often but not in every year. Such cavities and dolines have been personally observed in Greece.

The local MAT, which is assumed to approximate the MAT outside the cave entrance is also shown in the diagram, at the right of each spot. It was problematic to find such a data, since only the studies dealing with show ice caves, all of which are dynamic ones, offered this parameter measured in situ. The problem was faced by calculating the local MAT on the basis of a lapse rate 0.6±0.05°C per 100m /5,p.125-126; 8,p.109; 9,p.489/ as well as on data of meteorological stations nearest to the cave as it was found in literature for the decade 1950-1960/5,Appendix C; 10,1955-1961/. All possible uncertainties and calculation errors had to be considered. This resulted to temperature estimates of a precision ranging from ±0.1°C up to ±1.6°C, but mostly it is close to ±1°C.

The ice caves found in Figure 3 have a lowest altitude of 440m(a.s.l.) for Rasovna ponor shaft cave in Moravian Kras(CZ), and a highest local MAT of 9.9°C for Eftestomo shaft (±0.6°C) and Ideon Andron cave shaft (±0.9°C) in Greece. It is impossible to draw isotherms through the total study space because of regional differences in lapse rates and in climatic regimes. Only two isotherm belts look to be somehow reasonable: the one at 0°C and the other at 10°C. The 0°C belt seems to emerge from the snow belt, while the 10°C belt seems to be the lower limit for the presence of an ice cave.

Although simplified mathematics do not allways work in generalizations of such complex processes as the atmospheric ones, the equation for the 10°C isotherm belt:

$$T(°C)=37.43-0.52L(°North)-0.006A(m) \qquad I$$

is given just for comparison to similar equations of deep cave temperatures, previously appeared in literature:

$$T=38-0.6L-0.002A \qquad II \qquad /4,p.29/$$

and

$$T=54.3-0.9L-0.006A \qquad III \qquad /11/$$

Equation I is closer to II, except the last coefficient, which corresponds to the lapse rate.

GENESIS

It is well understandable that detailed thermodynamic study of an ice shaft or an ice cave in general is not an easy task. The study would be more demanded if someone had the ambition to be led into generalized results. Perhaps he should have to look for a side way to overcome the problem. Such a way is the statistical treatment of the subject. To do this, the greater the data someone uses the safer the results he will be led to. In this study, an effort has been done to show that, even by using limited data, something is discerned in the horizon. It is rather a proposal for the method than a study of integrated results.

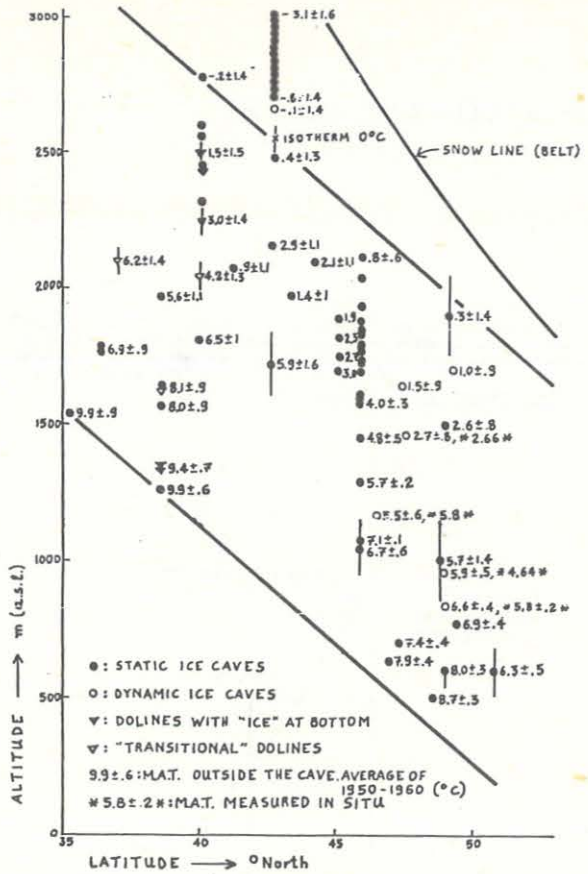

FIGURE 3

The only one thermodynamic parameter used here is the local MAT, the rest variables belonging to the cavity's geometry, that is: effective volume, depth of ice presence, and entrance width. The term "effective volume" indicates the cavity's part which receives the freezing effect during the cold air trapping process. It is usually the total volume of the Aven type shafts, or it is the upper part of a shaft system the lower part of which does not present the character of an ice cave. This happens because very narrow passages are intercalated in between the upper and the lower parts. By the microclimatic point of view, the lower part behaves as being almost a separate cave or shaft. The term "entrance width" indicates the smallest of the two or three basic dimensions of the entrance, the largest one being the "entrance length", regardless the entrance orientation.

Figure 4 illustrates the diagram of local MAT against ice shafts' effective volume. Volume calculations were based on maps of plan, vertical extended, and cross sections for each shaft. The Regular Solid Best Fit method was applied by dividing shaft's space into several regular solid pieces. This is why the volume error was accepted to be quite high (±10%).

Two sets of ice shafts are distinguished: the one of small volume where most shafts belong to and the other of large volume where several shafts occupy the inclined belt beyond of which there is not any other ice shaft. It seems that the larger the volume the lower the outside air temperatures that shaft requires in order to achieve the necessary freezing effect. It also seems that the ice shafts on this boundaring belt may have similar freezing effect, in the sense of similar ability to preserve ice all over the year. A comparative study of the state of ice (e.g. degree of snow crystalinity or firn density) which is found within these boundering ice shafts would be quite useful. Another boundaring belt seems to be above the small ice shafts, so that an optimum effective volume for the 10°C ice shafts may exist.

A belt for the ice dolines has been drawn, similar to the one for the ice shafts. Two Greek dolines are also shown, the one being close to this belt (see the arrow) and possessing crystalized snow on its bottom for almost 11 months per year (transitional doline); the other doline keeps snow till only the early spring although it is situated just next to the former. A neighboring ice shaft of Aven type preserves firn all over the year.

Figure 5 shows the entrance width against shaft's depth. The rectangular bars correspond to the ice presence depth within the shaft. There have been

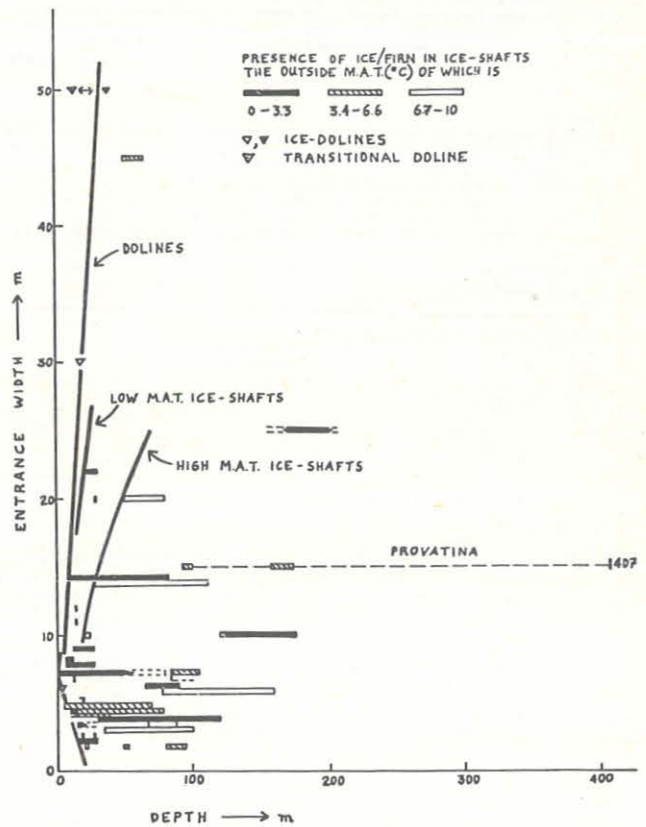

FIGURE 5

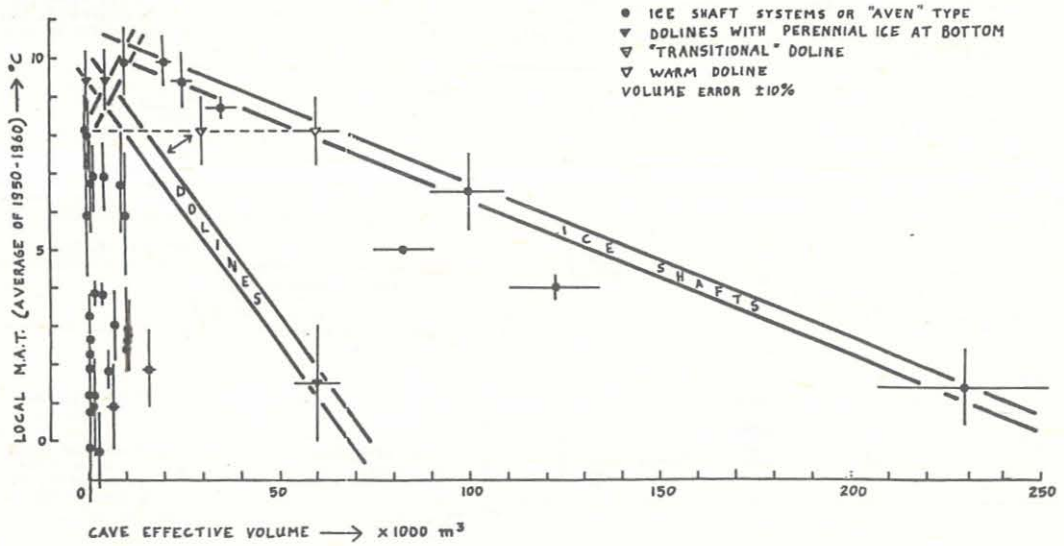

FIGURE 4

separated three sets of shafts and dolines according to their local MAT: those of low, middle, and high temperatures, ranging from 0°C up to 10°C. The important variable regarding ice presence should be the ice upper limit depth which could be affected directly by any surface environmental change.

The ice upper limits become apparently deeper as one goes from the optimum entrance width of 7m to larger or narrower widths. It is understandable that during the summer wider entrance allows warm air masses to alter the shaft's upper part freezing state. It is also reasonable that narrow entrance may not allow much cold air and snow to freely enter the shaft. The narrowest width was found to be 2m. The diagram also shows that high MAT ice shafts keep generally their ice deeper than low MAT ones.

A similar line for ice dolines shows the same, although slower, trend. The transitional doline indicated by an arrow at the uppermost left corner of the diagram is the one mentioned previously, which preserves ice for almost 11 months of the year. The Greek ice shaft Provatina has got a peculiarity, for its lower ice presence depth is not limited due to narrow passages. This tube like ice shaft, the one drop depth of which is 407m, does not keep ice at the bottom all over the year, possibly because of combined geothermic and hydrologic effects. A detailed cave air temperature profile would be very helpfull to this question.

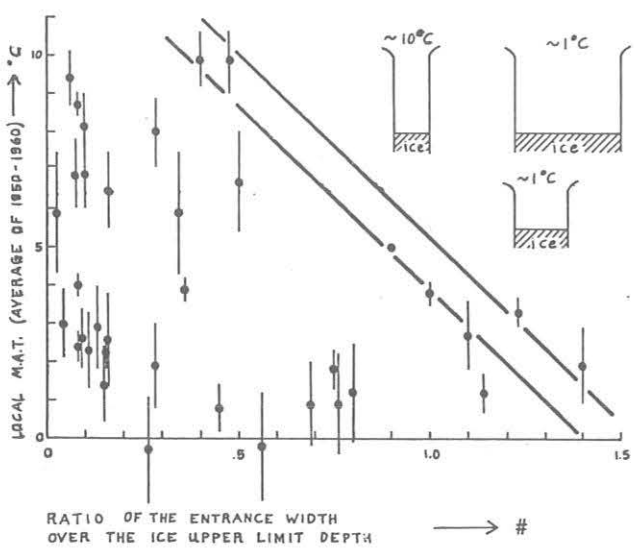

FIGURE 6

Figure 6 presents the same ice shafts' data of figure 5, plotted in a different way, that is: the local MAT against the ratio: "entrance width" over "ice upper limit depth". By doing this plot:

a) two opponent effects, that the "entrance width" has on the "ice upper limit depth", meddle into one index which reflects the combined result. So, the optimum entrance width of figure 5 disappears. As a result, the two idealized ice shafts of 1°C MAT at the upper right corner of the figure should be equivalent and should be represented in the plot by the same spot.
b) a thermodynamic parameter faces directly a geometric index.
c) MAT magnitudes' uncertainties can be plotted, so that any conclusion will be more safe.

The inclined bounding belt is recognized again in this diagram, as it was in the case of the effective volume (Fig.4). The bounding ice shafts are the same in both plots. It was previously mentioned that a similarity may exist: on the freezing effect these ice shafts have achieved. If this could be verified, then a grouping clue for at least the ice shafts of Aven type would possibly be established. For example, all the three idealized ice shafts shown at the upper right corner of figure 6 would be equivalent and would belong to the same group.

EPILOGUE

The previous discussion notifies the significance that may have in a thermodynamic study those ice shafts which are found close to or into the bounding belts. It should be mentioned here that the most recent global climatic changes have moved the snow line towards higher elevations in several places of the world. The case of the summit Rasdasssen in Ethiopia is a typical example (Fig.2). Snow lay all the year on this summit during the end of the last century/I2/ while in the early seventies it was unknown/I3,p.I8I/. This trend towards warmer climatic regimes, now widely recognized /I4/, might have some impact on the existence of those ice caves, the ice of which has reached the limit of its presence. Such transitional ice caves could possibly be used as monitors of the upcomming climatic change. Historic records related to these ice caves might also be usefull in evaluating recent climatic changes.

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I4. The M.I.T. PRESS (Publ.) /I97I/ : Inadvertent Climate Modification

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PALEOKARST - A KEY TO PALEOGEOGRAPHY AND STRATIGRAPHY ON CONTINENTAL PERIODS

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Karst features developed partly or entirely during past geological periods have been known as paleokarst. In its forms and fills, it preserves a record of the nature of geological and geographical changes, which have only scarce evidence from other records or correlative deposits. It serves as a conserver of the geological past evidencing the evolution of hypergene zone of the Earth crust. It serves as a key to bio- and lithostratigraphy of continental periods and as a guide to paleogeographic analyses and paleoecologic considerations.

1. INTRODUCTION

In the last time, the investigation of paleokarst forms became more intensive mostly due to large economic potential of deposits of economic minerals and rocks (cf. Zuffardi 1976; Perna 1975; Laznicka 1985), and due to economic problems connected with large civil engineering projects (e.g. Głazek and Szynkiewicz 1979; Bosák et al. 1989), and with hydrogeology of deposits in karst (cf. Böcker and Vizy, and Wilk in Bosák et al. 1989). The scientific evaluation of paleokarst as a geological phenomenon has stayed on the margin of interest of geologists and geographers, although there are possibilities and perspectives for the solution of many problems connected with sciences on the environment of the geological past.

2. TERMINOLOGY

The term p a l e o k a r s t refers to karst forms developed largely or entirely in the geological past (Gèze 1973; Jennings 1985; James and Choquette 1988; Bosák et al. 1989). It can be or cannot be a part of modern karst landscapes (cf. Monroe 1970; Quinlan 1972; Baud and Masson 1975; James and Choquette 1988). Its basic feature is a polycyclic and polygenetic character (Panoš 1965). The term paleokarst has been often applied contemporaryly with the use of the term f o s s i l k a r s t, which has the same sense according to some authors (de Martonne 1910; Jennings 1971). The application of both terms must follows the proper sense of each of the terms. The fossil karst refers to entirely inert, non active and fossilized karst forms (Bosák 1981a) completely de-coupled from the present hydrogeochemical system (Ford and Williams 1989). However, in some languages the application of the term paleokarst has not tradition and from the language point of view its use is not desirable (e.g. in Polish).

The term paleokarst covers a broad scale of fossilized karst forms buried by younger permeable and/or impermeable deposits (b u r i e d k a r s t) or only by permeable sediments (c o v e r e d k a r s t). The evolution of covered karst can continue under the overlying cover, therefore the complete fossilization is, in some cases, impossible (cf. Tsykin in Bosák et al. 1989). Fossilized karst features developed within the karst rocks are common (i n t r a s t r a t a l k a r s t), as well as along bedding planes (i n t e r s t r a t a l k a r s t) and along boundaries of karst and nonkarst rocks (s u b j a c e n t k a r s t ; cf. Quinlan 1972, 1978; Palmer and Palmer in Bosák et al. 1989). The paleokarst refers also to the category of r e l i c t k a r s t, i.e. forms which remain a part of developing karst landscape, old karst forms beeing reworked, and e x h u m e d k a r s t, i.e. uncovered from overlying strata with renewed karstification (c.f. Sweeting 1972; Quinlan 1972; Panoš 1978; Ford and Williams 1989).

3. PERIODS AND PHASES OF KARSTIFICATION

The karstification in the time after karst rocks emerged and during denudation can last for different time-spans. Long-lasting period of continental weathering and groundwater circulation, which is finished by marine transgression of by mass continental deposition, can be designed as k a r s t i f i c a t i o n p e r i o d (cf. Głazek 1973; Bosák 1981a; Bosák et al. 1989). Karstification period is connected with disconformities of different types. Many karst forms develop in the period, even in more impressive stages, designes as k a r s t i f i c a t i o n p h a s e s (Herak and Stringfield 1972). Each of phases is caused by geodynamic or substantial climatic change; e.g. by uplift, subsidence, origin of permafrost etc. Large changes occurring in a short time-span, e.g. sudden collapse, can be designes as k a r s t i f i c a t i o n e v e n t (Bosák et al. 1989).

Głazek (1973, in Bosák et al. 1989) distinguished different tectonic processes and cycles controlling the karstification periods. The longest periods are caused by the general change of movement character of lithospheric blocks, i.e. by orogenies. The second category of karstification periods corresponds to changes in the movement of lithospheric plates in the segment of spreading ocean. The change is caused by the orogeny in other segment of the Earth. Both categories of periods correspond to interregional paleokarst of James and Choquette (1988). The shortest karstification period (i.e. phase) originates during glacial-eustatic fluctuations of the sea level and local tectonic movements. On numerous recent and fossil carbonate platforms (mostly on passive continental margins) it is reprezented by disconformities and unconformities on aerally limited regions. Such periods classified Boni and D´Argenio (in Bosák et al. 1989) to periods of less or more short stratigraphic gaps not accompanied by expressive disconformity without conditions favourable for origin of deep karst circulation (correspond to synsedimentary paleokarst of James and Choquette 1988), and to periods characterized by the traces of erosion and disconformities, and by the development of subsurface paleokarst in the limited vertical span (equivalent of local paleokarst of James and Choquette 1988).

4. FOSSILIZATION

The karst become fossil or inactive when losts its hydrologic function. The general cause of the process is in local or regional and global changes of geotectonic and tectonic conditions or in the change of the level of the world ocean. Fossilization can be the consequence of uplift or subsidence, transgression or huge continental deposition (Bosák et al. 1989). Continental drift can change geographic position of karst regions in different geologic periods and can cause, by this way, the climatic change which contributes both the fossilization and rejuvenation of karst (Bosák 1981a, b; Zhang 1986).

Owing to the fact, that karst is only the presence of open space within rocks suitable for deposition of fills (Laznicka 1985), the paleokarst represents a trap for stratigraphic record of continental periods, i.e. of time without any lithologic record (Głazek 1973). Fossilization preserves, therefore, features exited in the certain time and preserves them. The fossilization includes stages of karst evolution, weathering, deposition, climatic changes, life etc. (Bosák and Horáček in Bosák et al. 1989). The presence of fossil karst forms indicates that the emegrence and continental conditions existed in the time of a gap in depositi-

on. It enables to characterize the conditions more precisely. According to the character of karst, we can specify tectonic processes and features preceding the evolution of subaeric conditions and of karst. Present climatic conditions during origin and evolution of karst, and its fill can be reliably characterized when based on typology of karst forms and lithology of the fill, on the nature of faunistic and floristic remains etc. (Głazek 1973).

The absence of paleokarst forms and features on large areas with distinct traces of erosion and denudation has also a great importance. It informs on the fact, that long-lasting erosion damaged developed karst forms. Therefore, preserved are only youngest forms or the deepest developed features (e.g. the example of the pre-Cenomanian paleokarst of the Bohemian Massif, Bosák 1981b, c). The absence of paleokarst can also indicate, that there were not created conditions for the karst evolution, e.g. large extent of nonkarst rocks on the surface which were eroded only in later development phases, etc. (Głazek 1973).

The fossilization preserves a number of sediments, fossil rests and indirectly also the evidence of different processes during the continental periods. Data on features of biotic environment, paleoecology, etc. are also of a great importance. From this point of view, the paleokarst represents a c o n s e r v e r of the geological past. Unfortunately, such data are often unredeable and degraded by later rejuvenation, reactivation and redeposition processes, which were not reliably detected or entirely overlooked (Horáček and Bosák in Bosák et al. 1989).

5. REJUVENATION

The rejuvenation of a karst is caused by a number of factors. Generaly, it leads to the renewal of the hydrologic function of karst and of groundwater circulation. The rejuvenation is a process opposite to fossilization effects. New creative and destructive karst processes, deposition and redeposition, exhumation and weathering injure the content of paleokarst. They cause a chaotic changes in the original superposition of elements of karst fill. The direct consequence is in the presence of sediments of different age and origin at one site and in the direct relation or superposition.

The aspect of rejuvenation and related processes led numerous authors to sceptic position during evaluation and utilization of karst sites for the broader geologic and geomorphic studies. Numerous and surprising results from last years indicate, that there is a possibility to maintain reliable interpretation of hidden nature of paleokarst sites using broad and multidisciplinary investigation of karst and paleokarst and of their fill. Such interpretation brings reliable results utilizable mainly in paleogeographic interpretation in a very broad sense.

6. INTERPRETATION

Present paleogeographic evaluations have been based mostly on research and interpretation of marine sediments or on analysis of continental basins. Such record of the geological past in the platform areas covers maximum 50 to 60 % of the geological time, if the situation is favourable (Głazek 1973). Practically, the record covers much more less time , for example in the Bohemian Massif only 12 to 45 % of the geological time after Lower to Upper Paleozoic marine deposition finished. The record of marine or terrestrial sediments is interrupted by 55 to 88 % of time without any evidence in corelate sediments. Only in the very recent time, paleokarst sites dated by fossils serve as a key to paleogeographic reconstructions, e.g. Neogene of Poland (Głazek 1989).

A prevailing terrestrial nature of paleokarst serves as special opportunity to study phases of continental development, which are without any other fossil record. More, the study can be broad. Polycyclic and polygenetic nature of paleokarst supports the importance of the investigation, nevertheless it brings some troubles. Besides the terrestrial record reprezented by continental fill, paleokarst contains also marine deposits in the direct superposition with the terrestrial ones. Such sites are of special importance, they are k e y s to locked doors of bio- and lithostratigraphic correlation of continental and marine deposits and to continuous geochronology of the geological past. The whole complex of such properties makes often paleokarst a m i s s i n g l i n k s in regional and global chronostratigraphy (Horáček and Bosák in Bosák et al. 1989).

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GEDANKEN ZUR HYDROBIDENFAUNA UNGARNS

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ABSTRACT
Thought about the Hydrobioidea-Fauna of Hungary
The following species of Hydrobioidea aquatic snails are cited in the literature from Hungary:Bythinella hungarica; Lartetia hungarica;Lartetia gebhardi and Paladilhia oshanovae.
Bythinella hungarica is now considered by FALNIOWSKI as a subspecies of B.cylindrica.
Lartetia hungarica and Lartetia gebhardi from subterranean waters in South Hungary have been cited as species of the genera Iglica-Paladilhiopsis ; Paladilhia.

Several recent works on anatomy of Hydrobioidea and particularly my revision of the genus Bythiospeum,have shown that Lartetia is synonymous with Bythiospeum: and that Paladilhia: Paladilhiopsis and Iglica are different and distinct taxa.Paladilhia is a french mediterranean genus, Bythiospeum colonize the hydrographic basins of Rhone,Rhine and Danube between Ardèche,Bavarian Alps, Bingerloch and Bernese Alps.i.e. eastern France, northern Switzerland and southern Germany.Iglica and Paladilhiopsis are balcanic elements in eastern Europa,the verified most western stations are in North Italy.

In order to elucidate the correct attribution of the hungarian Lartetia on anatomical basis .I undertook last year a journey to Mecsek range;unfortunately only a few empty shells have been collected in the Orfü cave-resurgence.In spite of the lack of an anatomical study,it is very probable that Lartetia hungarica is neither a Bythiospeum nor a Paladilhiopsis,but represents in fact an Iglica.The same can be said for Paladilhia oshanovae. More search for living specimens in the Orfü resurgence is needed.

ZUSAMMENFASSUNG
Es wird auf die wenigen aus Ungarn zitierten Arten der Gattungen Bythinella und Lartetia hingewiesen.Die beiden ungarischen "Lartetien" (Lartetia hungarica;Paladilhia oshanovae) stellen vermutlich Arten der Gattung Iglica dar.Die Notwendigkeit einer anatomischen Überprüfung und weiterer Erforschung von Karstquellen wird hervorgehoben.

Aus Literaturangaben aus den Jahren 1881 bis 1968 geht hervor,dass vier Wasserschnecken der Superfamilie Hydrobioidea aus Ungarn beschrieben worden sind:
•Bythinella hungarica HAZAY 1881: aus Quellen;
•Lartetia hungarica SOOS 1927
•Lartetia gebhardi WAGNER 1931: aus unterirdischen Gewässern;
•Paladilhia oshanovae PINTER 1968 aus Donaugenist.

Bythinella hungarica HAZAY 1881 wurde ursprünglich aus einer Quelle in Budapest beschrieben.FALNIOWSKY 1987 soll sie lebend auch in Polen (Lubomir Gebirge) gefunden haben und betrachtet sie als eine conchyliologische Form der Bythinella cylindrica FRAUENFELD 1856.
Im Gegensatz zur Bythinella austriaca aus Karstquellen,lebt B.cylindrica in kleineren Quellen ausserhalb von Karstgebieten.

Lartetia hungarica wurde von SOOS 1927 aus der Abaliget-Höhle , **Lartetia gebhardi** von WAGNER 1931 aus der Manfa Höhle sowie aus verschiedenen Karstquellen des Mecsek-Gebirges in Südungarn beschrieben.Spätere Autoren haben die beiden Mecsek-Lartetien als Iglica (in:WAGNER 1936);als Paladilhiopsis (in: WAGNER 1942;SOOS 1957;GEBHARD 1960);als Paladilhia (in: ROTARIDES 1943) erwähnt.
Als die beiden Holotypen der beiden Mecsek-Lartetien durch Feuer vernichtet bzw. verschollen wurden,hat PINTER 1968a aus Material der Originalfundorte einen Neotypus für die Lartetia hungarica designiert und die Lartetia gebhardi als Synonym zu hungarica gestellt;der Neotypus erhielt die Bezeichnung **Paladilhia (Paladilhiopsis)hungarica** (SOOS 1927).Gleichzeitig hat PINTER 1968b noch eine **Paladilhia oshanovae** aus dem Donaugenist bei Esztergom in Nordungarn beschrieben.

Wie sind nun diese Funde zu werten?
Es besteht kein Zweifel,dass Paladilhia oshanovae zur gleichen Gattung wie die Mecsek-Lartetien gehört;dem damaligen Wissensstand entsprechend brauchte PINTER für die Lartetien die Bezeichnung Paladilhia.Heute wissen wir aufgrund der anatomischen Merkmale,dass Lartetia identisch ist mit Bythiospeum,nicht aber mit Paladilhia.
Die Frage ist nun welcher Gattung die erwähnten Hydrobiden aus unterirdischen Gewässern Ungarns zuzuordnen sind.Handelt es sich wirklich um Lartetien bzw. um Bythiospeen ?

Meine kürzlich verfasste Revision der Gattung Bythiospeum hat gezeigt,dass Paladilhiopsis und Iglica nicht als Synonym von Bythiospeum aufgefasst werden können,da sie conchyliologisch und anatomisch abweichen.Es hat sich gezeigt,dass Bythiospeum in Westeuropa beheimatet ist und die hydrographischen Becken Rhône-Rhein-Donau zwischen Ardèche, Bingerloch, Berner Voralpen und bayerischen Alpen besiedelt.Noch ungeklärt sind die Verhältnisse in der bayerischen und öster- reichischen Ebene.
Paladilhiopsis und Iglica gehören bereits zur Balkan- und osteuropäischen Fauna und stossen im Westen bis nach Norditalien vor. Das bis heute bekannte westlichste Vorkommen von Iglica liegt im Piemont.Bei Graz in Südösterreich ist Iglica mit der Art tschapecki vertreten;diese als Vitrella beschriebene,als Lartetia bzw. Bythiospeum später zitierte Art erweist sich in Wirklichkeit aufgrund ihrer Anatomie als eine Iglica,ähnlich wie jene Sloveniens.
Das bis heute bekannte westlichste Vorkommen von Paladilhiopsis liegt in der Lombardei;weitere Paladilhiopsis-Arten sind aus Yugoslavien,sowie Bulgarien und Rumänien bekannt,aus letzteren allerdings nicht anatomisch gesichert.
Paladilhia schliesslich ist anatomisch von den obengenannten Arten sehr verschieden und ist auf das mediterrane Südfrankreich beschränkt.

Die einzigen sicheren Zuordnungskriterien sind die anatomischen Merkmale.Zu diesem Zweck bin ich vor zwei Jahren ins Mecseck-Gebirge gereist,um lebende Exemplare der Lartetia hungarica zu sammeln.Leider erfolglos,in der Resurgenz-Höhle von Orfü konnten lediglich einige wenige leere Schalen gesammelt werden;die Quellgegend von Melyvölgy war durch Wasserfassungen und die Abaliget-Höhle durch den turistischen und Kur-Betrieb derart verändert,dass das Sammeln erfolglos bleiben musste.
Eine anatomisch eindeutige Zuordnung des gesammelten Materials ist somit heute nicht möglich;immerhin kann die Gattung Paladilhiopsis und die Gattung Bythiospeum mit grosser Wahrscheinlichkeit ausgeschlossen dafür die Gattung Iglica in Betracht gezogen werden.
Es ist zu hoffen,dass mit gezielten und länger dauernden Filtrations-programmen an der Resurgenz-Höhle von Orfü endlich auch lebende Exemplare gesammelt werden können,damit die oben geschilderte Wahrscheinlichkeit Gewissheit wird.

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TASMANIAN CAVE FAUNA

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ABSTRACT
Tasmania is well endowed with karst areas and caves. The invertebrate cave fauna is poorly known although recent study has proven the existence of a rich assemblage of both terrestrial and aquatic troglobites. The fauna shows a pattern of similarity with the cave faunas of other periglacial regions. Troglobites or stygobionts are presently known from the following groups: Gastropoda (Hydrobiidae); Diplopoda (Dalodesmidae); Crustacea-Syncarida (Parabathynellidae, Psammaspididae, Anaspididae), Amphipoda (Crangonyctoidea), Isopoda (Oniscidea, Phreatoicidea, Janiridae); Arachnida-Pseudoscorpionida (Chthoniidae), Opiliones (Triaenonychidae), Araneae (Amaurobiidae, Micropholcommatidae, Pholcidae, Stiphidiidae, Textricellidae, Theridiidae); Insecta-Collembola (Sminthuridae, Paronellidae), Coleoptera (Carabidae).

INTRODUCTION

Tasmania is an island of 68 330 square kilometres, situated between 41 and 43 degrees latitude South and rising to a maximum elevation of 1617m. The climate is cool temperate with annual rainfall ranging from 500mm to 3600mm. The majority of karst areas are located in the western half of the State, which is characterised by high rainfall; the main vegetation types are temperate *Nothofagus* rainforest, wet *Eucalyptus* forests, sedgeland, and alpine vegetation.

Compared with the mainland of Australia, Tasmania is well endowed with karst and caves. There are more than 60 karst areas and more than 1000 caves recorded, although exploration of them is far from complete. The deepest cave is the Ice Tube-Growling Swallet System at 375m depth and the longest is Exit Cave at 17km. The caves are developed predominantly in Ordovician limestone, upper Precambrian and lower Cambrian dolomites and limestones, and occasionally in Permian limestone and Pleistocene dune limestone. Some psuedokarst caves are also known. Air temperature in the caves varies from 4 to about 12° C. Tasmania's climatic history includes several periods of Pleistocene glaciation in upland areas and the development of some caves has been directly influenced by glacial and periglacial processes.

The Tasmanian fauna in general has many special groups: endemics, relictual forms and Gondwanaland elements. However, the invertebrate fauna is generally poorly known; for example, there are approximately 6000 described species of insects and probably 3-6000 undescribed. The cave fauna is likewise poorly known although it is evident that the caves contain a rich assemblage of both terrestrial and aquatic troglobites.

This paper is a brief review of the major animal groups recorded from Tasmanian caves.

VERTEBRATES

Bats do not roost in Tasmanian caves although there are 8 species of forest dwelling vespertilionids. However, skeletal remains indicate that at some time in the Recent past these species did roost in caves.

Other extant mammals utilising caves as shelter include the Tasmanian Devil *(Sarcophilus harrisii)*, the Wombat *(Vombatis ursinus)*, Ringtail Possum *(Pseudocheirus peregrinus)* and Platypus *(Ornithorhynchus anatinus)*.

Epigean fish found in cave streams include the Spotted Mountain Trout (Galaxiidae: *Galaxias truttaceous*), lampreys (Mordaciidae) and the introduced Brown Trout *(Salmo trutta)*. Frogs, lizards and snakes are recorded as occasional or accidental visitors.

PLATYHELMINTHES

Both freshwater flatworms (Paludicola) and terrestrial flatworms (Geoplanidae) are found, though none appear to be restricted to caves.

NEMERTINI

Freshwater nemertines are recorded occasionally.

OLIGOCHAETA

Earthworms are common in riparian mudbanks, particularly where the cave catchment has been affected by agriculture. The groups recorded are Lumbricidae *(Lumbricus sp.)*, Enchytraeidae and Megascolecidae.

GASTROPODA

The aquatic fauna is dominated by the Hydrobiidae, most of which are unmodified surface species. However, at least one new genus and species is a stygobiont, and other cave modified forms are known. The terrestrial fauna consists of adventitious pulmonate snails and slugs, of the Caryodidae, Rhytididae, Ancylidae, Charopidae, Helicarionidae and Arionidae.

MYRIAPODA

Troglobitic millipedes belonging to the Dalodesmidae are common in Tasmanian caves. Symphyla also occur, but both these groups remain unstudied.

ONYCOPHORA

Tasmanian onycophorans are of special significance, including one of the few oviparous species, *Ooperipatellus insignis* . This same species is occasionally found in caves. Recently discovered is a new genus and species of blind and white peripatus. Its restricted range is centred on a karst area, although to date it has only been found in surface habitats and not in the caves!

CRUSTACEA

This group is well represented in aquatic habitats and includes the Amphipoda, Isopoda, Syncarida and Copepoda.

Tasmania has the greatest species diversity of freshwater amphipods in Australia and about two thirds of the species are endemic. There is a rich fauna of cavernicolous crangonyctoids and the genus *Neoniphargus* contains both troglophilic and stygobiontic forms. A new genus and species of paramelitid is known only from a single cave system, where it inhabits seeps and hygropetric surfaces.

Asellus does not occur in Australia, instead the aquatic Isopoda are represented by Phreatoicidea and Janiridae. Phreatoicids are a Gondwana group restricted to Australia, New Zealand, India and South Africa. They are most diverse in Tasmania and over half the known genera and species are Tasmanian. The Janiridae, a predominantly marine group, have several freshwater representatives in the genus *Heterias*. Cave adapted forms are present in both these groups.

The Syncarida are well represented in caves and Tasmania is the centre of diversity for the Anaspidacea, an archaic group of southern hemisphere distribution (ex Gondwanaland). Strictly subterranean families include the Parabathynellidae and Psammaspididae (*Eucrenonaspides spp.*) , but there are also troglodytic Koonungidae and Anaspididae *(Anaspides sp).*

Whilst no stygobiont crayfish are yet known from Tasmania, there is a diverse assemblage of parastacid species. Amongst these is *Astacopsis gouldi* which can grow to more than 4Kg in weight, and is probably the world's largest freshwater invertebrate. A breeding population of this species has been found in a cave.

Terrestrial Crustacea are represented by the Oniscidea, of which the Styloniscidae are the most important family although troglophilic Armadillidae are also present. *Styloniscus* is the dominant cavernicolous genus. It has a southern hemisphere distribution and contains at least two new species of troglobite; one species is known from a single cave system only whilst the other is widely distributed in several karst areas.

ARACHNIDA

Cavernicolous arachnids include Opiliones, Acarina, pseudoscorpions and spiders.

Within the Opiliones, troglophiles occur in the Phalangiidae *(Spinicrus sp.)* whilst troglobites occur in the Triaenonychidae. Recent study of the latter family has shown that the genus *'Monoxyomma'* consists of a complex of at least 10 closely related species, with each species restricted to a single karst area. Also discovered recently is a species of *Lomanella*, which is only the second known blind triaenonychid.

Cavernicolous pseudoscorpions belong to the Chthoniidae. At least 4 species are troglobitic, all of the genus *Pseudotyrannochthonius* which elsewhere occurs in Chile and mainland Australia.

There is a diverse and interesting spider fauna associated with Tasmanian caves. Perhaps the best known example is the Tasmanian Cave Spider *(Hickmania troglodytes)* . This large endemic species is common in caves. Its closest relatives live in Chile and Argentina. It is a member of the Austrochiloidea which, together with the Hypochiloidea (from China and the U.S.A.), are the most primitive of the araneomorphs, the true spiders.

Caves are a principal refuge for several other groups of rare, relictual and systematically important spiders. The following groups contain troglobites: Amaurobiidae, Anapidae, Micropholcommatidae *(Olgania spp.)* , Pholcidae *(Physoglenes spp.)* , Stiphidiidae, Textricellidae *(Textricella sp.)*, Theridiidae *(Icona spp.)*. Troglophiles occur in the Metidae (including *Meta sp.)* , Linyphiidae (including *Porrhomma sp.)* , Cyclactenidae, Theridiosomatidae *(Baalzebub sp.)* , Holarchaeidae, Orsolobidae and Clubionidae. An interesting recent discovery is a mysmenid spider, attributable to the genus *Trogloneta*. This is a small northern hemisphere genus of 3 species, one from France and two from North America. The Tasmanian *Trogloneta* represents a relictual species which must date back at least to the break-up of Gondwana. Its discovery establishes an intriguing link between northern and southern faunas.

No troglobitic Acarina are yet known although this group of cave invertebrates has received little attention. Ticks parasitic on mammals are recorded (Metastigmata), as are mostly free-living mites in the families Anystidae, Erythraeidae, Eupodidae, (near) Macrochelidae, Oribatidae, Trombellidae, Trombidiidae and Uropodidae.

INSECTA

The major insect groups occurring in Tasmanian caves are springtails (Collembola), crickets (Orthoptera), beetles (Coleoptera) and flies (Diptera). Caddisflies (Trichoptera), stoneflies (Plecoptera) and mayflies (Ephemeroptera) frequently occur as adventitious cavernicoles. Less commonly recorded are lacewings (Neuroptera), bugs (Hemiptera) and Psocoptera.

The most spectacular cave dwelling insect is a glow-worm, the luminous larva of a fungus gnat (Diptera: Keroplatidae: *Arachnocampa {Arachnocampa} tasmaniensis* Ferguson). The larva builds a hollow, tubular nest of mucus and silk, in which it suspends itself from the ceiling by a number of fine silk threads. From the nest it lets down long sticky threads or "fishing-lines". Flying insects such as midges are attracted to the light and become entangled in the glow-worm's snares. The larva then hauls up the appropriate fishing line and consumes its prey. Dense populations of glow-worms adorn the interior of many Tasmanian caves; the display in Exit Cave is said to be at least comparable with that of the famous Waitomo caves in New Zealand!

Various other groups of troglophilic Diptera are recorded, the most prominent being crane flies (Tipulidae) in the genera *Limnophila, Monophilus* and *Trichocera*. Also recorded are midges (Chironomidae), fungus flies (Sciaridae), Anisopodidae (probably *Sylvicola sp.*), Sphaeroceridae *(Sphaerocera sp.)* , Ceratopogonidae, Culicidae and Phoridae.

Cave dwelling crickets in the family Rhaphidophoridae are common troglophiles. Caves are the principal habitat for the 5 described species in the genus *Micropathus* , which is endemic to Tasmania. Large numbers of crickets shelter in caves during the day, at night a portion of the population moves outside to feed. They are omnivorous scavengers. *Parvotettix* is the other genus found in caves.

Springtails recorded from caves belong to the families Entomobryidae, Hypogastruridae, Neanuridae, Onychiuridae, Paronellidae, Sminthuridae and Tomoceridae. Troglobites occur in the Sminthuridae *(Adelphodera sp.)*, and a new genus and species of paronellid.

The only other insect troglobites are carabid beetles in the tribes Trechini and Zolini. In an Australian context all the most primitive species of Trechini are today confined to Tasmania, whilst a large proportion of the most derived species occur on the mainland. Six troglobitic species, in two genera (*Goedetrechus* and *Tasmanotrechus*), are so far recorded. The other important group of cave dwelling beetles is the Zolini (=Merizodini) which are confined to Australasia. Five troglobitic species of *Idacarabus* are presently known. *Pterocyrtus* is the other cavernicolous genus within this tribe.

It has been hypothesised that climatic vicissitudes during the Pleistocene caused extinction of surface populations of these beetles, leaving cave populations to survive as troglobites; each species known is restricted to a single karst area.

FINAL COMMENTS

The Tasmanian cave fauna is poorly known although collections to date have proven the existence of a rich and highly interesting invertebrate fauna. More so than mainland Australia, this fauna shows a pattern of similarity with the cave faunas of other periglacial regions such as New Zealand, Japan, United States and Europe.

Some caves have been altered, or are presently threatened by, agriculture, forestry and mining, although the effect of such activities on cave biota has not been studied in Tasmania. Nonetheless, the vast majority of caves remain in a completely undisturbed condition and17% of the State's karst areas are protected within parks and reserves.

Both cave exploration and biospeleology are in an early stage of development here. This paper is a brief introduction to the current state of knowledge in biospeleology, but doubtless there are many new and exciting discoveries yet to be made!

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ESTIMATION OF VELOCITIES FOR TRACER EXPERIMENTS

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The type of communication below the surface is of substential influence on the magnitude and shape of the tracer wave arriving at the observation point. Where the connection is a direct one, a definite wave may be expected, whereas where the tracer moves along several parallel paths the shape of the wave may become complicated /Fig.1./

The tracer material that is infected as a short pulse is dispersed along the paths of flow. In open channels considerable differences in velocity are caused by turbulent diffusion, but different flow paths may develop in fissured and granular formations as well. The ratio of the lowest and highest velocities measured between the feeding and observation points was found to be at least 1:2 /Fig.2./ Unless this condition is not satisfied a tracer experiment may not be consedered as succesfull. In the case of short distances the observable lenght of the tracer wave is generally much longer.

In the course of evaluation a base-level must be established, which depends on the type of tracer used, the sensitivity of the method of detection, further on the natural background concentration and the "white noise" present occasionally in the water.

The results of 45 different tracer experiments have been compiled in Fig. 3. The vertical line-sections indicate the velocity ranges observed in the individual experiments. Where the arrival of the tracer was given by a single velocity-value, it has been assumed that the data applies to the first

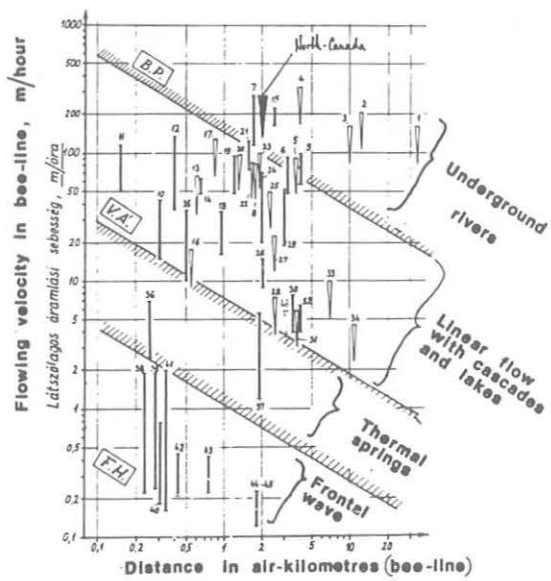


Fig. 3. Relationship between virtual flow velocities and distances from the results of actual tracer experiments

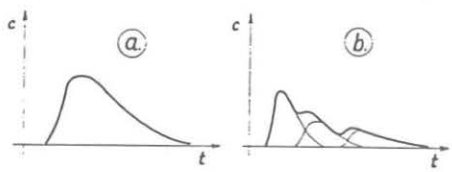


Fig. 1. Arrival of the dye at the observation point a./in a single wave b./in several overlapping waves

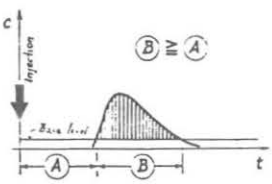


Fig. 2. Time-ratio of the arrival and passage of dye-wave

detection, thus to the highest velocity. In these cases the 1:2 velocity ratio has been assumed in calculating the probable terminal point of the tracer hydrograph, indicating the result by a triangular peak.

In Fig. 3. the field results are situated in clearly discernible ranges. The highest velocities occur in submerging creeks, where the flow conditions are comparable to those in open channels. This velocity range is indicated as Underground rivers. The range in which the flow occurs in caves along definite paths, but is interrupted by waterfalls, rapids and lakes is indicated as Linear flow. When the tracer appears in subthermal springs the velocities are even smaller. The lowest subsurface flow velocities occur where the tracer is dispersed in the vicinity of the feeding point and migrates in a diffuse manner, in a broad wave towards the observation points, sometimes in confined aquifers. This group is indicated as Frontal wave.

The object of tracer experiments in the first phase is the exploration of hydrologic connections. In such cases it may be anticipated to detect the arrival of the tracer at several different points and for this goal the method of integrated sampling is most preferably adopted. In the second phase the subsurface flow conditions must be examinated where the time data concerning the different tracer-concentrations assume also significance. For this purpose continuous recording or periodic integration are most suited.

In Fig.4. the time elapsed from the injection of the tracer is shown in days on the horizontal axis, while on the vertical axis the time between the individual samplings has been entered in hours. The inclined straight line in the figure corresponds to sampling at continuously increasing intervals of time, which provides at the velocity ratio 1:2 at least 12 samples during the passage of the tracer hydrograph. In practice the frequency of sampling is decreased gradually. This system of observation is indicated by the step-diagram fitted to the inclined straight line.

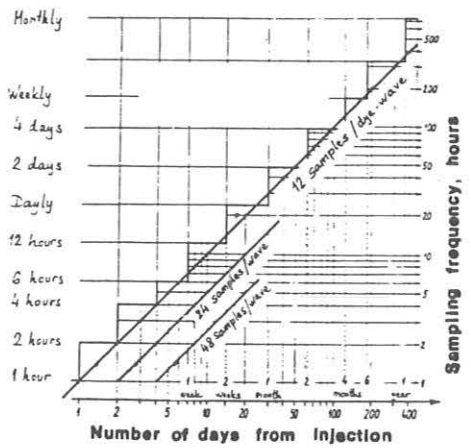


Fig. 4. Principle of determining a sampling-time pattern with gradually decreasing frequency

Changes in the discharge at the observation point during the investigation may influence the concentration of the tracer. For this reason it is advisable to analyse the samples also for the concentration of one or several natural components as well. With the help of the data obtained the effect of changes in the discharge can be taken into account. Detection of several components by different methods is considered desirable also for checking continuously the system of observation.

References

The data of experiments represented in Fig. 3.were drawn from the books, articles and manuscripts of the following authors:

Balázs/1957/, Balázs-Hazslinszky/1960 , Borbély/1962/, Burger-Dubertet/1975/, Burin-Spassov-Koler-Apostolov-Delcher /1975/, Dénes/1970/, Gyenge/1961/, Hazslinszky/1965/, Jakucs/1954,1959/, Job-Zötl/1969/, Kessler/1960/, Majko/1959/, Mauche/1960,1976/, Rhoades-Sinacori/1941/, Sárváry/1964, 1968,1969,1971/, Schmalz/1959/, Zojer-Zötl/1974/.

OBSERVATION OF TECTONIC PARAMETERS FROM COMPUTATIONS OF CAVE-SURVEY-DATA

HENNE, Peter - KRAUTHAUSEN, Bernd

Even in our days, when cave-exploring tends to shift from scientific research towards a recreation-activity a tremendous amount of valuable data is collected by the active groups. At least a more or less complete survey is done - mainly to obtain a map of the subterranean world which is used as a reference for most of the other subtopics of the exploration. With the availability of personal computers with sufficient computation-speed and memory-capacity this task is extremely simplified compared to the ancient days when normally the slide-rule was the only calculation-tool. The computer is mostly used for filing of the survey-data and performing the calculations necessary to draw a ground plan of the cave. An increasing number of attempts are reported which go beyond this simple application: Using the computer for purposes of **scientific visualization** and as a vehicle for the **test of geological hypotheses**. In the following we want to show some instances about what can be done in these fields - and hopefully give some feeling too about the scientific pitfalls we should avoid.

We now exspecially put our focus on the scientific use of the survey-data: Increment-vectors are measured in the cave based on a spherical coordinate-system giving the length, the inclination and the direction of a particular small part of the cave. The whole cave is described as a collection of these vectors which are combined into a polygonal skeleton resembling the subterranean paths used by the explorers. Sometimes additional values are measured or simply estimated, describing the extensions of the cave-rooms by values for the distances to the left-, right-, top- and bottom-bounds perpendicular to the direction of each survey-vector at his end-point.

The basic hypothesis (interpreting KRAUTHAUSEN 1989) is:
A prevalent factor determining a cave's dimension and shape is the tectonic situation of the local environment.
This means: The inclinations, directions and shapes of the cave-passages are images of the inclinations, directions and combinations of the predominant faults, clefts and layers. And vice-versa: Tectonic rock-parameters can be deduced from cave-survey-data.

Visualization:

By computing views of the survey-skeleton with arbitrary rotation- and tilt-angles and plotting this onto the computer-display it is possible to "see" the cave's image from any direction. If in our instance we plot around 30 km of survey-data of the Dachstein- Mammuthöhle (Northern Alps, Austria) as an E-W-extending vertical projection in parallel perspective (**Fig.1**)we see an extremely complicated mesh of chaotic lines. If we rotate and tilt the view with the result of looking about 30 Degrees down and in a direction of 18 degrees (**Fig.2**) we notice a remarkable reduction of complexity:

As we know from other sources (KRAUTHAUSEN 1989) we are looking "into" the strata of the upper-triassic limestone building up the local mountain-environment. Using this direction of view a great number of survey-vectors are drawn one on each other and so become invisible. This again means that a lot of cave-passages are closely bound to the tilted limestone-layers - as we know from our personal explorations in the Dachstein-Mammuthöhle these are mainly the net-shaped labyrinthic areas. A similar result is obtained by only rotating a vertical projection with the result of looking into the direction of strata (**Fig. 3**): A large number of vectors is drawn one on each other with an angle which resembles the slope of the limestone-layers (around 30 degrees).

Further improvement of the imagination is obtained by computing a stereoscopic picture (two central-perspective projections from slightly different points) of the survey-mesh which gives a three- dimensional impression of the cave-skeleton if viewed using some adequate optical method. If we finally use additional data describing the cave's room-dimensions to "fill" the skeleton-plot we are able to visually distinguish between small labyrinthic areas and the large rooms which are often bound to a tectonically severely stressed environment - we see (**Fig. 4**) a more or less naturalistic picture of the cave which is never to be seen in nature!

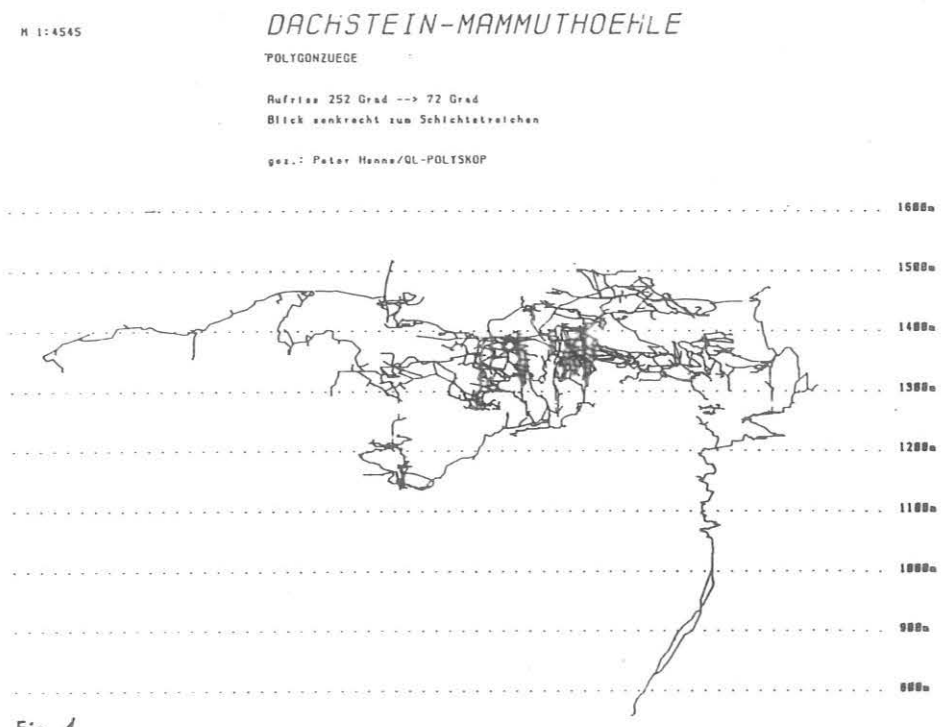


Fig. 1

M 1:4545

DACHSTEIN-MAMMUTHOEHLE

POLYGONZUEGE

Sicht nach 18 Grad, 28 Grad abwaerts
Blick in das Schicht-Fallen

gez.: Peter Henne/GL-POLYSKOP

Fig. 2

M 1:4545

DACHSTEIN-MAMMUTHOEHLE

POLYGONZUEGE

Auftau 198 Grad --> 18 Grad
Blick in Richtung Schichtstreichen

gez.: Peter Henne/GL-POLYSKOP

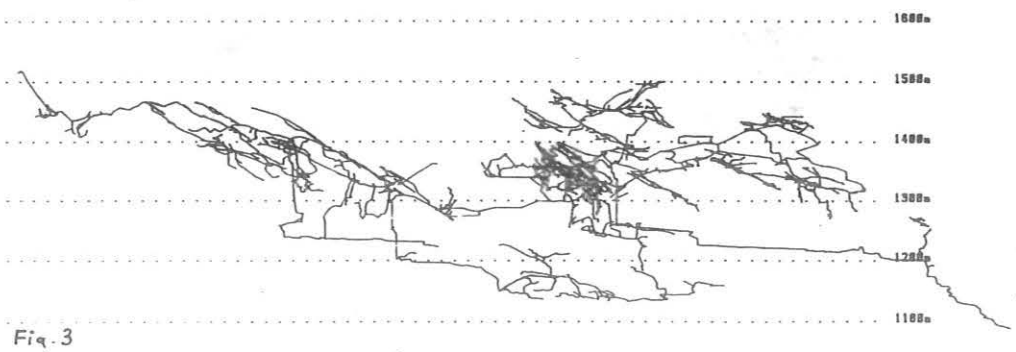
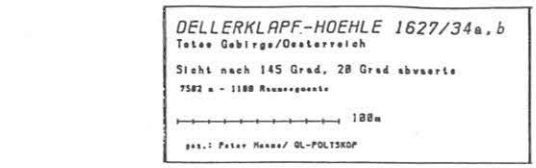


Fig. 3

Statistics:

Several properties of the survey-data may be used to obtain further insights into interesting aspects of a cave. Splitting the possible directions of the polar-vectors into convenient collections - in our instance 120 groups in steps of 3 degrees for all vectors slanting down into that direction - and adding the lengths of the vectors in each group gives the length-distribution of the survey-paths over the directions. Drawing a polar-plot from these values clearly shows the presence of favorite path-directions. This would be not surprising in the case of small caves where only a few directions are covered due to the limited size of the object, but this is observed for caves extending over tens of kilometers described by far more than a thousand polar-vectors.



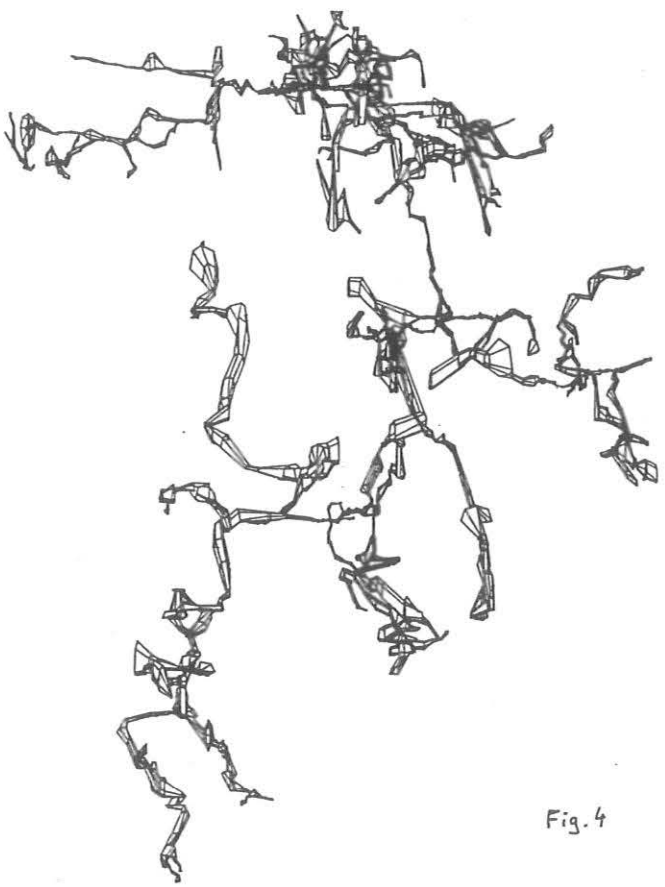
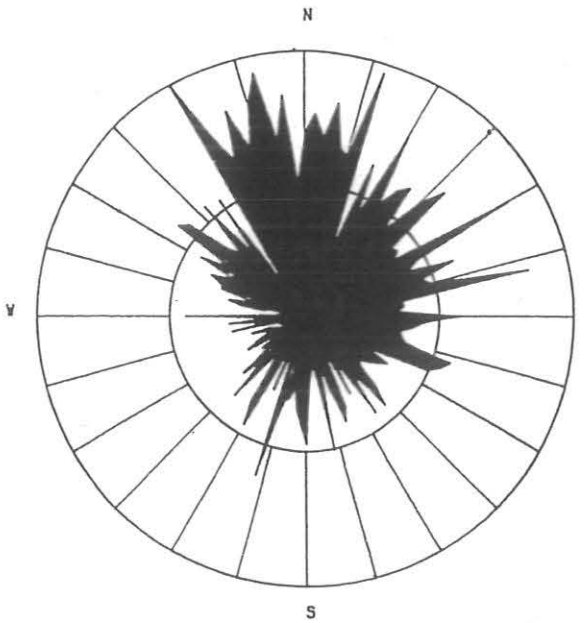


Fig. 4

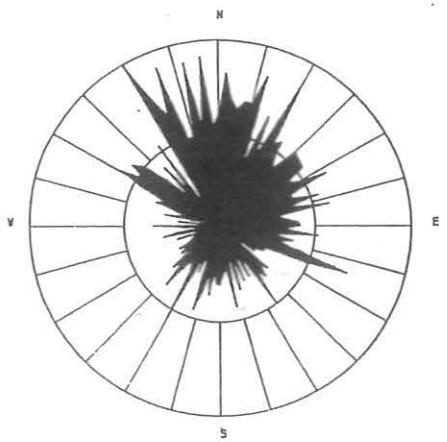


Maximum=576.68 m
3610 Polygone
Gesamtlaenge=30179.1 m

DACHSTEIN-MAMMUTHOEHLE (total)

Richtung des Einfallens der Messzuege

Fig. 5

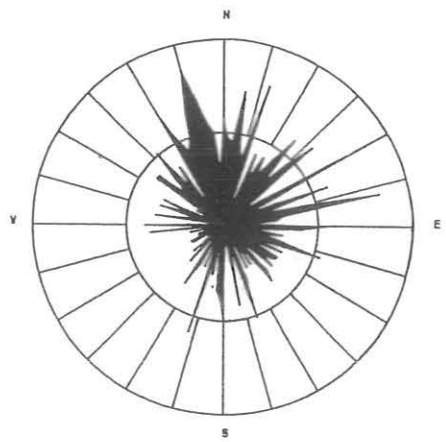


Maximum=334.6 m
2057 Polygone
Gesamtlaenge=16671.16 m

DACHSTEIN-MAMMUTHOEHLE
Tagferne Teile
Mappen 02,04,05,06,07,08,
16,86,19

Richtung des Einfallens der Messzuege

Fig. 6a



Maximum=345.95 m
1553 Polygone
Gesamtlaenge=13507.94 m

DACHSTEIN-MAMMUTHOEHLE
Tagnahe Teile
Mappen 00,03,09,10,11,12,13,
14,15,96,17,20

Richtung des Einfallens der Messzuege

Fig. 6b

We have examined three caves from different areas and geological formations of the Northern Alps: The Dachstein-Mammuthöhle (Upper Trias of the Dachstein-Gebirge), the Hüttstatt-Höhle (Jurassic formation of the Totes Gebirge) and the Dellerklapf-Höhle (Upper Trias of the Totes Gebirge). The cumulated lengths of all survey-vectors of these caves are around 30 km for the Dachstein-Mammuthöhle, 10 km for the Hüttstatt-Höhle and 10 km for the Dellerklapf-Höhle.

Each diagram (**Fig. 5 - 7**) shows prominent directions which correspond closely to the directions of a tectonic main-system of faults and dislocations (extending NW-SE and NE-SW, X-System, see a.o. GANSS 1938). The relative location of the next main-drainage-channel determines which special branch of the "X" is predominant. This image of the primary tectonic directions is expecially apparent in those parts of the cave which are more distant from the borderline of the mountains (**Fig. 6a**). For the subterranean paths located near the periphery (**Fig. 6b**) of the mountains we find strong evidence for an additional rectangular system of directions matching the directions of a secondary tectonic system (roughly extending E-W and N-S with larger variations, see a.o. WILTHUM 1954). To be complete, we have found correspondence to the local direction of the inclination of the layers of the upper-triassic limestone which are absent in the case of the Hüttstatt-Höhle located in the jurassic formation.

Since we do not find other significant directions in the diagrams (the remaining distribution is easily explained due to random-differences between the directions of the survey-vectors and the main-path-direction) we are allowed to conclude that the path-direction-statistics closely support our hypothesis that the directions of the cave-paths are strongly related to the directions of the tectonic environment. Switching the view we are allowed to cautiously deduce the main-properties of the tectonic environment from cave-survey-data if other explanations are carefully ruled out - this may be interesting expecially in the tropical areas where the surface is over-grown and tectonic measurements are difficult to perform.

To end this contribution we want to show a negative example for the usefulness of statistic examinations: If we plot the cumulated lengths of the survey-vectors against their height above some reference-plane (normally sea-level) we find a very impressive distribution-pattern (**Fig. 8**). Unfortunately there is not only one hypothesis which is supported by this: The existance of levels with a large inventory of cave-rooms in contrast to levels with only little amount of evacuation may be explained by:

1. Different rock-parameters of the strata.
2. Changes in climate-conditions.
3. Different phases of the vertical movement of the mountains.
4. Changes in the location of the local main-drainage-channel.
5. Combinations of the above.

A distingt causal main-influence cannot be concluded from the level-statistics. Without additional knowledge these diagrams must be judged as to be more or less worthless exercises - a confirmation of a theory must refute other possible theories!

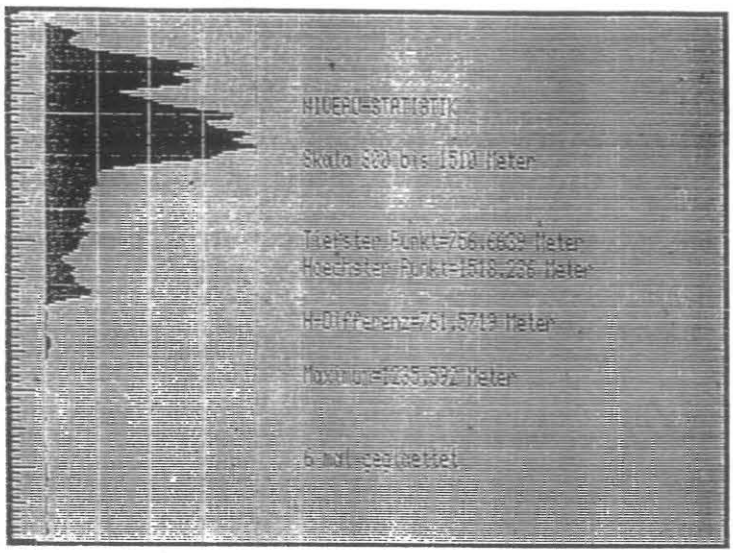


Fig. 8

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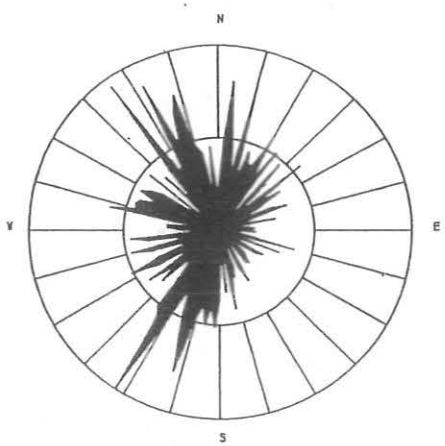
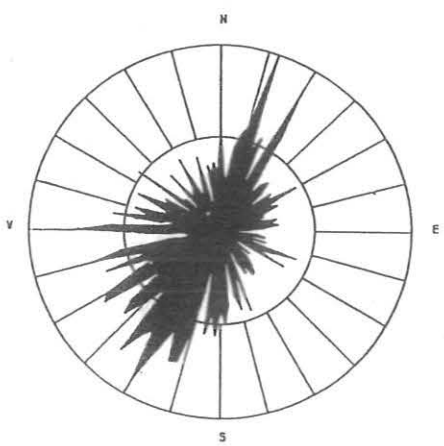


Maximum=170.63 m
1109 Polygone
Gesamtlaenge=7502.51 m

DELLERKLAPF-HOEHLE (total)

Richtung des Einfallens der Messzuege

Fig. 7a



Maximum=188.94 m
1441 Polygone
Gesamtlaenge=9853.98 m

HUETTSTATT-HOEHLE (total)

Richtung des Einfallens der Messzuege

Fig 7b

EVOLUTION OF THE PLATEAU MARGIN KARST OF TENNESSEE AND ALABAMA, USA

WHITE, William B. - WHITE, Elizabeth L.

resume p. 659

1. INTRODUCTION

The Cumberland Mountains in the states of Tennessee and Alabama are the dissected southern portion of the Appalachian Highlands. The physiography is that of a dissected plateau underlaid by Carboniferous rocks that dip gently toward the center of a large sedimentary basin. The plateau is capped with resistant sandstones but the flanks of the mountains are underlaid by limestones with a thin intermediate sandstone unit. Deep valleys known as "coves" are eroded into the plateau margins for distances of tens of kilometers. These are predominantly fluviokarst valleys often occluded by saddles with extensive underground drainage. The floors of the coves are alluviated plains related to the present day drainage of the Tennessee River.

Evolution of the plateau margin karst takes place by slope retreat aided by internal drainage through vertical shafts and controlled by the retreat of the resistant caprock. Past base levels are recorded in the karst saddles and in tiers of caves along the margins of the coves. Our objectives are to examine the valley morphology and cave distribution for that portion of the Cumberland Mountains that extends from southcentral Tennessee into northern Alabama. Figure I shows the area of interest. This paper is one of a continuing series of investigations by the authors concerning the Appalachian karst and its focal point is the interrelationship between karst processes and the general process of slope retreat and dissection of the clastic rock-capped plateau.

Previous research on the karst geomorphology of this area is sparse; the comprehensive investigations of Crawford (1979, 1980) in an area somewhat to the north of the present study are most pertinent as are some investigations of karst valley development (White and White, 1979, 1983; Sasowsky, 1988). A substantial cave data base exists (Barr, 1961; Matthews, 1971; Varnedoe, 1980).

2. GEOLOGIC SETTING

The Appalachian Plateaus are underlaid by a vast sedimentary basin with gently folded rocks mainly of Carboniferous Age. The basin was infilled from source areas in the northwest and east with the southern part more frequently open to the sea. Carbonate units located between clastic sediments are thickest in the south and thin and give way to clastics in the northern part of the basin. For this reason the degree of karst development also increases toward the southern part of the Appalachian Highlands.

At the base of the Pennsylvanian Age sequence is a complex series of massive quartz sandstones known variously as the Pottsville formation, the Warren Point sandstone, and the Sewanee conglomerate. This is a highly resistant rock and forms the topographic support for the plateau. The mountains created by the resistant sandstone rise from north to south from near 400 meters in the north to elevations in excess of 1000 meters in the area of interest.

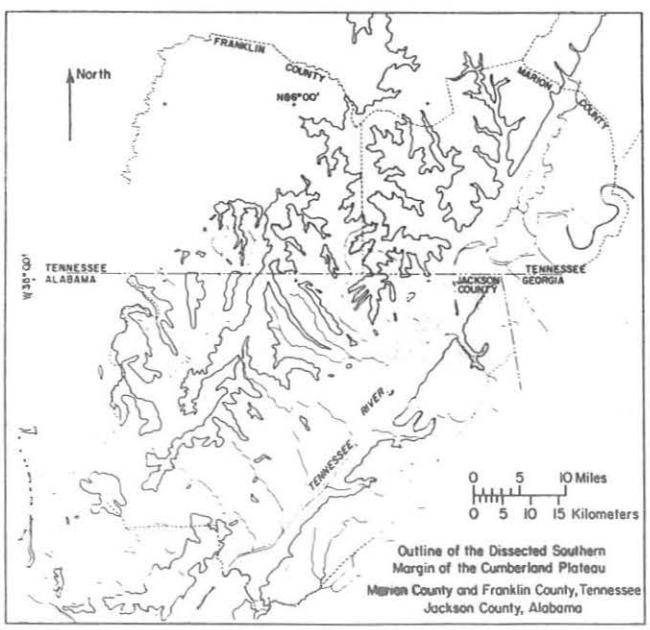


Figure 1. Map showing the southern margin of the Cumberland Plateau. Form lines mark the contact between the Sewanee Conglomerate and the Pennington Formation and thus the sharp break in slope at the margin of the plateau.

A summary of the stratigraphic section is superimposed onto Figure 2. See Milici et al. (1979) and Thomas et al. (1979) for a detailed discussion of facies changes and stratigraphic nomenclature. Beneath the resistant sandstone is a sequence of interbedded shales, dirty sandstones, and limestones, known as the Pennington formation. Directly below the Pennington is a thick sequence of Mississippian age carbonates. From top to bottom these are the Bangor limestone, the Monteagle limestone, and the St. Louis limestone. All three of these units are high purity limestones with relatively little dolomite. Below the St. Louis is the Warsaw formation which, although it is often classified as a limestone, contains so much chert and sandy and shaley material that karst is poorly developed in it. Thus the Warsaw and not the underlying Fort Payne chert is considered the karst base for the region. In much of the region a few meters to a few tens of meters

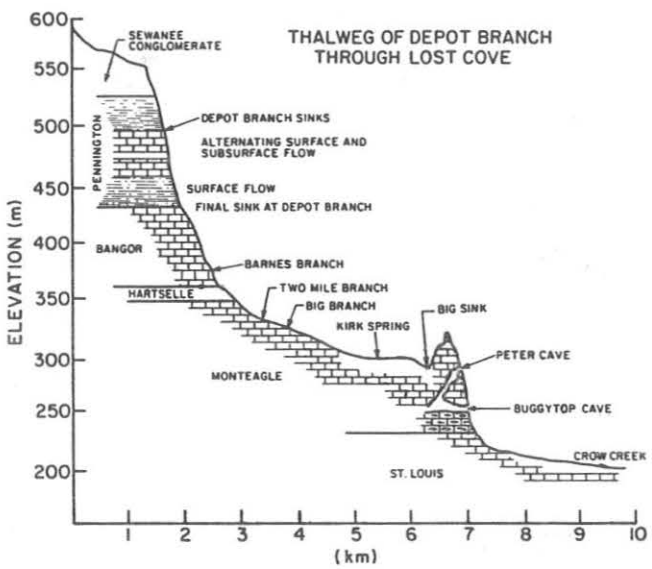


Figure 2. Profile of Lost Cove. Constructed from U.S. Geological Survey Sewanee and Sinking Cove 7.5 minute topographic quadrangles.

of Hartselle sandstone occurs between the Bangor and the Monteagle limestones. Where it is thick, the Hartselle sandstone plays an important role in slope development and in the development of vertical karst drainage within the escarpment.

The escarpment formed at the edge of the Cumberland Mountains is made up mainly of the cavernous limestones with a caprock of sandstone. This in turn means that the karst processes will play an important role in dissection, retreat and subsidiary valley development. It is this particular geologic situation that Crawford chose to call a "plateau margin karst".

The main drainage system for the southern Appalachian region is the Tennessee River and its tributaries. The headwaters are east of the plateau in the folded and faulted portion of the Appalachian Highlands. The river flows generally southwestward along the plateau to the southeastern corner of the present area of interest (Figure 1). It then turns westward, flows along the southern margin of the mountains and then angles to the northwest ultimately to become part of the Mississippi River drainage.

We have taken as our boundaries for the present study the south-facing escarpment, a bit of the west-facing escarpment, and as the eastern margin, the Sequatchie Valley through which the Tennessee River flows. The line between the states of Tennessee and Alabama bisects the area in an east-west direction. Most of the area of interest falls into Franklin and Marion Counties, Tennessee, and Jackson County Alabama. The latter is the principal cave area of Alabama; one third of the caves in the state occur in the Jackson County Mountains.

Although the broad scale geologic structure is that of a regional basin, the rocks have been much influenced by the folding and faulting that took place in the eastern Appalachians at the close of Paleozoic time. The eastern escarpment of the plateau is usually taken as the structural boundary. In fact, there is substantial folding within the plateau itself. One of the most prominent folds is the Sequatchie anticline which has been eroded out to form the striking linear topographic feature known as the Sequatchie Valley on the eastern edge of the plateau

3. KARST VALLEYS

3.1 Valley Form and Profile

The dissected edge of the Cumberland escarpment is very irregular. The walls of the coves are steep and contain many caves of substantial size formed, presumably, during the development of the drainage system. The coves which are closest to the Tennessee River have wide, flat floors which are generally alluviated and graded to more recent stands of the river.

Some coves in the more northerly part of the area are incompletely dissected. Some form closed valleys. Small streams that flow from the escarpment sink into the limestone along the margin of the cove and then reappear as large springs near the mouth of the cove. The profiles of the coves are sometimes discontinuous with the downstream end of the cove separated by a high saddle in the limestone beneath which the drainage must pass by underground routes. The profile of Lost Cove, Franklin County, Tennessee (Fig. 2) is representative. There is a smooth valley thalweg above the cove although the stream channels are usually dry below the Pennington-Bangor contact. The lower part of the cove is a completely dry valley with no surface drainage. There is an alluvial infilling of unknown depth within the lower part of the valley. Streams that sink in the upper reaches of Lost Cove flow underground and appear in Buggytop Cave. The stream, Crow Creek, that emerges from the cave entrance flows in a surface channel through a narrow, flat-floored cove for many kilometers to the Tennessee River.

In a still earlier phase in the development of the coves, there is no true floor and instead one has a valley consisting of closed depressions with extensive underground drainage. The Cave Cove-Farmers Cove-Wolf Cove-Sinking Cove complex, Tennessee, (Fig. 3) is an excellent example. The closed depressions all drain into an underlying cave system which carries the water to the head of Sinking Cove. Within Sinking Cove the water again goes underground, finally forming the head of Little Crow Creek. The deep depression of Wolf Cove itself is related to breaching of the Hartselle Sandstone. Around the perimeter of the depression, the relatively flat floor of the cove is supported by the sandstone. Once the sandstone is breached, deep solution takes place rapidly and the result is a very large closed depression.

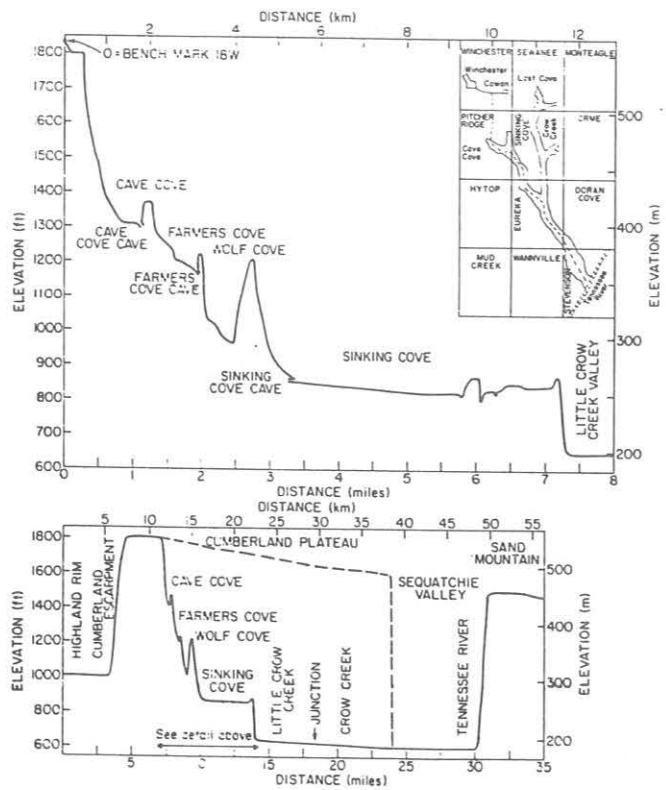


Figure 3. Profiles along the Crow Creek drainage. The lower map shows a long profile from the Highland Rim to the north and west, over the Cumberland Plateau, down the Sinking Cove valley, through Little Crow Creek to its confluence with Crow Creek, and along Crow Creek to the Tennessee River. The upper plot is an expanded profile through the coves. In the upper right is shown the traverse line of the profile across the U.S. Geological Survey 7.5 minute quadrangle maps. The origin for the long profile is Highway 64 between Winchester and Cowen. The origin for the detailed profile is a labeled benchmark on the Cumberland Plateau.

The floors of Cave Cove, Farmers Cove and Wolf Cove occur at successively lower elevations which seem to be related to the old valley thalweg. However, the floor of Sinking Cove is a long nearly flat valley that appears to be an old base level. It is blocked at the downstream end by a low saddle from which the surface drops steeply to the valley of Little Crow Creek.

The more highly developed coves near the Tennessee River has very flat floors. There is a sharp break in slope between the valley floor and the steep valley sides. There is little evidence of terrace development along these valleys. The floor slopes are gentle, in the range of 0.005 in the downstream reaches of the coves. It is apparent that the evolution of the karst valleys is rapid compared with the rate of downcutting of the regional drainage.

3.2 Valley Elevations

At the foot of the Cumberland Escarpment on the western margin of the Plateau is the Highland Rim which surrounds the central basin of Tennessee. The Highland Rim is a doline karst surface developed on the Carboniferous carbonate units. Although it is gently dissected by surface streams, the elevation of the Highland Rim is a nearly constant at 1000 to 1050 feet (300 to 320 meters) and this is also the elevation of those flat-floored coves that open to the west (see Fig. 3). Coves that open to the south are graded to the present day elevation of the Tennessee River at about 600 feet (180 m).

The elevation of the Plateau itself in the small region considered in this paper is at 1800 feet (550 meters). The dashed line in Figure 3 shows the gradual lowering of the plateau remnants to the south. On Sand Mountain, southeast of the Tennessee River, the elevation has decreased to 1500 feet (450 m). The plateau elevation continues to decrease southward due to the dip of the Paleozoic rocks beneath the Coastal Plain sediments in central Alabama.

4. CAVES

4.1 Cave Patterns and Relation to Karst Valleys

The caves in the study area vary greatly in length, but most are very small, consisting either of single shafts or fragments of horizontal passage less than 100 meters in length. Caves tend to be located along the flanks of the flat-floored coves or beneath the floors of the incompletely eroded coves.

In the Cave Cove-Farmers Cove-Wolf Cove-Sinking Cove complex described above, more than 7 km of cave passages are found, mostly oriented along the axis of the cove and directly beneath the valley floor. A group of caves form a branchwork pattern beneath the karst valley of Newsome Sinks in the southern part of the area (Varnedoe, 1963). Caves are not generally observed to cross beneath the mountain spurs from one valley to the next. There is a very close relationship between cave development and the present day surface drainage suggesting that conduit drainage has played an important role in the evolution of the coves.

4.2 Cave Levels

Figure 4 shows the distribution of cave elevations in Jackson County, Alabama. Generally similar patterns are seen in the cave entrance distributions in southern Tennessee although no complete data base is publicly available. Figure 4 shows the distribution of entrances which weights the distribution toward the small caves which are the most numerous. A similar pattern is seen if the distribution of cave lengths is plotted. However, length distributions tend to be dominated by a few large caves.

There are two concentrations of caves. One is near 650 feet (200 meters) which represent caves just above the present day level of the coves. The second is at an elevation of 1100 feet (335 meters) and is clearly related to the Hartselle Sandstone (see Fig. 2). Some caves are formed by water perched on the Hartselle; others are formed by water trapped under the Hartselle. There is no strong evidence for distinct cave concentrations related to old base levels other than contemporary cove floors.

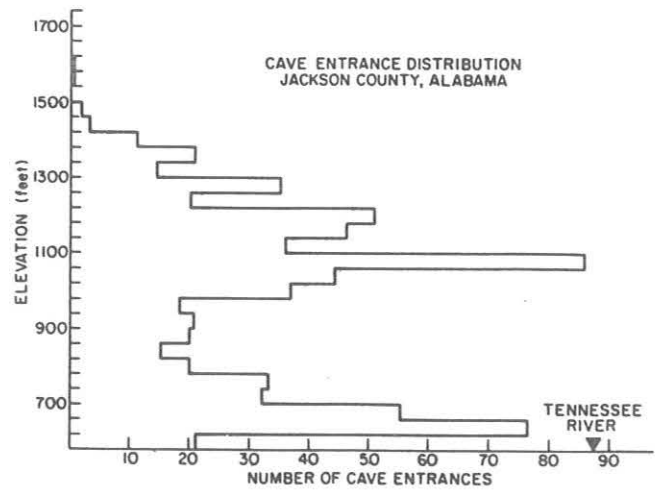


Figure 4. Distribution of caves by elevation in Jackson County, Alabama. The source of data is Varnedoe (1980).

4.3 Vertical Solution

The steep slopes of the valley walls are formed in part by internal drainage through vertical shafts which allow slopes to be oversteepened. An earlier investigation (Brucker et al., 1972) showed that undersaturated water derived from the clastic caprock provided the driving force for the formation of vertical shafts. There are a large number of shafts along the margins of the plateau, with openings to the surface either near the Pennington/Bangor contact or at the top of the Monteagle Limestone just below the Hartselle Sandstone.

Because of the geological controls on shaft development, one might expect shaft depths to reflect the thickness of the limestone in which they are developed. However, a plot of the frequency distribution of shaft depths in the Jackson County Mountains (Troester et al., 1984) reveals that the number of shafts falls off exponentially with depth according to the equation

$$N = 751\, e^{-0.02\, d}$$

with a correlation coefficient of 0.96. The exponential curve may be considered to be the tail of a Poisson distribution. If this is so, most shafts have depths determined by random processes of rockfalls blocking the bottoms and random processes of the formation of surface breakthroughs.

Only a few shafts breach the Hartselle Sandstone. Two of the most spectacular with depths near 150 meters are in Fern Cave which is the largest cave in the Jackson County Mountains. In this particular example a major lineament has apparently provided the pathway for vertical solution through the sandstone (Wilson, 1977).

5.0 CONCLUSION: THE EVOLUTION OF THE PLATEAU MARGIN KARST

Karst processes are the primary reason for the steep-walled, flat-floored coves that develop in the process of dissection of the Cumberland Plateau. When the protective sandstone is breached, vertical solution, combined with horizontal cave development takes the drainage underground. Karst valleys occur near the retreating plateau. As time progresses, solutional removal of the limestone reduces the system to a base level dictated by the major regional drainage systems. Caves have acted as drainways closely related to the present day drainage pattern.

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CAVE DIVING PART OF THE CZECH SPELEOLOGICAL SOCIETY RESCUE SERVICE

PISKULA, Michal

In every country, where cave diving is popular a cave rescue service is organised. The reason is obvious. Cavers can get in a dangerous situation, that they are not able to cope with by themselves. They need help from outside. In such case, specialy trained and equiped team, rescue service, can work most effectively. As the conditions in caves are quite variable, specialisation is required in rescue service. Cave diving rescue is highly specialised branch of the cave rescue service. It is important to note, that not only cave divers can need diving rescue intervention. That is why all advanced cave rescue organisations have their cave diving part or at least a diving team. C.S.S. is no exception in this point. I present an information on the structure and the organisation of the cave diving part of its rescue service.

Czech cavers recognised, they need a cave diving rescue service already some years ago. But not very much was done for it. A list of volunteers was compiled and some basic procedures were described. There was neither special trsining nor special equipment developed for rescue purposes. It was fortunate that no intervention of cave diving rescue was required at that time.

When reconsidering the whole situation in the C.S.S. Cave Diving Commission, taking into account foreign experience, we came to the conclusion, that our rescue service must be organised in a different way. In agreement with the chief of C.S.S. Rescue Service, its independent cave diving part has been established. This part is fully responsible for all underwater operations as well as interventions behind sumps. Close cooperation of both parts is presumed before sumps. As there are three main regions of caving activities in Czeach countries, three independent teams have been estblished. One in Bohemia /divers from Praha/, second in South Moravia /divers from Brno/ and the third one in Northern Moravia /divers from Olomouc/.

Organisation of the teams is uniform. Chief of the team, six divers and four assitants. Assistants are also cave divers. What is concerning personel, there is a diving medicine doctore in each of the teams. There is also a blasting expert in the South Moravian group. Functions of the team members are evident.

Activation of the team starts, when any of the members recieves a demand for the rescue intervention. He informs the dispatcher of the team, that cares for calling out the other members. After this call out, members gather at the equipment depo. As the rescue team members are no proffesionals, and they are not obliged to be on duty because of their membership in a rescue team, ther is no guarantee, that all members will meet. To find a compromise between required urgency and necessery number of rescuers, a simple scheme is used for departing from the depo for the action:

Time elapsed from the first person arrival to depo /minutes/	30	45	60	90	120
Required minimal number of persons	10	8	6	5	3

In the case of known high urgency, the chief in charge can decide for faster action. As all members are comming by their own cars, they can reach the accident site by themselfes also later.

Operation taken by the team at the accident site depends on actual conditions. It is controled by chief in charge. It is the chief of the team, or in his absence the member of the team with the lowest number in the list. When self rescue from the sump or from behind the sump is not possible the rescue team should establish contact with the victim. It must be decided:
- if an immidiate transport is possible
- some treatment is necessery already underground.

Problems of medical treatment are rather complicated and must be consulted with experts. To this subject only one note, that might be important. Using of medicaments for pain relief is very riscy. Its side effects could be very dngerous, especially during an underwater transport. It seems, that local anesthetics should be prefered to general analgethics. A group of medical experts has been estblished in C.S.S., that should farther work on those problems.

Equipment used by members of rescue teams is in most cases their own caving and cave diving gear. Besides they have some conteiners for underwater transport of rescue material. For the rescue in the dry part of a cave they can use equipment beeing supported by "dry rescue", as stretchers etc. For the most delight part of the rescue operation from behind a sump a dry suit should be used. We have not satisfactory solved the system of the air supplying during the transport until now. An injured person could be transported in a stretcher, or preferably just with immobilised injured part of the body.

Training in using special equipment and techniques for the rescue is of basic improtance. We organise meetings of the members of the rescue teams with the aim to present them latest foreign experience, to enable them to excnange their own experience, as well as to practicise special rescue techniques together with "dry rescue". Besides, there is own training of each of the teams.

This rewiev shows very briefly new organisation of the cave diving rescue in Czech Speleological Society. When introducing this new model we have widely used foreign experience, especialy that of English, French, Italian and German cave divers. We coould make use of their experience, knovledge and skills that they gained during years of real operations and numerous successful rescue interventions. Their sharing information with us was of great help for us.

Some important names and addresses:
Michal Fiškula, Ondrova 23, 635 00 Brno
Chief of the C.S.S. Cave Diving Part of the Rescue Service
Jiří Hovorka, Petyrkova 1943, 149 00 Praha 4
Chief of the group Bohemia
František Fiškula, Olbrachtovo nám. 3, 624 00 Brno
Chief of the group South Moravia
Lubomír Benýšek, Řezníčkova 4, 772 00 Olomouc
Chief of the group North Moravia.
Contact with any of the above mentioned persons is sufficient for activating Cave Diving Rescue of C.S.S.
A complet list of the teams can be mailed upon a request.

PERIGLACIAL PROCESSES IN KARST REGIONS

DEMEK, Jaromir

resume p. 656

Roughly 25% of lands surface exhibit negative thermal balance.They are regions in the cold climate with the occurence of permafrost.Permafrost are rocks whose temperature has been permanently below the freezing point(0° C) for more than 2 years.Typical of permafrost is the occu - rence of water in the form of underground ice.The presence of permafrost gives rise to different cryogenic processes.Those territories are usually denoted as periglacial regions.In periglacial regions special complex of processes is acting, e.g.frost weathering, nivation, solifluction etc. Large parts of periglacial regions are constituted by karst rocks.Large karst territories are found in the periglacial regions of Siberia,Canada and Alaska.

Climatic conditions of cold regions and the occurence of permafrost do not support the formation of karst in periglacial regions.On the other hand,permafrost concentrates surface runoff and cold climate increases the solubility of carbonates.The dissolution of carbonates in cold climate is relatively intense and it has been observed in all regions.The values of chemical erosion in cold climate are relatively high.At present a number of observations confirm the fact that karst processes are in progress in permafrost at different depths below the Earths surface and with different intensity.

Karst regions at the present-day periglacial zone can be divided into low platform territories(such as in the northern parts of Siberia and Canada)and, on the other hands, into mountain karst territories.Karst forms in present periglacial regions can in turn be divided into contemporary forms and fossil forms(paleoforms).

The progress of karst processes in cold climate can be divided into low platform territories development and mountain karst development.The progress of karst processes in mountain karst regions in cold climate can be illustratively shown on the example of the Moravian Karst in the central part of Czechoslovakia which in the cold periods of Pleistocene was situated in a periglacial climatomorphogenetic zone.

The Moravian Karst is a karst territory 25 km long and 3 - 6 km wide.It is constituted by folded Devonian and Lower Carboniferous limestones.Folded karst rocks were planated and karstified. The earliest karst forms in the region are depressions on the Pre-Cretaceous planation surface.The depressions are filled with Jurassic and Cretaceous deposits.In the Tertiary period the surface of planation was dissected by deep karst canyons and caves were formed at several levels.

In the cold periods of the Pleistocene the whole of the Moravian Karst was situated in a periglacial klimatomorphogenetic zone.In the region there is evidence that in the last 2 milions years permafrost was repeatedly formed in the cold periods of the Pleistocene and subsequently it thawed again.The thickness of permafrost in the Moravian Karst surpassed 130m, probably reaching as much as 300m.In many caves synchronous periods were found of considerably falling of big angular blocks from the roof of caves.Even in very deep caves stratified cave deposits were found.In the profiles layers of angular fragments (congelifracts) alternate with cave loams.In accordance with the experience from other European countries(such as France-J.J.Blanc,1985)the falling of angular fragments from cave roofs is linked up with the melting of permafrost at the end of cold periods of Pleistocene(so-called degradation of permafrost). Probably also at the end of stadials of the last glacial period(Würmian) the degradation of permafrost at the end of stadials W_1 and W_2 took place. Frost weathering in the cold periods resulted in the damaging of cave roofs and the formation of frost fissures. Underground ice,however, strengthened the loosened rocks and only during ith thawing in connection with permafrost degradation the individual angular rocks fell from the cave roofs.

Cryogenic processes considerably affected the development of the Moravian Karst in Pleistocene. Firstly,permafrost caused the formation of ice plugs in the caves.Ice plugs prevented the movement of karst water in the caves. At the same time permafrost formed an impermeable table for surface water and in karst valleys surface(at least intermittend) water streams originated.In karst valleys we often come across erosion forms created by those streams as well as fluvial deposits(mainly only partly rounded gravels).Secondly, permafrost led to a considerably increase in the intensity of slope processes.Frost weathering shattered karst rocks and resulted in the formation of large amount of angular fragments.Solifluction and slope wash transported angular fragments to the valley bottom.Braided streams transported angular fragments through the valleys. In blind and semi-blind valleys fluvial and lacustrine deposits accumulated.Thus, a blind valley near Sloup is filled by fluvial and lacustrine sediments 80 m thick(L.Slezák in Moravský kras,1984,p.63).In blind valleys near villages of Holštejn and Jedovnice(Rudice) sediments of intermittend periglacial lakes can be observed.Some blind valleys were completely filled with those fluvial and lacustrine deposits.The blind valley near Sloup thus changed into a semi-blind on and during floods the water flows over to the canyon of Pustý žleb.The sediments blocked the original ponors in the bottoms of blind valleys, new ponors originating at the level of sediments at much higher level than had been the original ponors at the beginning of the Quaternary Period.Also earlier Tertiary period ponors may have been activated.Some caves were completely or prevailingly filled by fluvial deposits(such as in the blind valley near Holštejn).

Debris and deposits also stopped karst springs.The deposits at the bottoms of karst valleys made the karst water levels rise.In the interglacials the lowest karst level bound to the bottom of karst canyons was filled with water.New karst springs arose(or earlier karst springs were activated) at the level of deposit surface at the bottoms of karst canyons.A new karst level began to be formed which was bound to the surface of deposits at the valley bottoms(J.Přibyl,1986).Thirdly, frost weathering in the cold periods of the Pleistocene changed some cave entrances.In the caves debris cones were formed consisting of angular fragments.I have mentioned the fact also in deep caves the aggradation and the degradation of permafrost formed stratified cave deposits.In some caves pseudomorphoses after ice wedges were formed(e.g.in the Ochoz Cave).Frost weathering also damaged speleothems.In rough scree dripstone fragments are found.Fourthly,cryogenic processes changed the surface forms of the Moravian Karst. Besides the accumulation forms mentioned above also erosion forms developed.On the slopes cryoplanation terraces were formed(such as in the southern part of the Moravian

Karst on the slopes of Hády Hill). Karst pediments are bound to the surface of sedimentary filling of blind and semi-blind valleys(V.Panoš,1961,p.85).Due to fact that they are bound to the surface of Pleistocene accumulation filling of a blind valley, they are evidently cryopediments.The upper surface of the permafrost table impermeable for water and a lot of material descending from the slopes caused the braiding of streams and supported the side erosion and undercutting of slopes.

Karst processes in periglacial regions with the occurence of permafrost are characterized by a specifity which has not been completely known up to the present.The study of the development of karst regions under periglacial conditions is thus a very important task of karsology and speleology.The knowledge of the operation of karst processes under periglacial conditions with permafrost is important not only for the recognition of karst development in present-day cold climates, but also for the explanation of the development of the karst under periglacial conditions in the Pleistocene.

The conclusions following from the study of contemporary karst regions with permafrost as well as karst regions in Pleistocene cold periods can be summarized as follows:First,karst processes take place also in periglacial regionswith the presence of permafrost.Even in continuous permafrost there are unfrozen aquifers(the so-called taliks) at different depths and water circulates in karst rocks.The circulating water is usually bound to deep-seated faults and fissure zones.Very frequent are taliks in valley bottoms.I have already mentioned the fact that permafrost concentrates the runoff and in the valleys of the present periglacial zone there are water streams (at least intermittent).Due to the heat brought by the surface water streams taliks are formed under the bottoms of karst valleys (closed or even open taliks). Second,frost weathering,formation of ice wedges and further cryogenic processes widen the fissures in karst rocks.The opening of fissures increases the intensity of karst processes.In open fissures surface waters,underpermafrost waters and waters of open taliks in permafrost circulate.This water circulates along the fissures,widening them and forming karst cavities even in permafrost. Third,permafrost slows down karst processes.Karst cavities are sealed by ice.Cave ice forms ice plugs in caves and in other karst cavities(such as ponors).Frost weathering produces large amounts of angular fragments which fill in ponors and in places they fill the caves up to their roofs.

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NEW RECORDS OF CAVE COLLEMBOLA FROM THE NEOTROPICAL REGION AND NOTES ON THEIR ORIGIN AND DISTRIBUTION

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ABSTRACT

The cave fauna from the Neotropical Region is one of the richest and most interesting of the world. From Mexico more than 2,100 cavernicole animales have been cited, some of them are completely adapted to cave life. This fauna includes a great diversity of groups, from Protozoans to bats. Some of them have been well studied, as cave fishes, but, many of them are very litle known.

Among the Arthropoda, the Collembola or springtails are very wall reprented in all the caves, and they are an important source of food for many predators, as well as a very good example of cave evolution.

Even the recent studies we have bean doing about the taxonomy of several families of Collembola (Cassagnau & Palacios-Vargas, 1983; Christiansen, 1973, 1982; ; Ojeda & Palacios-Vargas, 1984; Palacios-Vargas, Ojeda y Christiansen, 1985; Christiansen & Reddell, 1986) ther is still a lot of taxonomical work to be done, as we lack informations from many regions form Central and Southamerica.

This absence of knowledge makes it very dificult to complete biogeographical studies. This is why I decided to studie the cave Collembola from México and other countries from the Neotropical Region. To do this, I studied some specimens from saveral countries of the Neotropical Region, as Mexico, Costa Rica, Venezuela and Brazil. Some of them were collected by myself, other by other colleagues.

Among the more representatives genera there are: Acherontides, Acherontisella, Mesaphorura, Onychiurus, Folsomia, Proisotoma, Folsomides, Pseudosinella, Cyphoderus, Troglopedetes, and Arthrogalites. Some of these genera are represented by new species.

When an analisis is done, we can see that a very high percentage of the genera are cosmopolitan, some are restrinted to the Neotropical Region and some others, that were only known from the Palearctic and Nearctic Regions also have representatives in Southamerica. Maps of distribution of the species and a comparative table are finely given.

RESULTS

List number 1 shows countries, caves and collectors and the springtails we have identified. The 39 species listed are new recors for each cave, exception of Schaefferia guerrerensis. Some of the records are new for the countries (see list 2), and several are new taxa for the science.

With all the information about this group of arthropods (see bibliography), including the new records, we made the list number 2, where we can see that for the Neotropical Region there are 153 species of cave Collembola, from 15 different families, but the third part of it (52) inhabits also soil and leaf litter.

Only one species have been cited from caves of the following countries: Guatemala, Jamaica, Haiti and Honduras. From Venezuela there are two records, five from Costa Rica, six from Ecuador, seven from Brazil and 22 from Cuba. From México, 127 species have been recorded, but 47 are known to occur also as soil fauna of other countries and 8 species are shared with Cuban cavernicole fauna.

A high percent (30%) of this cave fauna has a wide distribution in America, and some members of the Isotomidae Family seem to be cosmopolitan. The remaining 64% of the species are restricted to the Neotropical Region and some of them to just one cave.

Distribution of the more representative genera is as follows: Of Cyphoderus (Map 1) there is one species known from Yucatán, other from Ecuador and saveral still unpublished from México, Costa Rica and Brasil. Oncopodura has four described species in México and two in Ecuador. Map 6 shows the distribution of Mexican species one of ther still unnamed.

Among the Hypogastruridae there are three interesting genera: Acherontides, Acherontiella and Acherontiellina, their distribution in Latin America is in the map 2. Acherontiellina arbina and Acherontides arboreus are very wide distributed in Mexican caves, as can be seen in the map 4. Other genera to be manticned are Schaffalla and Typhlogastrura, with a distribution very restrinted (Map 3), excepting Sch. emucronata, known from Europe.

Species of Mexican Pseudosinella, have been studied recently by Christiansen y Reddell (1986). This is the most important genus among the Entomobryidae because their adaptations to the cave life. We still have many records and new species of the Neotropical Region that need to be studied.

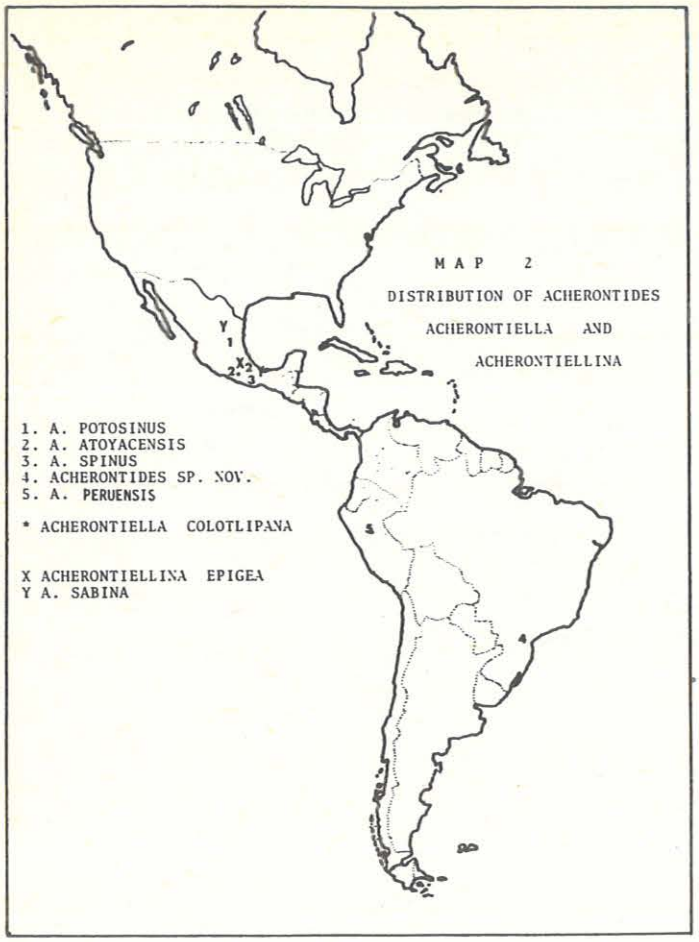
In the Paronellidae Family a total of 19 cave especies have been recorded from América, 18 belong to the genus Trogolaphysa and one to Cavernella. Their distribution is shown in the Map 5, they are known only from the Neotropical Region. Their biggest diversity have been found in México (Mapa 7).

DISCUSSION AND CONCLUSIONS

Collembola is the most ancient group among the Hexapoda, their fossil Rhyniella praecursor, dates from Lower Devonic. Thanks to their ecophisiological aptitudes they have passed all the geological times. They inhabit almost all the biotopes, from the littoral marine to the perpetual snow, in all kinds of weather and all the latitudes.

MAP 1

DISTRIBUTION OF CYPHODERUS AND ONCOPODURA



MAP 2

DISTRIBUTION OF ACHERONTIDES

ACHERONTIELLA AND

ACHERONTIELLINA

Even this, and the fact that they had plently of time to disperse world wide, we find that the distribution of some species, and even genera are limited, as it happens to the well adapted cavernicolous species.

The origin of the cave Collembola from the Neotropical Region (part of México, Central and Southamerica), is very difficult to establish. For some genera as Troglolabyes and Onypodura, it seems to be in certain part of Africa, when it was still jointed to the ancient Gondwanaland. But other genera as Schaefferia, Acherorthides, etc., are much more diversified in the Palearctic Region, while in Neotropical América they have very few representatives.

I have suggeste for the Collembola (Palacios-Vargas, 1983), at least three groups becasuse of their possible origin and actual distribution. 1) the Palearctic group, whith very wide distribution in the Holarctic Region, as the Schaefferia, Typhlogastrura and Acherontiellina. Some of them have invaded cavas of the Neotropical Region recently. 2) the Neotropical group, They have invaded the Central American Region maybe after the Pliocene and their distribution is limited to the South of Sierra Neovolcanica of México. Good representatives of this fauna are the Troglopedates and Metagricolla species. These genera are more diversified in Mezoamerica. 3) Group with cosmpolitan distribution as many Isotomidae. Some genera like Pseudosinella have under gone to a good evolution into the caves, with endemic troglobius species.

It is very interesting the fact that some genera with epigeic species in Southamerica, have more cave representatives in Centroamerica, where they are more frecuent and diverse. This might be because of the geological and climatical history of this Region, that made the fauna to take refuge inside the cave. After this, with the climatic changes epigeic populations were eliminated, staying some of them as relicts inside the caves, and others during the evolution have become true troglobites. This fact have been observed in other groups as the Ricinulids (Arachrida), and I think that can be common in other arthropods.

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MAP 3

DISTRIBUTION OF SCHAEFFERIA

AND TYPHLOGASTRURA

MAP 4 DISTRIBUTION OF ACHERONTIELLINA SABINA (o)
AND ACHERONTIDES POTOSINUS (x)

MAP 5 DISTRIBUTION OF PARONELLIDAE

1. T. MAYA
2. T. OZTOTLICUS
3. T. XTOLOKENSIS
4. T. TOROI
5. T. NACIONALICUS
6. T. MARIMUTTI
7. T. VARIABILIS
8. T. RELICTUS
9. T. YOSHIUS
10. T. STRINATII
11. T. HAITICUS
12. T. JAMAICANUS
13. T. HONDURASENSES
14. T. GUACHARO
15. P. CARPENTERI
16. T. AELLENI
17. T. HAUSERI
18. T. ECUATORICUS
19. T. COTOPAXIANA

I. LIST OF CAVES AND COLLEMBOLA FOUND

MEXICO

COLIMA

1. Cueva del Sótano de la Escondida. (25-X-1982, 4-V-1989; J. G. Palacios-Vargas & V. Granados Cols.)
Species:
Acherontiellina sabina Bonet, 1947
Arrhopalites sp.
Brachystomella parvula (Schaeffer, 1896)
Cryptopygus sp.
Deutonura sp. nov.
Lepidocyrtus sp.
Megalothorax minimus Willem, 1900
Mesaphorura macrochaeta Rusek, 1976
M. yosii Rusek, 1967
Protaphorura sp.
Seira sp.

GUERRERO

2. Gruta de Cacahuamilpa (16-VI-1981, P. Strinati et al. Cols.)
Species:
Mesaphorura yosii Rusek, 1967
Onychiurus sp.
Pseudosinella ca. reddelli
Trogolaphysa ca. relictus
Schaefferia guerrerensis

3. Grutas de la Estrella (20-II-1986, P. Strinati & Ch. Hug Cols)
Species:
Pseudosinella sp. nov. ca. caya

OAXACA

4. Cerro Rabón. Cueva de la Araña. (18-III-1987, U. Widmer Col.)
Species:
Acherontiellina sabina Bonet, 1945
Pseudosinella humutia Christiansen, 1982

NUEVO LEON

5. Gruta de Sustamante. (28-III-1986, J.G. Palacios-Vargas Col.)
Species:
Mesaphorura yosii Rusek, 1967
Proisotoma sp. nov. ca. minima
Folsomina onychiurina Denis, 1931.

VERACRUZ

6. Cueva Puente de Piedra. (3-V-1988, J.G. Palacios-Vargas Col.)
Species:
Ballistura sp. nov.
Cryptopygus sp.
Cyphoderus sp.
Friesea claviseta Axelson, 1900
Pseudosinella volca Christiansen, 1982
Xenylla humicola (Fr. 1788)
Xenyllodes sp.

7. Cueva del Diablo. (4-V-1988, J.G. Palacios-Vargas Col.)
Species:
Agherontides patagiatus Bonet, 1947
Pseudosinella sp.

COSTA RICA

ALAJUELA

1. Caverna Gabinarraca. (21-III-1987, P. Strinati, Ch. Hug et Asoc. Espe. Costarric. Cols.)
Species:
Ballistura latiscuda
Brachystomella sectorta Denis, 1931
Cyphoderus sp.
Irregolaschysa cf. guachaca Yoshii, 1983

PUNTARENAS

2. Caverna Damas. (3-III-1986, P. Strinati et. al Cols.)
Species:
Isotomiella cf. minor

3. Sima Carma (23-3-1987, P. Strinati et Ch. Hug Cols.)
Species:
Cyphoderus sp.

BRASIL

SAO PAULO: Iporanga

1. Caverna Casa de Pedra (2-IV-1987, P. Gnaspini & E. Trajano Cols)
Species:
Agherontidae sp. nov.

2. Gruta Colorida (30-III-1986, P. Gnaspini & E. Trajano Cols.)
Species:
Agherontidae sp. nov.
Pseudosinella sp., Cyphoderus sp., Megalothorax sp.

VENEZUELA

FALCON

1. Cueva de Zárraga (7-III-1986, P. Strinati, Ch. Hug & Lattke Cols.).
Species:
Paronella cf. carpenteri Denis, 1925

MAP 6

DISTRIBUTION OF ONCOPODURA

MAP 7

DISTRIBUTION OF PARONELLIDAE

2 CAVE COLLEMBOLA OF LATIN AMERICA AND CARIBE

ANURIDIDAE
Micranurida cf. pygmaea (Boerner, 1901) MEX (ARG, MEX. PER, USA)
Neotropiella silvestrii (Denis, 1929) CUBA (PR, TOR)
Pseudachorutes orghidani Massoud & Gruia, 1974 CUBA
P. subcrassoides Mills, 1934 MEX (ARG, USA)

ARRHOPALITIDAE
Arrhopalites sp. nov. MEX
A. cf. pygmaeus (Wankel, 1861) MEX (USA)
Pararrhopalites anops Bonet & Tellez, 1947 MEX

BRACHYSTOMELLIDAE
Brachystomella contorta Denis, 1931 CUBA MEX CR (BAR, BRA, CR, GUAD, JAM)
B. parvula (Schaeffer, 1896) MEX (ARG, BRA, CHI, CR, DR, GUAD, JAM, JF, MAG, SL, SV)
B. stachi Mills, 1934 MEX (GUAD, MAR, USA)
B. tancosana Palacios-Vargas & Najt, 1981 MEX
B. zapatai Najt & Palacios-Vargas, 1986 MEX

CYPHODERIDAE
Cyphoderus innominatus Mills, 1938 MEX (ARG, BRA)
C. napoensis Thibaud & Najt, 1987. ECUA
*Cyphoderus spp. BRA, CR, MEX

ENTOMOBRYIDAE
Dicranorchesella fina Mari Mutt, 1981 MEX
Heteromurus (Heteromurtrella) caecus Najt, et al 1988 ECUA
Lepidocyrtus spp. MEX
L. finus Christiansen & Bellinger, 1981 MEX (USA)
L. pseudofasciatus Gruia, 1983 CUBA
L. pearsei Mills, 1938 MEX
Metasinella (M.) armbatus Denis CUBA
M. (Sulcuncus) [illegible] Mari Mutt & Gruia, 1983 CUBA
M. (S.) falcifera Mills, 1938 MEX
M. (S.) nunezi Massoud & Gruia CUBA
M. (S.) racovitzai Massoud & Gruia CUBA (RD, PR)
M. (S.) topotypica Bonet, 1944 CUBA
Neorchesella boneti Mari Mutt, 1981 MEX
N. mexicana Mari Mutt, 1980 MEX
*Pseudosinella spp. MEX
P. sp. nov. ca. cava MEX
P. bonita Christiansen, 1973 MEX
P. cava Christiansen & Reddell, 1986 MEX
P. crypta Christiansen & Reddell, 1986 MEX
P. decipiens Denis CUBA
P. finca Christiansen, 1973 MEX GUAT
P. huautla Christiansen, 1982 MEX
P. kenchristianseni Gruia, 1984 CUBA
P. leoni Christiansen, 1982 MEX
P. palaciosi Christiansen & Reddell, 1986 MEX
P. petrustrinatii Christiansen, 1973 MEX
P. reddelli Christiansen, 1973 MEX
P. vera Christiansen, 1982 MEX
P. violenta (Folsom, 1973) MEX (JAM. USA)
P. volca Christiansen, 1982 MEX
P. voylesi Christiansen, 1982 MEX
P. yuca Christiansen, 1982 MEX
Seira spp. MEX
S. bipunctata (Packard, 1873) MEX (USA)
S. mexicana Folsom, 1893 MEX (ARG, PER)
Sinella caeca (Schoett, 1896) MEX (PER, USA)

HYPOGASTRURIDAE
*Acherontides sp. nov. BRA
A. atoyacensis Bonet, 1943 MEX.
A. potosinus Bonet, 1946 MEX
A. spinus Christiansen & Reddell, 1986 MEX
Acherontiella colotlipana Palacios-Vargas & Thibaud, 1985 MEX
Acherontiellina onigoa (Bonet, 1943) MEX
A. sabina Bonet, 1945 MEX
Ceratophysella sp. MEX
C. gibbosa (Bagnall, 1940) MEX (USA)
C. cf. guthriei (Folsom, 1916) MEX (USA)
C. succinea Gisin, 1949 MEX (USA)
Hypogastrura sp. MEX
Schaefferia guerrerensis Bonet, 1945 MEX
Sch. oaxacana Palacios-Vargas & Thibaud, 1985 MEX
Sch. emucronata Absolon, 1900 MEX
Schoettella glasgowi Folsom, 1916 MEX (USA)
Tafallia sp. MEX
Typhlogastrura veracruzana Palacios-Vargas & Thibaud, 1985 MEX
Willemia bulbosa Bonet, 1945 MEX
W. persimilis Bonet, 1945 MEX (ES, PER, USA)
X. humicola (Fab., 1780) MEX (CHI, CUB, MAR, USA)
Xenylla yucatana Mills, 1938 CUBA, MEX, BRA (CR, ECU, JAM)

ISOTOMIDAE
Appendisotoma dubia Christiansen & Bellinger, 1981 MEX (USA)
Ballistura sp. MEX
*B. laticauda Christiansen & Bellinger, 1981 RC (USA)
Cryptopygus sp MEX
C. ca. benhami Christiansen & Bellinger, 1980 MEX (USA)
C. thermophilus (Axelson, 1900) CUBA MEX (CR, ARG, CHI, JAM, PER)

Folsomia sp. MEX
F. candida MEX (ARG, BRA, PER, PR, VEN)
F. stella Christiansen & Tucker, 1977 MEX (USA)
Folsomides americanus (Denis, 1931) CUBA MEX (CR, ARG, BRA, CHI, GUAT, JAM, PR, PER, VEN DR)
F. angularis (Axelson, 1905) MEX (ARG)
F. cf. marchicus (Frenzel, 1941) MEX (USA)

Folsomina onychiurina (Denis, 1931) CUBA MEX (CR, AARG, BRA, JAM, PER, VEN)
Isotoma sp. MEX
I. notabilis Schaeffer, 1896 MEX (CR, ARG, CHI, JF, PER, VEN)
I. trispinata MacGillivray, 1896 MEX (USA)
Isotomiella minor (Schaeffer, 1896) MEX CP (CR, ARG, BRA, CHI, DR, GUAT, JAM)
Isotomurus sp. MEX
Proisotoma sp.nov. MEX
P. centralis Denis, 1931 MEX CUBA (CR, BRA, PER, VEN)
P. minuta Tullberg, 1871 CUBA MEX (ARG, CHI, PER)

NEANURIDAE
Americanura nova (Christiansen & Reddell, 1986) MEX
A. mexicana Cassagnau & Palacios-Vargas, 1983 MEX
A. macgregori Cassagnau & Palacios-Vargas, 1983 MEX
A. sotanofila Cassagnau & Palacios-Vargas, 1983 MEX
*Deutonura sp. nov. MEX
Paranura sp. MEX
Friesea claviseta Axelson, 1900 MEX (USA)
F. magnicornis MEX (CR, GUAD, MAG, SL)
F. mirabilis (Tullberg, 1871) MEX (USA)
N. muscorum (Templeton, 1835) MEX (CR, ARG)
Vitronura giselae (Gisin, 1950) MEX

NEELIDAE
Megalothorax minimus Willem, 1900 MEX CUB (BRA)
M. incertus Boerner 1903 MEX
M. tristani Denis, 1933 CUBA (MEX)
Neelus murinus Folsom, 1896 MEX (CR, CUB, JAM)

ONYCHIURIDAE
Mesaphorura spp. MEX BRA
M. iowensis (Mills) CUBA (MEX, USA)
M. fovesta Bonet, 1944 MEX
M. granulata Mills, 1934 MEX (USA)
M. yosii Rusek, 1967 MEX (USA)
M. krausbaueri Boerner, 1901 MEX (ARG, CHI, GUAD, GUAT, JAM, MG)
M. macrochaeta Rusek, 1976 MEX (USA)
Onychiurus sp. MEX
O. acuitlapanensis Palacios-Vargas & Deharveng, 1982 MEX
O. gr. fimetarius MEX
Protaphorura sp. MEX
P. armata (Tullberg, 1869) MEX (ARG, CHI, MEX)
P. encarpata (Denis, 1931) MEX (CR, ARG)
P. sensillata Thibaud & Massoud, 1980 MEX (ECN, GUAD)

ODONTELLIDAE
Odontella (Superodontella) lamellifera (Axelson, 1903) CUBA (USA?)

Xenyllodes gr. armatus (Axelson, 1903) MEX

ONCOPODURIDAE
Oncopodura atoyacensis Bonet, 1943 MEX
O. dura Christiansen & Reddell, 1986 MEX
O. ecuatoriana Thibaud & Najt, 1987 ECUA
O. naca Thibaud & Najt, 1987 ECUA
O. prietoi Bonet, 1943 MEX
O. susanae Christiansen & Reddell, 1986 MEX

PARONELLIDAE
Paronella carpenteri Denis, 1925 MEX, VLA, (CR, EG)
Salina sp. MEX
Trogolaphysa aelleni Yoshii, 1988 BRA
T. bessoni Thibaud & Najt, 1988 ECUA
T. cotopaxiana Thibaud & Najt, 1988 ECUA
T. ecuatoricus (Palacios-Vargas et al. 1985) ECUA
*T. guacharo Yoshii, 1988 VLA RC
T. haiticus (Palacios-Vargas et al. 1985) HAIT
T. hauseri Yoshii, 1988 BRA
T. hondurasensis (Palacios-Vargas et al. 1985) HOND
T. jamaicanus (Palacios-Vargas) et al. 1985) JAM
T. maya Mills, 1938 MEX, CUBA, RD
T. marimutti (Palacios-Vargas et al. 1985) MEX
T. nacionalicus (Palacios-Vargas et al. 1985) MEX
T. oztotlicus (Ojeda & Palacios-Vargas 1984) MEX
T. relictus (Palacios-Vargas et al. 1985) MEX
T. strinatii Yoshii, 1988 MEX
T. toroi (Palacios-Vargas et al. 1985) MEX
T. variabilis (Palacios-Vargas et al. 1985) MEX
T. xtolokensis (Palacios-Vargas et al. 1985) MEX
T. yoshiii (Palacios-Vargas et al. 1985) MEX

SMINTHURIDAE
Sminthurus sp. MEX
Temeritas sp. MEX
Neosminthurus sp. MEX

SMINTHURIDIDAE
Sminthurides sp. MEX
Sphaeridia sp. MEX

TOMOCERIDAE
Tomocerus ca. celsus MEX

* New record for the country. Names of countries between parenthesis are epigean records for the species.

Abreviations: ARG, Argentina; BAR, Barbados; BRA, Brazil; CHI, Chile; CR, Costa Rica; DR, Dominican Republic; ECUA, Ecuador; GUAD, Guadalupe, GAUT, Guatemala, HAI, Haiti; HOND, Honduras; JAM, Jamaica; JF, Juan Fernández Islands; MAG, Maria Galante; MAR, Martinique, MEX, México; PER, Perú; SV, Saint Vincent; TOR, Tortola; P.R., Puerto Rico; VEN, Venezuela.

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HOHLENDARSTELLUNGEN ALS AMBIVALENTES THEMA IN DER BILDENDEN KUNST

ILMING, Heinz

Bei einer Überlegung, mit welchen Inhalten die Darstellung von Höhlen in den verschiedenen Zeiträumen der menschlichen Kulturgeschichte in Zusammenhang gebracht wird, fällt auf, daß diese, meist literarischen Inhalte ausgesprochen gegensätzlich sind.
Oft war - oder ist - die erste Gedankenassoziation die Höhle als Eingang in eine Unter- oder Gegenwelt, Aufenthalt der Toten, des Bösen, oder todbringender Wesen, wie zum Beispiel der Drachen. Dazu kommt, daß im Mittelmeerraum und Orient höhlenähnliche künstliche Grabkammern weit verbreitet waren und - das sei zu diesem Überblick grundsätzlich bemerkt - kaum jemand zwischen natürlich entstandenen und künstlichen Höhlen unterschied. So reichen beispielsweise Darstellungen dieses Themenkreises von der Höhle des gefährlichen Polyphemus, auf griechischen Vasen, der Unterwelt in der Orpheussage - häufig in der Kunst der Renaissance -, Drachenhöhlen in Zusammenhang mit Heldensagen und Heiligenlegenden bis zu Vergänglichkeitsdarstellungen der Romantik des 19.Jahrhunderts. Abb.1

Abb.1

Der Tod in einer Darstellung des Jüngsten Gerichtes
(Skizze nach einer Ikone, um 1500, Verkündigungskathedrale, Moskau)

Wenig beachtet, aber von grundsätzlicher Symbolik ist die Darstellung einer Höhle mit dem Schädel Adams unter dem Kreuz Christi, besonders in der Kunst der Orthodoxie.
Gegensätzlich dazu wird eine Geburt "im Schoß der Erde" schon in der Antike als besonders und göttlich aufgefaßt. So werden, zum Beispiel Zeus und Hermes in Höhlen geboren.
Bei den häufigen Darstellungen der Geburt Christi in Höhlen handelt es sich nicht einfach um die im Vorderen Orient üblichen künstlichen, höhlenartigen Ställe, vielmehr nennt ein apokryphes Evangelium ausdrücklich eine Höhle als Geburtsort. So findet sich in der Kunst der Ostkirche das Weihnachtsgeschehen fast immer in, oft sehr ornamental stilisierten Höhlen, während in der mitteleuropäischen Kunst Höhle und Stall oft kombiniert erscheinen. Abb.2

Abb.2

Geburt Christi
(Ikone, 16.Jh., Ausschnitt)

Konträr sind zum Beispiel auch die Gründe für den Aufenthalt in Höhlen bei vielen historischen und legendären Personen. Hier steht das Sich-Verbergen-müssen des Verfolgten dem sich freiwillig aus geistigen - zum Beispiel religiösen - Gründen, - oft sogar gegen den Wunsch von Mitmenschen - erfolgten Sich-aus-der-Welt-Zurückziehen gegenüber.
Wieder einige Beispiele: im Alten Testament fliehen David vor Saul, Elias vor Ahab und Loth mit seinen Töchtern beim Untergang Sodoms in Höhlen. Mohamed versteckt sich auf der Flucht in einer Höhle, ebenso wie viele verfolgten Christen. Abb.3
Häufig ist auch das Phänomen, daß sich Menschen freiwillig von der Hektik der Welt abwenden, um sozusagen in der Gegenwelt der Höhle Ruhe und Geborgenheit zur Klärung ihres Weltbildes zu finden. Nach

Abb.3

Der Prophet Elias in der Höhle
(Wandmalerei in Gracanica, Serbien, Anfang 14.Jh.)

den eingangs aufgezeigten landläufigen Vorstellungen von der Höhle als Aufenthaltsort des Bösen, ist das nicht immer ein leichtes Unterfangen. So muß der heilige Prokopius die Dämonen erst mit dem Kreuz aus der Höhle vertreiben, um sich in ihr betend niederzulassen und Bilder des heiligen Hieronymus in einer Höhle, von bösen Wesen belästigt, sind besonders beliebt.
Aus der großen Zahl der in Höhlen dargestellten Heiligen sei hier nur der heilige Benedikt erwähnt,da dieser - durch Festellung der vatikanischen Ritenkongregation - Schutzpatron der Höhlenforscher ist. Die Begründung dieses Patronates ergibt sich daraus, daß Benedikt, als Vater der abendländischen Gelehrsamkeit, in der Abgeschiedenheit der Höhle von Subiaco die Grundlagen des lehrenden Mönchtums erdachte. Abb.4

Abb.4

Der heilige Benedikt wird in der Höhle von Subiaco von Romanus mit Brot versorgt.
(Aus dem Codex 73 von Monte Cassino, 11.Jh.)

Zwei weitere Gründe, Höhlen darzustellen, stehen im thematischen Gegensatz. Das ist zuerst ihre Verwendung als ausgesprochenes Beiwerk zur Erzeugung einer von geistigen Vorstellungen gestalteten romantischen Natur, gegenüber den seit der Aufklärung beginnenden Versuchen, die Phänomene der Natur zu erforschen und bildlich zu dokumentieren. Während die Höhle als romantische Bereichung von Szenen fast durchgehend von der Renaissance bis zur eigentlichen Romantik im 19.Jahrhundert und darüber hinaus immer wieder erscheint, beginnen Versuche, Höhlen wissenschaftlich mit Mitteln der Kunst darzustellen, großteils erst im 18.Jahrhundert. Obwohl diese Höhlendarstellungen von all den mythischen und mystischen Vorurteilen des Vorhergesagten belastet sind, stellen sie wertvolle Dokumente der Wissenschaftsgeschichte und oft hervorragende Kuntwerke dar. Erlangt doch gerade in den lichtlosen Höhlen die Fotografie erst spät, etwa zu Beginn des 20.Jahrhunderts eine Bedeutung auf dem Gebiete der Dokumentation. Bis dahin lag es ausschließlich in der Hand von Künstlern, bildliche Darstellungen von Höhlen in Form von Kupfer- und Stahlstichen, Lithographien und Holzstichen für die interessierte Allgemeinheit herzustellen. Eine unübersehbare Zahl von Höhlendarstellungen im 19.Jahrhundert ist die Folge.

Diese drei gegensätzlichen Themenkreise:

Unterwelt und Aufenthalt des Bösen - Ort göttlicher Geburt,

Zuflucht vor Verfolgung - freiwilliger Rückzug aus geistigen Gründen,

romantische Vorstellungswelt - Gegenstand naturforscherischen Interesses

sollten Denkmodell sein bei der Betrachtung von Höhlendarstellungen in der bildenden Kunst.

(zur bildlichen Erläuterung ca.50 Dias)

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LA GROTTA DEI COCCI PRESSO NARNI (TR) - UMBRIA - ITALIA

DE ANGELIS, Maria Cristina - NINI, Roberto - ROSSI, Alberto

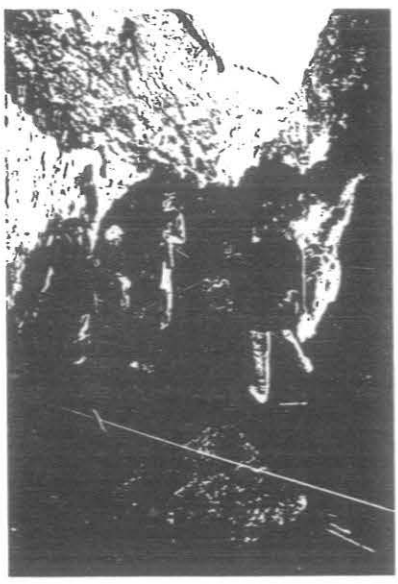
resume p. 688

La presente relazione è stata presentata verbalmente ed in modo succinto il giorno 18/08/1989 in seno al X° Congresso Internazionale di Speleologia svoltosi a Budapest tra il 13/08/1989 ed il 20/08/1989.
Quando fu richiesto di partecipare ai lavori del Congresso e venne presentato il riassunto, era in programma per l'inizio dell'anno 1989 uno scavo alla Grotta dei Cocci presso Narni; lo slittare del lavoro per vari problemi e gli inconvenienti incorsi durante lo svolgimento dello stesso hanno ritardato la redazione del presente testo ed anche limitato il suo contenuto tecnico scientifico.

La città di Narni si trova collocata sopra uno sperone roccioso che domina la stretta valle del fiume Nera dalla sponda sinistra.
L'impianto originario è attribuito dalle fonti agli Umbri che furono sconfitti dai Romani nel 299 a.C. i quali trasformarono la città in loro Colonia e successivamente in Municipio.
Il territorio circostante è ricco di testimonianze che confermano la presenza dell'uomo sin da tempi remoti.
Tra queste testimonianze si colloca la Grotta oggetto di studio, situata in un affioramento di calcare massiccio del Monte Santa Croce di fronte a Narni sulla riva destra del Nera.
La difficoltà di accesso, possibile solo dopo una arrampicata in parete per circa trenta metri, ha consentito fino agli anni cinquanta la conservazione di quanto essa conteneva.
La scoperta si deve ad un gruppo di ragazzi di allora, persone mature oggi, che spinti dalla passione per l'alpinismo scalarono la roccia e si infilarono attraverso lo stretto ingresso. Tra la polvere trovarono dei frammenti di vasellame e intuendo la loro importanza avvisarono la Soprintendenza Archeologica e l'Ispettore Onorario di zona Prof. Castellani.
Un sopralluogo congiunto mise in evidenza l'importanza della Grotta che necessitava di uno studio ed uno scavo approfondito e meticoloso.
In attesa di tempi migliori e di finanziamenti adeguati si pose in opera un cancello metallico per impedire l'ingresso ai malintenzionati.
Purtroppo però la notizia del ritrovamento si diffuse, il cancello fu divelto e l'interno della Grotta venne letteralmente rivoltato e saccheggiato.

Nel 1978 il Gruppo Speleologico UTEC NARNI richiamò l'attenzione della Soprintendenza Archeologica dell'Umbria denunciando lo stato di completo abbandono della cavità che finalmente nel Giugno 1989 è stata oggetto di un primo scavo per cercare di salvare il salvabile.
Impiantato il cantiere fra notevoli difficoltà, dovute alla zona impervia e raggiungibile soltanto a piedi dopo circa 30 minuti di marcia, si iniziarono a raccogliere i tanti frammenti di ceramica sparsi lasciati dai clandestini che avevano aperto una profonda fossa al centro della saletta d'ingresso.
Purtroppo anche il saggio di scavo stratigrafico mostrava l'estrema frammentazione dei brani di terreno rimasti intatti ed evidenziava con maggior chiarezza il notevole danno subito dal deposito archeologico.
Pertanto il materiale raccolto non è altro che il rifiuto dei predatori che per lungo tempo hanno saccheggiato la Grotta dei Cocci.
Con questo materiale e con quello trafugato, che in parte è stato recuperato grazie all'interessamento di studiosi locali, possiamo ricostruire alcune delle fasi di occupazione umana della cavità, anche se lo studio è agli inizi e quindi lunge dall'essere completato.
Allo stato attuale delle nostre conoscenze sembra che il momento più antico risalga all'età neolitica con un'ampia campionatura di vari tipi ceramici.
I frammenti ossei umani ed elementi litici e di ornamenti fanno supporre la presenza di almeno una sepoltura databile all'età neolitica.
La frequentazione della grotta sembra non andare oltre la fase appenninica della media età del bronzo come testimoniano alcuni frammenti di ciotole carenate ad incisioni disposte nelle ricche sintassi caratteristiche.

De Angelis Maria Cristina
Nini Roberto
Rossi Alberto



INTERNO DELLA GROTTA DURANTE I RILIEVI, SI NOTA AL CENTRO LA PROFONDA FOSSA SCAVATA DAI CLANDESTINI.

LOS COLEOPTEROS CAVERNICOLAS DEL LEVANTE ESPANOL. CONSIDERACIONES BIOGEOGRAFICAS

ESCOLA, Oleguer

La denominación de levante español ha sido repetidamente utilizada por ESPAÑOL para designar la franja costera mediterránea de las provincias de Castelló,València y Alacant que integra una de las zonas biospeleológicas de la "Z" del karst peninsular en que se dividió la fauna coleopterológica de España (ESPAÑOL,1958),y en ella habitan insectos que en las últimas décadas se han revelado de un interés muy considerable.Esta nota es una introducción a un trabajo que se presentará en la "VI Sessió Conjunta d'Entomologia ICHN-SCL" que ha de tener lugar en Barcelona en Diciembre de 1989.

El primer coleóptero troglobio conocido fue el Bathysciinae Speleochlamys ehlersi Dieck,1870,de la Cova Juliana,en Alcoi (provincia de Alacant)y,posteriormente,uno de los primeros investigadores que se ocuparon con intensidad de la recolección de fauna cavernícola en esta zona fue sin duda el Abate Breuil,quien en 1913 visitó una numerosa serie de cavidades en Alacant y València.
Durante todo este primer período esta franja litoral poseía endemismos ibéricos como el tréquido Thalassophilus breuili Jeannel,1926 (especie muy próxima a Th. longicornis (Sturm.)) (ESPAÑOL,1965 b) (ESPAÑOL,1979),y todas las especies conocidas del grupo meridional de Anillochlamys (ESPAÑOL,1965 a): A.bueni Jeannel,1910 y A.baguenai Jeannel,1930,de la provincia de Alacant,A.tropicus Abeille,1881,de València,y A.moroderi C.Bolívar,1924 y A.moroderi subtruncatus Jeannel 1930,de Castelló.

Pero hay que esperar a entrar en la segunda mitad del Siglo XX para que Español centralice en el Museu de Zoologia de Barcelona,un grupo de colaboradores que recolectan interesantísimas especies de coleópteros cavernícolas y harán de este margen levantino una de las más notables zonas biospeleológicas de la Península Ibérica.Estos descubrimientos recientes se inician en 1965 en que NEBOT y MARTELL, del Grup Espeleològic Pedraforca (de Barcelona) llevan al Museo de Zoología el que sería el tipo de Ildobates neboti Español,nuevo género y nueva especie de un"Dryptidae aberrante,de muy discutible colocación en cualquiera de las secciones en que dicha familia está actualmente repartida,tipo quizá de una nueva división de la misma" (ESPAÑOL,1966 a,pag.77);este insecto se ha revelada de una considerabl rareza puesto que en la localidad típica: Avenc de Serenge (Cabanes, provincia de Castelló) se recolectó el tipoel 23-IX-65,un segundo ejemplar el 14-XI-65 Auroux et Nebot leg.,y un tercero el IV-66,Nebot leg. pese a una buena serie de visitas a la cavidad con la finalidad expres de recoger este extraordinario insecto;no obstante el interés despertado por él,por lo menos ha dado como resultado la captura de un cuarto ejemplar en el Avenc de l'Indi (Orpesa) el 6-IV-69,Comas leg. y un quinto y último ejemplar mucho mas apartado de la zona de Cabanes y Orpesa: la cova dels Encenalls,29-VII-74,D.Romero leg. (ESPAÑOL,1979 cerca del pueblo de Sant Mateu,en la parte septentrional de la provincia de Castelló,casi lindando con la de Tarragona.
Posteriormente,en 1971 un equipo de arqueólogos vinculados al Museo de Zoología,formado alrededor de P.Martí-Jusmet y R.Viñas,descubre un interesante Anillini en la población de Coves de Vinromà,en el norte de la provincia de Castelló: Speleotyphlus jusmeti Español,1974,y en la segunda visita,en la que participa Español,recolectan además otro interesantísimo Anillini: Iberanillus vinyasi Español,1974 gen.et sp. nov.Tanto S.jusmeti como I.vinyasi fueron capturados posteriormente en la parte septentrional de la provincia de Castelló,en la cova dels Encenalls por Bellés et Ribera.También en la segunda prospección al avenc Serenge se recolectó otro Anillini: Speleotyphlus aurouxi Español 1966 (ESPAÑOL,1966 a).

CATOPIDAE BATHYSCIINAE

Respecto a los Catopidae y particularmente a los Bathysciinae los hallazgos de novedades se inician precisamente en la primera visita a Castelló realizada en Abril de 1965 por F.Español,L.Auroux,I.Gonzalez y F.Pablos bajo el patrocinio del Laboratorio de Zoología de la Universidad de Barcelona y el Museo de Zoología,en distintos relieves que accidentan el N de la provincia de València y el S de la de Castelló.Durante ella se descubrió una nueva especie: Anillochlamys aurouxi Español. (ESPAÑOL,1965 c)cuyas localidades típicas son la cova Covatilla y también la cova Bartolo (Serra d'Espadan,Aín) 18-IV-65 Español,Auroux et Gonzalez leg..Posteriormente la especie se ha revelado de una distribución notable,presenta caracteres morfológicos con considerable variación(entre ellos la notable variación del ensanchamiento de los protarsos masculinos) por lo que parecería interesante una revisión de todas las poblaciones conocidas.
El segundo descubrimiento de Anillochlamys [illegible] en la zona lo efectu I.Gonzalez en el macizo del Montsià,en la provincia de Tarragona, inmediatamente al S del río Ebro y en una de las cavidades visitadas, la cova Bonica,no lejos de la cumbre del macizo se localizó Anillochlamys urgellesi Español. (ESPAÑOL,1965 a).El género Anillochlamys se ha visto incrementado con otras dos nuevas especies: A.avariae Comas(COMAS 1977) de diversas cavidades de los alrededores de Barx (València) y también A.cullelli Lagar (LAGAR,1978) de la cova Santa en la vecindad del pueblo de Serra d'En Galcran,hacia el N de la provincia de Castelló,en una zona en la que no se conocían Bathysciinae.Espeleólogos de Alcoi,colaboradores del Museu de Zoologia,descubren una especie perteneciente a un nuevo género de Bathysciinae,del grupo de Anillochlamys: Typhlochlamys bardisai Español.(ESPAÑOL,1975); el género se vería incrementado con su segunda especie: T.escolai Coma (COMAS,1978),del Avenc del Caldero (Alacant).

PSELAPHIDAE.

En su monografía a del pseláfidos cavernícolas de España Besuchet se ocupa de todas las especies de esta zona (BESUCHET,1974).
Tychobythinus urgellesi Besuchet,1974: Cova Oscura(Adzaneta,prov.Castelló)Gonzalez,Avalo et Español leg.
T. espanoli Besuchet,1974: Avenc Serenge(Cabanes,Castelló)
T. escolai Besuchet,1974: Avenc del Salany (Ports de Caro,prov.Tarragona).

CURCULIONIDAE.

Desde que Español describió Troglorrhynchus torressalai n.sp.,en 1945 no se produjeron nuevas aportaciones sobre el conocimiento de estos coleópteros tan característicos de nuestra fauna hipogea,hasta que en 1976 E.Vives describió la nueva forma Troglorrhynchus torressalai espagnoli Viv.,que se conoce de tres cavidades: Avenc Serenge,Avenc d'En Soria (cercana a la anterior) y la Cova de l'Aliga,en Cervera del Maestre (VIVES,1975/76).Poco después Español describió otra especie de València: T.avariae Español. de la Cova de l'Ullal (Pinet) (ESPAÑOL,1978).

El descubrimiento de la nueva especie Anillochlamys aurouxi Español. permitió (ESPAÑOL,1965 a) dividir las formas conocidas del género, escalonadas desde el Cabo la Nao (Alacant) hasta el de Creus (Girona), en dos grupos de especies,el catalán y el valenciano,separados ambos por la depresión del Ebro (ESPAÑOL,1965 a) y actualmente Anillochlamys urgellesi parece ser la única excepción ya que gracias al estudio del saco interno del edeago,realizado por Comas,parece del grupo de Anillochlamys (Paranillochlamys) catalonicus Jeannel,pese a hallarse al S del Ebro,aunque lindando con él.

Nota final:
Este trabajo se publicará con mayor extensión y detalle en la "VI Sessió Conjunta d'Entomologia ICHN-SCL",que tendrá lugar en Barcelona,en Diciembre 1989.

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EVOLUTION OF UNDERGROUND KARST SYSTEMS IN THE UMBRIA MARCHE APENNINES IN CENTRAL ITALY

GALDENZI, Sandro - MENICHETTI, Marco

Abstract

Important underground karst systems occur in the Umbria Marchean Apennines. The most important are localized in the Monte Cucco area and in the Frasassi Gorge. Both have a development of over 30 km in the lower liassic carbonate bank and present many common features. The presence of large deposits of sulphate speleothems and the structural position of the caves permit to define a strong influence on the speleogenesis of the rise of deep waters, rich in sulphates. The M.Cucco Caves are fossil and develop at about 600 m above the regional water table level, whereas the Frasassi caves are in part active and some galleries develop at the level of the river, where different springs of juvenile water are located, with geochemical characters of sulphates and chloride.

The common features of the caves permit to suppose that M. Cucco represents a fossil stage of Frasassi area, where the speleogenetic mechanisms, related to the rises of hydrothermal water, are still active.

Riassunto

Nell'Appennino umbro-marchigiano esistono importanti sistemi carsici sotterranei. I piu' grandi sono localizzati nell'area di M.Cucco e nella Gola di Frasassi. Entrambi si sviluppano per oltre 30 km negli strati di un calcare del Liass inferiore e presentano molte caratteristiche comuni. La presenza di larghi depositi di speleotemi solfatici e la posizione strutturale delle grotte permettono di definire una forte influenza nella loro genesi da parte di acque ricche in solfati. Le Grotte di M.Cucco sono in genere fossili e si sviluppano a circa 600 m sopra l'attuale livello di base regionale. A Frasassi alcune gallerie sono ancora attive e parti delle grotte si sviluppano pochi metri sopra l'alveo del fiume , dove sono localizzate alcune sorgenti di acque con caratteristiche geochimiche solfato-clorurate.

Le caratteristiche comuni dei diversi sistemi carsici permettono di supporre che M.Cucco rappresenta lo stadio fossile di Frasassi, dove i meccanismi spelogenetici legati alla risalita di acque solfato-clorurate sono ancora attivi.

1. INTRODUCTION

The caves in the M.Cucco and Frasassi Gorge represent the largest underground karst systems in the Central Apennines of Italy. Their total development is of over 60 km and the two areas are situated at about 20 km of distance. (Fig. 1)

The caves are well known since a lot of years and for both areas are available accurate maps and morphological surveys (SALVATORI, 1973; BOCCHINI & COLTORTI, 1978), studies on the underground morphology (BOCCHINI & COLTORTI 1978; GALDENZI, 1987; MENICHETTI 1987), on superficial and underground hydrogeology (MENICHETTI 1985, 1988; SIGHINOLFI, 1988; TAZIOLI et Al., 1988) and on the speleothems (BERTOLAMI et Al., 1977; FORTI et Al., 1989). The karst systems of the M.Cucco and of the Frasassi Gorge are very complex and their underground morphology is clearly different: in M.Cucco

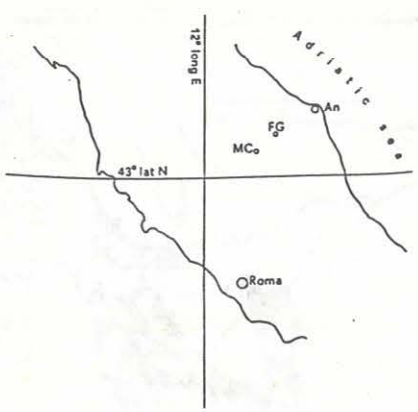

Fig. 1 - Position of Monte Cucco area (MC) and Frasassi Gorge (FG) in Central Italy

vertical developments with vertical pitches and inclinated galleries are prevalent; in Frasassi, instead, the caves mostly develop in an horizontal way . Accurate observations of some underground morphologies and the study of speleothems have carried out some genetic analogies between these two karst systems.

2. GEOLOGY

2.1. Lithology

The M.Cucco and Frasassi karst systems developed in Lower Liassic Carbonate bank, with a thickness of over 900 m. The limestone is very pure with sedimentary facies of packstone and grainstone in cyclothemic sequence, with a thickness of 4-5 m. . The limestone presents a very high syngenetic porosity and a well developed network of fractures. The primary porosity has had a strong influence on the embryonal genesis of the karst.

The L.Liassic carbonate overlies an Upper Triassic sequence of anydrites, gypsum and dolomites, thick over 1800 m and underlies a thin level of micritic and nodular limestone, interbedded with marls and a thick level of Lower Cretaceous limestone. This stratigraphic sequence forms an important karst level and it is delimitated by an acquiclude of marls and marl limestone of the Middle Cretaceous.

2.2. Tectonic setting

The Umbria-Marche Apennines are a fold-and-thrust belt, verging NE and developing from the Upper Miocene.

Both karst systems are situated in the external part of anticlines, close to the master transpressive fault, orientated N-S.

M.Cucco forms a gently folded monocline, with the hinge orientated N130 and the bedding dipping SW 20-40 degrees. The east side is cut by a dextral transpressive N-S fault and sinistral E-W. Many other fractures, such as joints, are developing with a NE-SW trend.

The Frasassi area is in the external liab of an anticline with N160 orientated axes, verging NNE. The karst system is extended in the hinge zone, where the bedding is subhorizontal. Here are also well developed N-S dextral and E-W sinistral transpressive faults. Coniugate sets of fractures orientated NW-SE and jointing in direction NE-SW are evident in the scarps of the gorge and in the underground passages of the caves.

In all the caves of the areas the fracture network has lead the development of the karst. In particular the N-S faults are related to the main galleries and passages and control the morphology of the larger underground passages. The E-W fault also influences the Mezzogiorno-Frasassi system and the superficial hydrographic network.

3.KARST

The superficial karst is very poor and limitated to the perpendicular surface of the bedding plane with small karren. In the M.Cucco area there are small sinkholes and gorges .

The underground karst is rich with more than 50 known caves in the M.Cucco area and 100 in the Frasassi area.

3.1. Monte Cucco

It is possible to distinguish two main systems: an extended dry system, with large passages and tunnels, and a wet system, still active, with narrow passages (Fig.2).

The main caves are fossil; "La Grotta" in the East side of the area, has over 26 km of length and a total depth of 948 m. It consists of large galleries at different depths formed inside stratigraphic levels at high primary porosity and connected by pitches and shafts. This morphology is constant until 300 m of depth, where there are several shafts higher than 100 m, which reach the water table levels.

The morphology of large tunnel passages is controlled by joints and faults and the floor is covered by clastic materials; the speleothems are scarce. In the lower levels the laminated clay sediments are predominant. They infill the gallery with a thickness of 2 m and are associated in few place with gypsum deposits.

The other important cave of M.Cucco area is that of Faggeto Tondo in the west side of the mountain and it hasn't any connection with "La Grotta". This cave is located under a thin impermeable level for a total depth of 300 m and a length of 3 km, with phreatic galleries, parallel to the stratification. In the upper part, the passages are infilled by gypsum speleothems (FORTI et al. 1989) with a total volume of over 1000 cubic meters and many other mineralizations .

Small underground caves with a depth and a length of over 100 m are to be found in the east side of the karst area; in particular, the active system develops on the main fracture lineations of the N-S fault systems.

The chemical characters of karst waters are mainly carbonate with low enrichment of sulphate, close to the water table. The whole karst system drains through Scirca Spring .

There aren't any datations on the speleothems and the chronological evolution of the underground karst can be postulated comparing the external evolution of the superficial hydrography. The M.Cucco karst is not older than the Pleistocene, and the last active period could be situated in the Wurm.

3.2. The Frasassi Gorge

The Sentino stream crosses the Frasassi Gorge from West to East, where there are more than 100 caves. The most important are situated at six different altimetric levels above the talweg in the eastern part of the area, from the hinge to the reverse side of the anticline (Fig 3).

The Grotta del Mezzogiorno - Grotta di Frasassi is a passage system with prevalent subhorizontal galleries, situated in the left side of the gorge, with a length of over 3.5 km and a total depth of 160 m . It is costituted by fossil and inclinated tunnels, parallel to the stratification connected by shafts, in corrispondence of fracture allineaments with E-W and NE-SW trends.

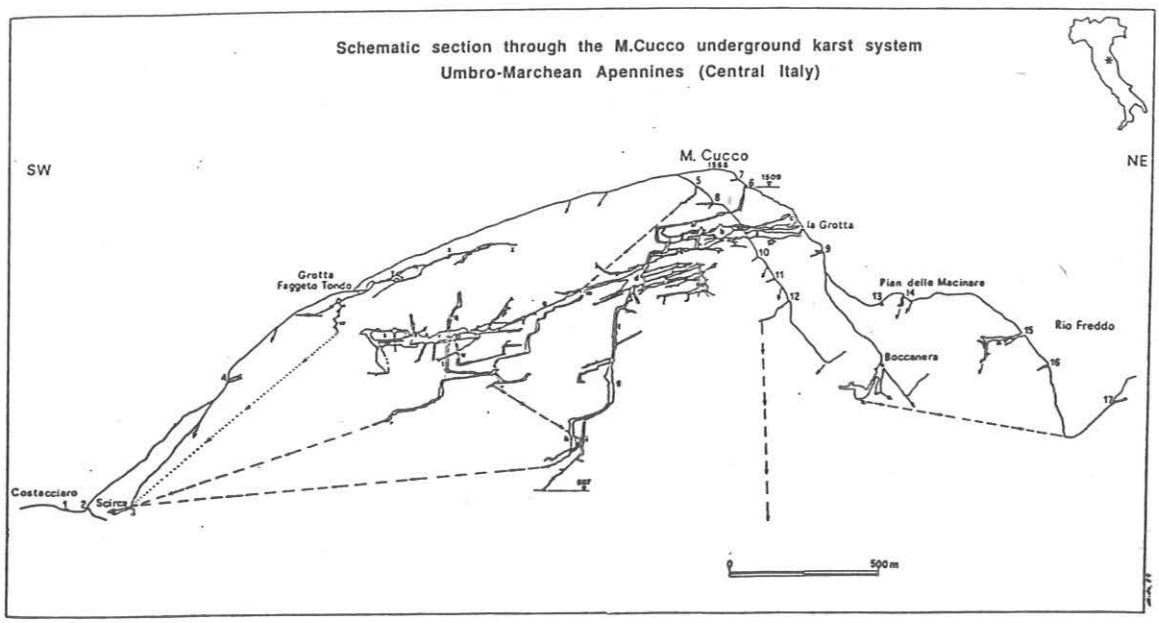

Fig. 2 - Schematic section through The Monte Cucco underground karst system in the Umbro-Marchean Apennines in Central Italy.

The underground karst system of M.Valmontagna in the right side of the valley is formed by Grotta del Fiume - Grotta Grande del Vento - Buco Cattivo and other minor caves. Buco Cattivo isn't connected with the others, but from the geological point of view they can be considered part of the same system. There are only impracticable passages, closed by mud and limestone flow. They extend for over 30 km with subhorizontal galleries and passages at different levels, connected with the general evolution of the talweg of the Sentino stream (CATTUTO, 1976; BOCCHINI & COLTORTI, 1978; COLTORTI & GALDENZI, 1982). The lower karst levels can be considered still active and related to the sulphuric water table evolution, controlled by hydrometric variations of the Sentino stream. The main karst levels are fossil with very large rooms and galleries as the Abisso Ancona with a total volume of over 1 milion of cubic meters and very rich of pure carbonate speleothems. The chronological measurements carried out on some stalagmites give an age range from 190.000 years to the present day (TADDEUCCI, 1987).

The chimism of the mineralized water table is prevalently controlled by sodium and cloride ions and secondary by the sulphur, such sulphate and sulphuric ions (SIGHINOLFI, 1988; TAZZIOLI et Al. 1988).

4. SPELEOTHEMS AND MINERALIZATION

Both karst systems present many common types of speleothems, mineralizations and sediments.

The main type of sediments are clastic materials : fragments, slabs of bedrocks and debris, as the result of the collaps of the rocks in the underground opening, caused by tension stress. This process, guided by tectonic features, controlls the morphology of the large rooms in M.Cucco and Frasassi caves.

The other common type of speleothems are the clay minerals, very diffused in the M.Cucco cave, after 300 m of depth. They are brown clay, mainly illitic with associated montmorillonite. In the Grotta del Fiume are present jarosite and halloysite (BERTOLANI et Al., 1976), associated with sulphate deposits.

The carbonate speleothems are very developed in the Frasassi caves, mainly as big stalagmites, in some cases high over 10 m, with a diameter of a few meters. Calcareous moonmilk deposits are also diffused in some levels of M.Cucco and Faggeto Tondo Caves and in a long flooded gallery in the Buco Cattivo in Frasassi.

Sulphate deposits in M.Cucco are mainly present in Faggeto Tondo caves, as microcristalline blocks of gypsum that in some cases completely infill the gallery. Here there are also other minerals like celestina and barite (FORTI et Al. 1989). In the caves of M.Cucco there are only small outcrops, probably due to the solvent action of the percolation water. .

In the Frasassi area the sulphate deposits are very diffused, specially close to the mineralized water table . Here it is possible to observe the formation on the calcareous walls of the caves of gypsum as selenitic or microcrystalline forms. In the Grotta del Fiume - Grotta Grande del Vento they exist in deposits of over 1000 cubic meters as microcristalline forms and as selenitic crystals inside sediments of China clay deposits, probably formed in the vadose phase. The gypsum is also present as arrowed cone , flowers and moonmilk forms.

Mineralizations in the karst host rock of M.Cucco are represented by fluorite, fluorapatite and dolomite in veins and lents. In Frasassi are known dolomite lents in the Calcare Massiccio Fm. .

5. EVOLUTION OF THE KARST SYSTEMS

In the Umbria Marche Apennines there is a disproportion between the subhorizontal karst levels and the vertical ones. The larger development of subhorizontal galleries at different altimetric levels, can never be related to the afflux in the karst massif of the external streams. Otherwise the low discarge of the springs around the carbonate massifs doesn't justify the present large karst volume .

In the Frasassi area the effect of the mineralized water, which has a strong speleogenetic action with sulphuric gas and water, is clearly evident. Many A. (CHOPPY,1975; FORTI et al, 1989) have described the important morphogenetic reaction, connected with the oxidation of sulfuric gas in vadose area. The main action here is phreatic : in the upper phreatic level in the transition boundary between the riducent and the oxidant zone, the sulphuric redox reactions are the main agents of corrosion (MOREHOUSE, 1968 ; GALDENZI, 1987) .

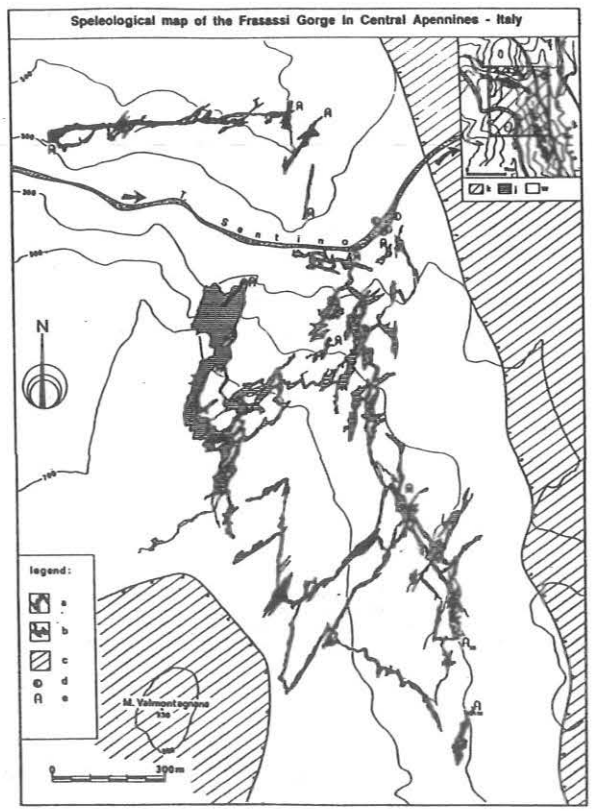

Fig. 3 - Speleological map of the Frasassi Gorge in the Central Apennines - Italy . a: caves developed under 340 m o.s.l.; b: caves developed above 340 m o.s.l.; c: impermeable Formations; d: sulphuric springs; e: caves entrance; k: enlarged area; j: Lower cretaceou marls; w: limestone outcrop.

The afflux of meteoric water, rich in oxygen, mixing with rising mineralized water, accentuates this action, as one can see in the flooded galleries. Infact, one recognizes morphological variations, with larger underground passages, in corrispondence of the impermeable stratigrafic cover, which concentrates the afflux of vadose percolant water inside the carbonate massif. As it is possible to observe now, the mineralized waters are the main responsible agents of karst genesis in the Frasassi area with production of gypsum deposits and the typical morphology of the galleries (Fig 4).

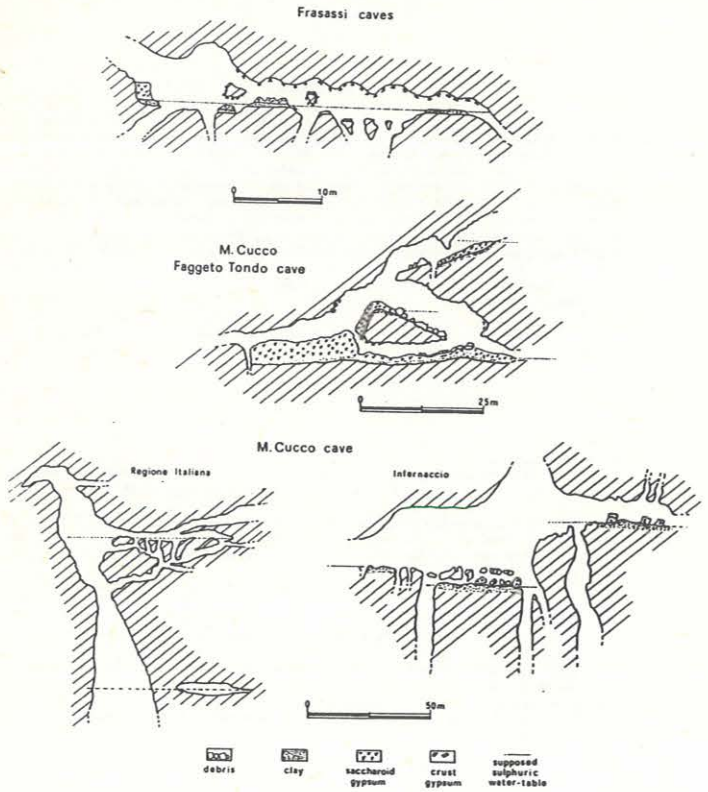

Fig. 4 - Similar underground morphologies and gypsum deposits in M.Cucco and Frasassi caves - note the different scale - .

The M.Cucco karst can practically be considered fossil, but the gypsum and fluoroapatite deposits and many underground morphologies (Fig. 4) lead to recognize that in this area, too, the main karstogenetic agent was the mineralized sulphuric water.

Generally one considers that karst genesis is the result of the action of a process, which propagates from the external to the internal host rock. The genetic agent of the karst - the aggressive water - moves from an input to an output zone through the rock mass - limestone -.

The void distribution in the caves of the Umbria-Marche Apennines shows that the karst phenomenon moves from the internal rock mass to the external, due to the strong effect of the sulphuric water as speleogenetic agent.

This mineralized water can be correlated with circulation patterns in open convective circuits, involving triassic evaporitic formations along the main transpressive N-S fault .

The age and the development of the karst is very recent and rapid and related both for M.Cucco and Frasassi area with the Upper Pleistocenic evolution of the superficial hydrography in Central Apennines.

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HYDROGEOLOGY OF M.CUCCO KARST SYSTEM IN CENTRAL ITALY

MENICHETTI, Marco

ABSTRACT

Underground karst systems are developing for over 30 km in the 3.7 kmq of the hydrogeological basin of Scirca Spring.

The tracing tests in the cave rivers, carried out in the last 15 years, have permitted to recognize the hydrogeological interconnexions of the different areas of the Scirca basin. Four quantitative tracing tests gave informations about the hydrodynamics of flow network.

The analysis of the hydrograms of the Spring clearly shows some recession curves and permits to calculate the ratio of the infiltration of water retention in the seasonal and annual water balance.

The physical chemistry character of the water in the Spring and in the caves shows slight variations in the chimism of the water during the seasons . Generally this water can be considered a typical lie-carbonate with low enrichment of sulphate in the water table level.

All the hydrogeological dates contribute to define the hydrodynamic behaviour of the Spring, which is controlled by a karstic drainage in the transfer zone and by a network of fracture in the water table zone

RIASSUNTO

Nei 3.7 kmq del bacino idrogeologico della Sorgente Scirca, si sviluppano sistemi carsici sotterranei per oltre 30 km . Colorazioni esequite su corsi d'acqua sotterranei negli ultimi 15 anni hanno permesso di definire le connessioni idrogeologiche tra diversi punti del bacino. Quattro colorazioni quantitative hanno fornito informazioni sulla idrodinamica della rete di flusso sotterraneo. L'analisi degli idrogrammi della sorgente ha permesso di riconoscere delle curve di recessione, calcolare il coefficiente di esaurimento e il bilancio idrogeologico annuale.

Le caratteristiche chimico-fisiche dell'acqua nella sorgente e nella grotta mostrano piccole variazioni staqionali. L'acqua puo' essere considerata una tipica acqua carsica carbonatica con un debole arricchimento in solfati in prossimita' della zona freatica.

Tutti i dati idrogeologici permettono di definire il comportamento idrodinamico della sorgente, che e' controllato da un drenaggio di tipo carsico nella zona di trasferimento e da una rete di fratture nella zona freatica.

1. INTRODUCTION

The M.Cucco consists of a well defined mountain chain, situated in the Central Apenines. The karst is highly developed with more than 50 known caves longer than 30 km and with a depth of 948 m (Fig. 2). The last 30 years of explorations and mapping of all the caves give many informations on the underground network and on their relationship with the hydrogeology of the karstic area (SALVATORI F., 1973). At the present day the M.Cucco underground system represents one of the most well known karsts in Italy, where many studies of geology, speleogenesis, cave minerals and specially hydrogeology have been executed (SALVATORI, 1974; MENICHETTI 1987, FORTI et Al. 1989).

The altitude of the main peak is 1500 m and the valleys around are at 500 m above sea level. The vegetation is distributed in altitudinal strips, showing woods with caduceus leaves until 900-1000 m, beech woods until 1300 m and grassland mainly with xerophil plants. The rock outcrops only in limitated areas and close to the step cliffs.

2. METEOROLOGY

The climate of the area includes temperate sub-continental regime in the main valley and a typical Apenninic continental regime in the mountain chain .

The annual average temperature is 11°C in the valley and 6° C in the areas over 1400 m a.s.l. (MENICHETTI 1988). The rainfall varies with an average range of 900 to 1400 mm/y in the valley and 1900 mm/y on the mountain.

The rains are locally very influenced by the geographical position of the side of the mountain and the main storms come from the Adriatic sea. The orographic position of M.Cucco and the divide line between the Adriatic and the Tirrenian sea characterize two different rainfall regimes, higher in the North-East side and lower in the South-West side of M.Cucco.

The snowfall occurs mainly in January and February with an annual average of 52 cm.

The precipitation had the maxima values in the late autumn and winter, whereas in the months of July and August the water balance shows a deficit with dry conditions.

The wind regime mainly consists of cold and wet from NE and subsequently warm from SW.

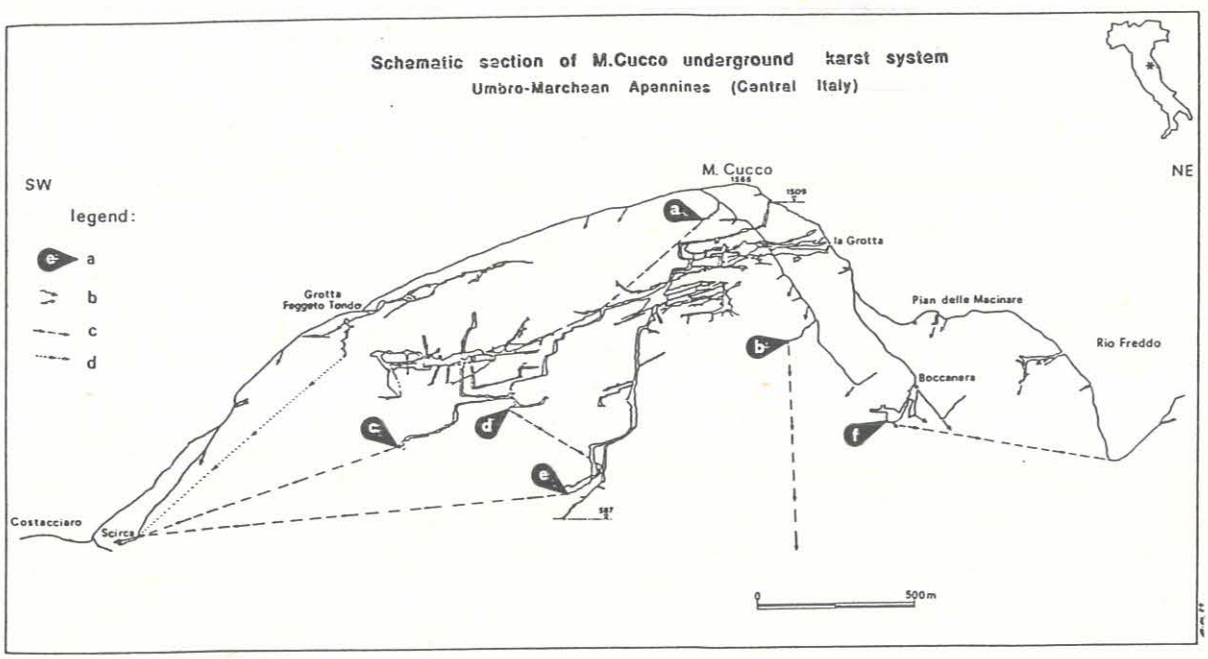

Fig. 2 -Schematic cross section through M.Cucco karst system.

a) injection point of tracing tests: a-1987(a), Abisso del Boschetto; b-1987(b), Grotta della Valcella; c-1976-1977, Meandrino; d-1987, Pozzo del Berro; e-1974 and 1987, Fiume Miliani; f-1989, Boccanera;
b) swallowing intermittent surface flow;
c) underground connection proved by tracer test (the straight line indicated represents a theoretical water course which does not necessarily correspond to the real course;
d) supposes underground connection

3. GEOLOGY

The main underground karst system is located whithin the Lower Liassic carbonate bank, Calcare Massiccio, thick over 900 m, which overlies an evaporitic formation of the Upper Triass. The Calcare Massiccio underlies a micritic limestone of the Upper Jurassic and a thick level of marly limestone of the Lower-Middle Cretaceous.

The carbonate bank had a rough stratification with a thickness of 4-5 m, with facies of grainstone and packstone . This limestone is very pure ($CaCO_3$ > 98%) and it is affected by high syngenetic porosity (15-20%)which had played a very important rule in the development of the initial stage of the karst genesis. The porosity is distributed in well defined horizons, in which the main underground galleries are located.

The structural setting of M.Cucco is costituted by a regular monocline, gently folded with an orientation of the axis to N130 and diping regulary to SW with an inclination of 20-40 degrees. The North-East side is affected by a right lateral N-S strike slip fault. This fault rises all the SW side of M.Cucco and overthrusts it at NE over an external anticline. This fault plays an important rule in the tectonic style of the M.Cucco area and many other faults are related to this dislocation. Many fracture patterns interest the karstic limestone, mainly as joints and secondary cleavages. The main trend of high angle joints are orientated at 30° N, while the system of fractures orientated N-S and E-W are related to the main faults. Some fracture, parallel to the bedding, interested all the Calcare Massiccio sequence (MENICHETTI M., 1987).

4.KARST

The superficial karst is scarcely developed and costituted by small and limitated karren. Small dolines and close depressions occur in corrispondence of main strike-slip faults and their genesis can be related to the tension field around the fault. Well developed are the gorge , mainly in the Nort-East side of M.Cucco, Rio Freddo e Valle delle Prigioni.

The underground karst is very extended with more than 50 known caves. These caves can be subdivided in two great groups: the dry system, older, and the wet system, still active. The first one has large passages and influent caves at the NE side and effluent caves at the SW side of the mountain; the second one is less developed, in some cases the caves are impracticable and only in a few points they intersect the dry system.

The main cave is "La Grotta" (Fig.2); it develops practically from the top of the mountain to the water base level for a total depth of 948 m and it owns a mapped development of over 30 km. This cave presents two accessible entrances and many other impracticable ones. It consists of large tunnel passages and dry galleries, formed on different levels and connected by pitches and shafts that rise, in some cases, over 100 m of depth (Fig1). In different zones this older and dry system intercepts the younger drainage network, specially in the lower levels .

The Faggeto Fondo Cave develops for over 3,5 km and has a depth of 350 m in the SW side of M.Cucco. This cave presents very rich speleothems and minerals of gypsum on the higher dry part . In the lower part there are deposits of mondmilch and a small river (FORTI et Al., 1989)

Other caves, important mainly for the hydrogeology of the area, are the Boccanera, Grotta della Valcella, Abisso del Boschetto in the NE side, which own underground rivers. The first caves developed along the N-S strike slip fault and present a drainage out of the hydrogeological basin of Scirca. The Boccanera drains along Rio Freddo Gorge, while the Grotta della Valcella drains at 2 km of distance in the spring of the "le Gorghe" valley. The Abisso del Boschetto presents a stream interconnected with a river in La Grotta and represents an individual and very rapid way of drainage system in the main Scirca hydrogeological basin (Fig.2).

5. HYDROGEOLOGY

In the past years different approaches of studies of the underground hydrogeology are carried out by different researches. The used methods consist mainly of several tracing testes (BERTUCCIOLI et Al, 1975), analysis of hydrograms of Scirca Spring (MENICHETTI, 1987) , physical and chemical characterizations of the underground waters (MENICHETTI M., 1988).

The hydrogeological basin is mainly delimitated by faults and only in the SW side of M.Cucco, in the Scirca Spring area, there is a stratigraphic permeability boundary (Fig.3).

The Scirca Spring has a social importance, because of its supplying the acqueduct for the main cities of the area. The study of underground hydrography is essential for to understand the mechanisms of the propagation of the pollution in the water . In fact, the spring is polluted after storms by the organic matter, deriving from the surface, where there is a lot of cattle-breeding .

5.1. Analysis of the hydrograms

The data of the daily discarge of Scirca Spring are available from 1948. The average discarge is 0.194 mc/sec with an annual discarge of 6.5 millions of cubic metres and a variability index of 1.59 .

The hydrograms show a direct relation with the meteoric regime, mainly, with the rain , but also the superficial water balance, due to the temperature and evapotraspiration. The maxima affluxes are in winter and in spring, while the defluxes are regular from May to September (Fig.4).

The deflux part in the hydrograms doesn't show a clear base flow, but an exponential diminution of the discarge.

The analysis of the few curves discarge/time permits to apply the Maillet equation for to find the taratur coefficient close to the value of the 10^{-3}, typical value of the mediterranean karstic spring (BONI et al,1986).

The analysis of the hydrological system with the methods proposed by MANGIN (1974) gives a higher value of taratur coefficient, with very low value of infiltration that takes only few days . In the hydrograms it is possible to recognize different zones with different slopes, but the alpha coefficient is always close to the 10^{-3}, typical of the fissurated karst drainage.

The value of the autoregulation (MANGIN, 1974) of the system is very high (0.9), in accordance with a very important rule of saturated zone and a wide dispersal infiltration with a negligible contribution of superficial run-off.

The hydrogeological balance shows that the recharge area corrisponds to the outcrop of karstic limestone on an area of 3.74 kmq; the mean efficacious infiltration is about 1000 mm/year and the superficial run-off is 500 mm/year.

5.2. Tracing tests

From the first discoveries and explorations of the main underground passages at the end of sixties, many tracing tests were executed. The first one qualitatively proved that the drainage of all the underground rivers goes through Scirca Spring (BERTUCCIOLI et Al., 1975).

Many other qualitative tracing tests have interconnected different underground rivers and permitted to define clearly the drainage network.

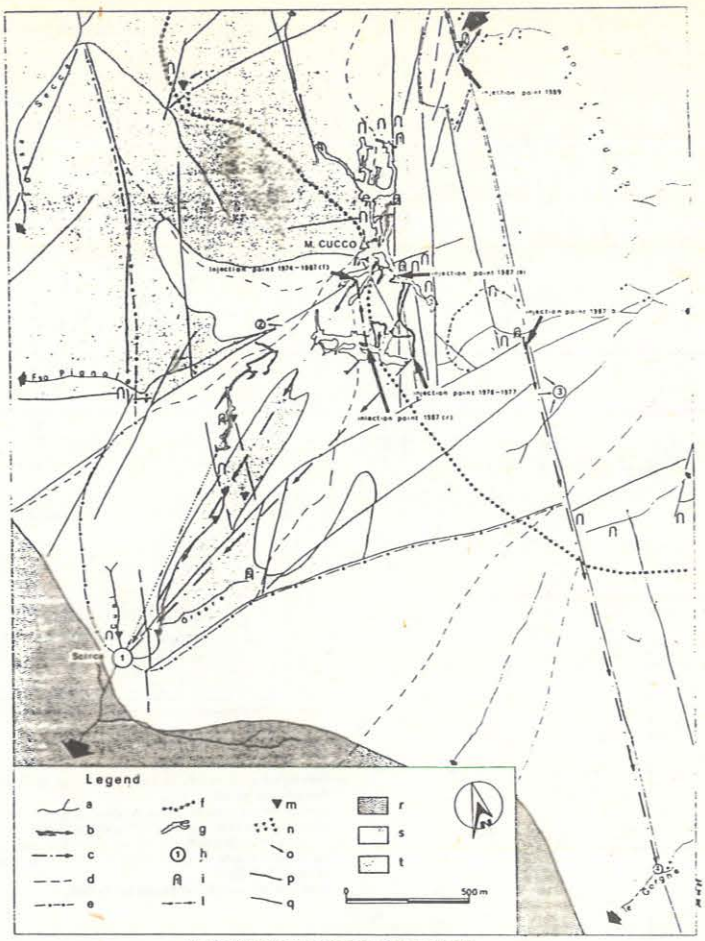

Fig. 3 - Hydrostructural map of M. Cucco karst area

a: surface streams; b: underground streams; c: underground connection proved by tracer test (the straight line indicated represents a theoretical water course which does not necessarily correspond to the real course; d: groundwater divide of small basins; e: groundwater divide of the Scirca basin; f: Appenninic surface-water divide; g: plan survey of the caves; h: main springs: 1. Scirca; 2.Acqua Ghiacciata; 3. Acqua Fredda; 4. Le Gorghe; i: main cave entrances: 1. Monte Cucco; 2.Pozzo del Ribbio; 3. Abisso del Boschetto; 4. Grotta del Faggeto Tondo; 5. Risorgenti di valle Orsara; l: supposes underground connection; m: localized swallowing interaittent surface flow ; n: dispersed swallowing interaittent surface flow; o: direction of surface flow; p: tectonic contacts; q: permeability boundary; r: Upper Cretaceous marly limestone and marls ; s: Middle Jurassic to Middle Cretaceous marly limestone and limestone cherts; t: Lower Jurassic limestone.

Small rivers in the Grotta della Valcella and Boccanera at the border of the hydrogeological basin, drain out of the Scirca basin along the main faults (Fig.2).

Four quantitative tracing test were carried out on two of the main underground rivers: in the Fiume Miliani, close to the water table level and in the Fiume dei Barbari, in the transfer zone, 600 m c.ca above the Scirca Spring. These two streams are only two minor collectors of all the drainage network of the hydrogeological basin. They completely developed in young narrow passages, whose genesis is controlled by a system of fractures.

The residence time of the tracers in the system takes few weeks and it's impossible to eliminate the influence of the rain in the concentration curves. Their analysis permits to understand two main mechanisms of propagation of the tracers.

First, close to the water table level, the movement of the dyes is affected by a lot of mechanical diffusion with very low speed. The tracer propagates in many different paths from the input to output zone. This behaviour, due to recirculations, by passes and stagnant regions in the vector fluid, can easily be recognized in the concentration/time curves.

Second, in the transfer zone the stream flow is very rapid and the predominant mechanism of propagation of the tracer is the mechanical dispersion.

In both mechanisms, the spring area plays a very important rule in regularization .

The calculated values of the hydrodynamic dispersion (MENICHETTI et Al. 1988) shows the vulnerability to the pollution of all the hydrogeological basins also in the area far from the spring, with a very rapid time of transit of few hours.

5.3.Geochemistry of the waters

Many analyses of the water of Scirca Spring are available; particularly during the hydrological cycle 1984-85 systematic analyses were made of the total hardness, conducibility, pH, solphates and clorures (Fig.3) .

During the tracing test of 1974 the total hardness was also examined. Other data are available from different underground streams and lakes.

The main ions, present in the waters of the area, are related to the carbonates, with very low enrichment of sulphate in the saturated zone. The data shows a strong influence of the saturated zone, that compensate the variation in depth of the ions in the water. The change of the mineralization of the water with the depth, is clearly shown in Fig.3.

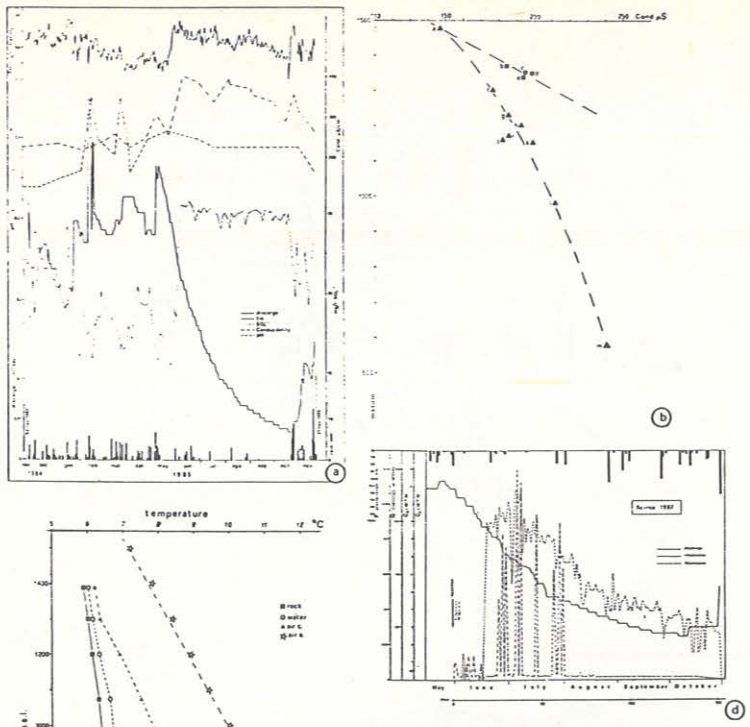

Fig.4
a: hydrological cycle 1984-85, variation of discarge, TH, SO_4^{--}, Conducibility and pH.
b: variation of the conducibility of the water in the underground stream and lake in M.Cucco karst system with altitude
c: variation of the temperature of the air superficial (air e) and underground (air c), of the rocks, and water in the M.Cucco caves with altitude
d: results of the tracing test carried out in 1987.

The variation of the total hardness with the discarge of the spring and with the rain is not clear and it depends probably on the climatic conditions. Some mm of rain, for instance, in different points of the basin, can strongly influence the increasing or the lowering of the general mineralization of the water at the spring.
The trend of the conducibility and pH is more relationable to the variation of the discarge.

The total hardness permits to know that the ammount of chemical erosion in to the basin is of about 106 mc/kmq/year.

5.4. Temperature

Several measurements of the temperature of the rock, air and water are available for several years. The result shows in Fig. 3 indicates a clear variation with the depth of the temperature of the water and of the air. At 1400 m above sea level the temperatures are similar, but at lower altitude the regular increase of the water and rock temperature is different.
The variation of the temperature of the water is related to the change of elevation during the underground runoff, in according to the loss of own potential energy of 0,25°C every 100 m . The increase of about 3°C in the saturate zone can only be explained with a wide contact of the water with the air in the well developed fracturated drainage network, close to the spring area..
The temperature of the rocks increase of about 0.5°C every 100 m, in according to local geothermal gradient.

6.DISCUSSION

All the data avalaible permit to define the hydrostructure and the hydrodynamic behaviour of the Scirca Spring in the M.Cucco karst system.

The analysis of hydrograms defined the hydrogeological system, controlled by a network of fractures. The discarge is very well modulated by the resurgence area, while in the infiltration and transfer zone the karstic type of drainage dominates.

The results of tracing test show a directly related drainage to the very rapid input by the infiltration and the immediate transfer in the saturated zone of the spring. Here the fracture network relatively controlls the constant ammount of the discarge, mixing different streams. It is clear, for example, that "lhe meandrino" stream is connected very proximally to the resurgence area, while the "Miliani stream" arises in the saturated zone in distal position (Fig.1).

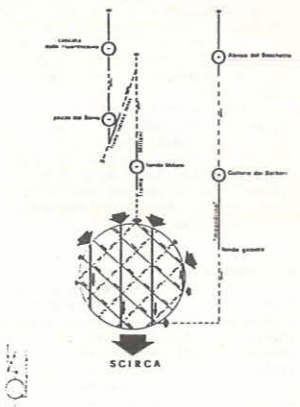

Fig.1 - Schematic cartoon of the underground hydrography of the Scirca Spring.

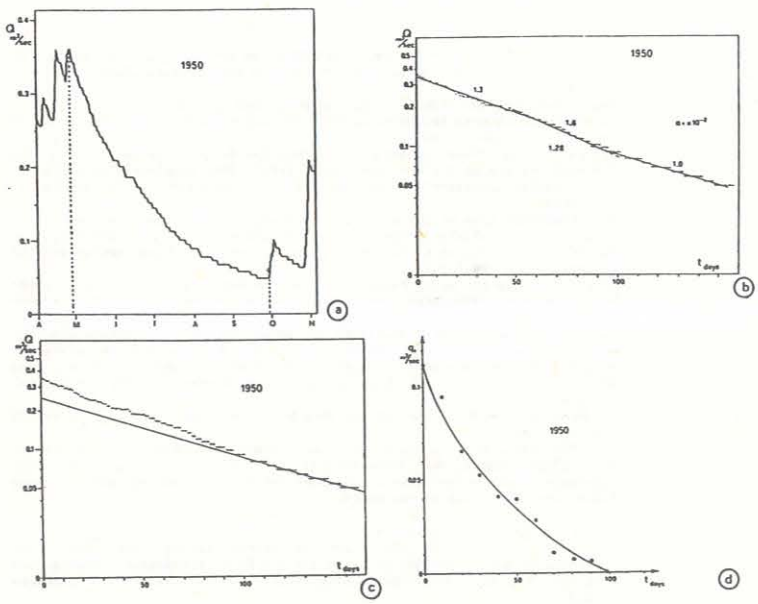

Fig.5 - Analysis of the hydrograms of the Scirca Spring in 1950
a: variation of discarge from April to November
b: variation in discarge with the time in days from May to October in log scale for the discarge
c: different slopes of the curve of the discarge and variation of coefficient alpha of the Kallet equation
d: infiltration discarge

The physical chemical parameters of the water in the hydrogeological system show the importance of the saturated zone. In fact, the temperature and the conducibility of the water are relatively constant in this zone that produces a tampon effect in the drainage.

The hydrostructural system of Scirca Spring shows both karstic drainage in the infiltration and transfer zone, and fracture controll drainage in the saturated and freatic zone. This situation related to the movement of the pollution shows a very high vulnerability of the aquifer of Scirca Spring.

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THE MORPHOMETRY OF GYPSUM TENTS CAPE NORTH, CAPE BRETON ISLANDS, NOVA SCOTIA, CANADA

STENSON, R. E.

Abstract: Measurements and observations of gypsum tents (blisters, bubbles) in an abandoned quarry site at Cape North were made during the 1989 field season. The sizes of the tents and their distribution varied slightly with site, but a number of similarities in form were found.

Site Description: Cape North is located at 60°30'E, 46°53'N. The anhydrite sites were exposed by strip mining in the 1940's and 1950's, but were abandoned early in the 1950's for economic reasons. This places a maximum time of development for features found on these exposed surfaces at less than 40 years. The surface gypsum, which shows a highly developed 'schlottenkarren' surface in remaining sections, was stripped away to a depth of about 10 meters. Anhydrite cores are exposed in the quarry walls, attesting to the relative lack of hydration at depth previous to mining. The environment is maritime-temperate.

Geomorphologic Observations: The quarry surface contains many "fields" of tents exhibiting at random three principle forms; blisters, rounded tents and A-tents. No obvious relationship between dimension and form is evident and it is presumed that the same processes initiated the development of all three types. It is further speculated that structural variations cause the differences. It was concluded that, for this paper, the distinction between types was unimportant. Very small doline (< 1m) exist in some parts of the quarry where tents do not. Rillenkarren are found on almost all exposed surfaces, however where even a slight covering of debris is evident, rillenkarren are not.

Gypsum Tents: Blisters, bubbles, tents have been described by various authors in various lithologies including granite (Jennings & Twidale, 1971), dolomite (Veber & Stansbury, 1958), limestone (Hall, 1843; Jennings, 1978; and Lundberg, 1976), and gypsum (Breisch & Wefer, 1981; Ford & Williams, 1989; Meyers, 1960, 1969; Pulido-Bosch, 1986; Stolberg, 1923; Tsui & Curden, 1984; White, 1988). The mode of formation in all cases is reportedly based on a change in pressure gradient within the rock. Where gypsum is not evident this is usually a result of the lessening of overlying pressures resulting in exfoliation of newly exposed rock. However, if internal pressures are increased the result would be the same, such as when anhydrite expands during hydration to gypsum, with the subsequent pressures exerted upon the overlying stratum. In many cases unequal hydration about a point (or line) will increase deforming pressures relative to that point and result in bubble structures.

The structural differences between gypsum-anhydrite and other, less plastic rocks result in either bubbles or A-tents forming (the latter forming in less plastic sections).

Comparison with Previous Research: The measurements taken at the Cape North sites are summarized in tables #1 & #2. The trimmed mean diameter (2.47 m) is slightly larger than the 1.78 m of Pulido-Bosch (1986) or the less than 2 m of Breisch & Wefer (1981). The median diameter (2.2 m) provides a better description of size. The symmetry measure from table #2 (trimmed mean 0.229) indicates a general lack of symmetry which was also noted by Pulido-Bosch (1986) and Breisch & Wefer (1981). The mean height of the Cape North bubbles (0.584 m) is again larger than either of the other two data sets (0.28 m and <0.25 m respectively). It can be concluded that the dimensions expressed in this new data set are larger than previously observed, the height measure being twice that of other examples.

Implications: Analysis of variance indicates that the least amount of variance exists within the height to maximum width ratios (h/A). This form measure exhibits normal distribution with a low standard error for the sites. Generally, however, all the variables display a high degree of variance. It is concluded that this is a result of non-synchronous processes of form development. The range of sizes seen in the tents is probably an indication of relative age. As one tent forms above the surface new pathways for water will expose other underlying anhydrite. Examples of "double" and "triple" tents were noted throughout the sites giving evidence to the punctuated initiation of tent growth. Despite this, the h/A ratio remains relatively close to 0.16.

The increased height measures at this site could be a function of the depth at which the hydration of anhydrite is taking place. Anhydrite cores are found in the walls of the quarry at less than 2.5 meters from the surface. Anhydrite would exist at even more shallow depths beneath the quarry floor. This would result in less resistance to expansion and might allow for greater heights to be displayed.

The thickness of the tents was observed in the field, but no relationship was evident. Some very small tents (<1.0 m) showed thicknesses of >35 cm, while large tents (>2.0 m) had thicknesses of <10 cm.

Conclusions: The Cape North site contains the largest number of gypsum tents reported to date. Since the site was man made a time limit of <40 years can be placed on all formations within it. The tents are generally larger in mean dimension, but exhibit an asymmetry and a shape in common with those previously recorded. It is surmised that the depth of hydration is the cause of this difference. The large degree of variability among the measured dimensions is attributed to asynchronous initiation of the tent forming processes.

Table #1
Summary Statistics for the Measured and Calculated Characteristics of Gypsum Tents Cape North, Nova Scotia

	A	B	C	ø	h	C'
number	69	69	69	69	69	69
mean	2.619	0.413	1.417	26.120	0.638	1.219
median	2.200	0.380	1.200	24.000	0.400	1.132
trimmed mean	2.470	0.397	1.360	25.620	0.584	1.176
standard deviation	1.478	0.305	0.770	13.970	0.551	0.635
standard error	0.178	0.037	0.093	1.680	0.067	0.076
minimum	0.8	0.0	0.4	6.0	0.1	0.4
maximum	8.2	1.2	4.1	59.0	2.4	3.3
1st quartile	1.60	0.22	0.85	14.00	0.30	0.73
3rd quartile	3.05	0.62	1.80	36.50	0.80	1.61

A = width; B = depth; C = length of side with steepest dip; ø = dip of steepest side; h = height above surface; C' = length of shortest radius;

The value of h was calculated using the relationship

$$\sin(\text{ø}) = \frac{h}{C}$$

$$h = C \cdot \sin(\text{ø})$$

The value of C' was calculated as

$$\cos(\text{ø}) = \frac{C'}{C}$$

$$C' = C \cdot \cos(\text{ø})$$

Table #2
Summary Statistics for Symmetry and Form Measures for Gypsum Tents Cape North, Nova Scotia

	$T_{symmetry}$	T_{f1}	T_{f2}
number	69	69	69
mean	0.234	0.169	0.475
median	0.200	0.160	0.474
trimmed mean	0.229	0.165	0.474
standard deviation	0.120	0.111	0.104
standard error	0.015	0.013	0.013
minimum	0.06	0.00	0.26
maximum	0.52	0.43	0.70
1st quartile	0.14	0.12	0.39
3rd quartile	0.33	0.25	0.55

$T_{symmetry}$ = symmetry ratio C'/A; T_{f1} = height to width ratio (h/A); T_{f2} = depth to width ratio (B/A)

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THE PHYSICAL SYSTEM OF SPELEOCLIMATE

GADOROS, Miklos

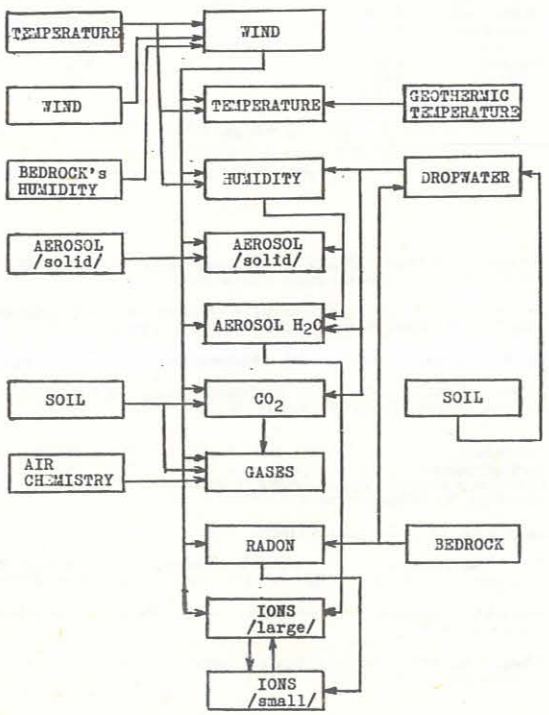
The paper presents the major impacts and interactions between the various elements of cave climate. A brief description is provided about the climatic elements and then outside climate and dwelling and cave climates are compared. It is pointed out that - opposing the wide-spread notion - speleoclimate can not be considered quiet and stable: the ranges of certain climatic elements are even higher than variability on the surface.

The cave is a semi-closed system with restricted and definable communication with the outer world. The transmitters of influences are air and water, i.e. ventillation, dripping water and (if exists) the stream.

Water is a slowly moving transmitter. Thus, excluding ventillation, an even more simply interpretable system is achieved.

Let us take a non-ventillated cavity in the interior of a rock mass. Its climate can be determined relatively easily from the geological, geophysical, geochemical, hydrochemical and other conditions of the environment. Another starting-point is the well-known outside climate. Actual speleoclimate lies between these two extremes, in the function of the influence of ventillation. It is clear that cave draught is not merely one in the series of climatic elements, but the most important one, controlling (usually without any countereffect) all the other climatic elements.

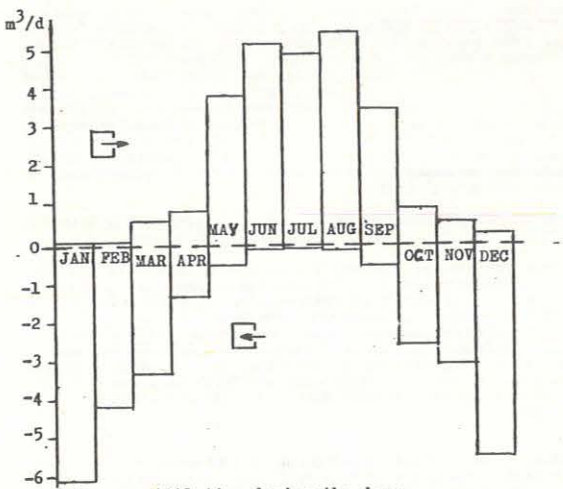
A simplified system of speleoclimate is presented by Fig. 1. In the right-hand column the major factors determining the climate of a closed cavity are listed, on extreme right the outside elements, which influence draught and indirectly certain elements of speleoclimate. In the middle speleoclimatic elements are listed. The arrows show the most important influences. As it is visible the system of speleoclimate is rather complicated even in its simplified form.



1. Action- and interaction-system of cave-climate

In the following the internal climate of karst caves in medium-height mountains, on valley floor or in its vicinity are reviewed.

Air current. It is characteristically inward in winter and outward in summer (Fig. 2.). This regularity itself proves that air current is first of all induced by the chimney effect: the air density difference resulting from differences between inside and outside temperatures. With increasing temperature difference current velocity moderately increases. In some opinions this nears a limit but this standpoint cannot be justified by physics. Wind can be of strong influence, while changes in air pressure cause a small degree of variation. There is no direct impact of regional differences in atmospheric pressure, except for the case when a high ridge separates cave entrances.

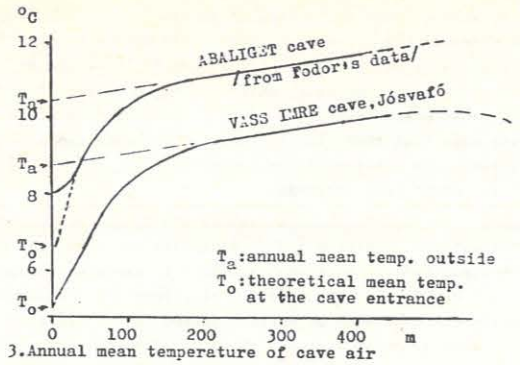


2.Cave ventillation during the jear /from FODOR's data/

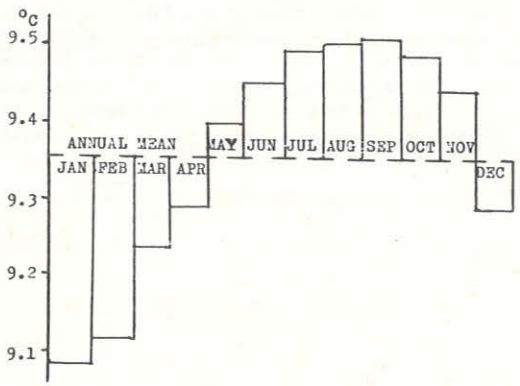
Atmosperic pressure. It is virtually the same as outside at the same elevation.

Air temperature. Because of ventillation the cave is cooled by cold air in winter and only heated by air close in temperature to the rock mass in summer. Thus the theoretical value of annual mean temperature for the entrance is ca 4°C lower than the outside temperature. (The annual mean temperature of soil surface, however, is 1-2°C higher, due to the influence of snow cover.) Along the cold entrance section temperature rises rapidly inwards, exponentially nearing the slow rate of rise along the inner section. The starting-point of the latter is annual mean temperature of outside air at the entrance (Fig. 3.).

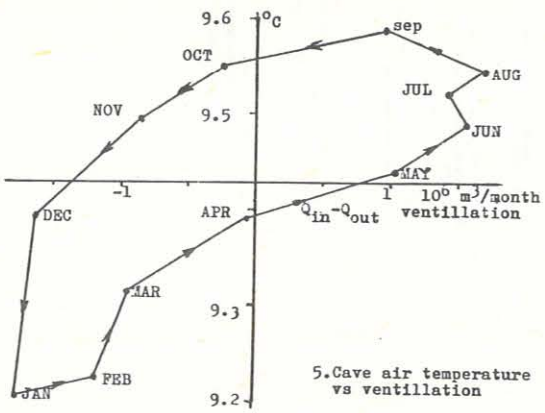
In the cave interior the daily range of temperature is moderate. The annual curve is characteristically different from that of the outside temperature (Fig. 4.). In the relation-ship between draught and temperature (Fig. 5.) several thermodynamic properties are manifested; for lack of space I cannot go into details.



3.Annual mean temperature of cave air



4.Annual variation of cave air temperature in Vass Imre cave, Jósvafő



5.Cave air temperature vs ventillation

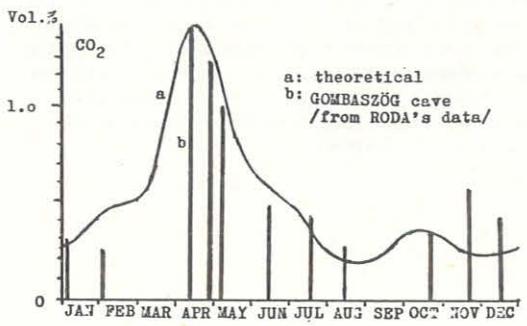
Air humidity. It is close to 100 per cent all the year round. A precise determination is difficult but for the aerosol minor (less than 0,1 per cent) changes are significant. Thus, about its changes it can be said that during a long cold winter the desiccating effect of inward air current can be felt along a several-hundred-metre entrance section.

At 10°C temperature 100 per cent relative humidity means ca 10 gram per m^3 absolute vapour, while it is only ca 30 per cent at room temperature. Thus, cave air is felt dry by the human organism (lungs).

Dust. As opposed to the outside air, it is a rare phenomenon in the subterranean climate. In the wet cave no dust forms and the occasionally arriving dust particles become condensation seeds and precipitate from the air. During the occasional winter desiccation outside air also contains less dust.

Hydroaerosol. It is a typical cave phenomenon, very rare on the ground surface. The seemingly similar fog is the result of condensation, while cave aerosol comes about from the pulverisation of dripping water. Some evidence shows that the pulverised drops of water become highly concentrated during aerosol formation. The theoretically estimated amount of aerosol is maximum 1 gram per m^3, while the amount of Ca related to air space is max. 1 mg per m^3. The diameter of aerosol drops cannot be more than 5 μm.

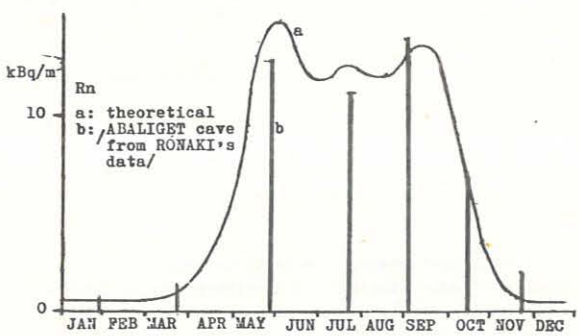
CO_2. The CO_2 content 10-100-fold higher than outside is a characteristic feature of cave climate. It mostly derives from dripping water during dripstone formation but it cannot be excluded that the summer air current brings CO_2 along directly from the soil. The typical annual curve is shown in Fig. 6. CO_2 concentration is highly dependent on draught but is is not unambiguously a function of ventillation since the yield of dripping water and its CO_2 content strongly fluctuates over the year.



6.CO_2 annual variation

Nitrogen, oxigen and argon. Unfortunately, very little is known about these gases. Some sporadic data indicate that oxigen concentration in caves was somewhat lower, while nitrogen concentration somewhat higher than in the open air. There is no data for argon. The first is natural regarding the high CO_2 content and the latter points to direct soil effect. The precise and regular measurement of the concentrations of the three gases would tell much of ventillation (through the soil or open cracks) and of CO_2 transport, how much came with dripping water and how much from the soil by draught.

Radon, thoron and radioactivity. The high level of radioactivity compared to the open air is a fundamental characteristic of cave climate. Limestones always contain some (on the average 2.2



7.Radon annual variation

ppm) uranium and thorium. Thus the cave is permanently surrounded by sources of radiation. The consequence is permanent gamma and betha background radiation. In addition, radon deriving from uranium and thoron from thorium as noble gases are diffused from the rock into cave air (from radon 500 to 16,000 atoms per m^2 a second and from thoron 2 to 55 atoms per m^2 a second). Also

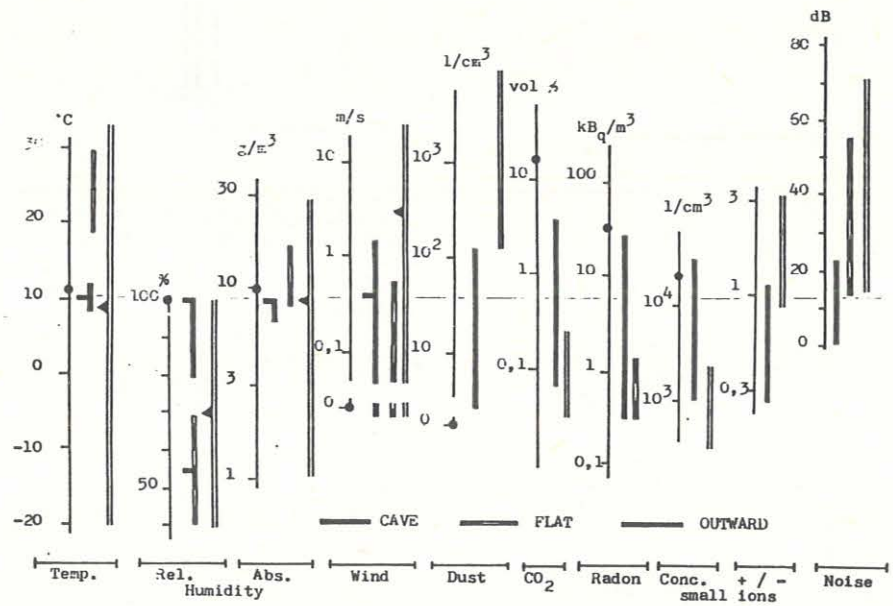
considering the products of their decay, a source radiation exists in cave air too which provides alpha, betha and gamma rays. The thoron arrives to equilibrium in a short time (about 4 minutes). Its concentration stays low and less depends on ventillation. Only near the entrance, at strong inward air current, thoron concentration is reduced. Several weeks are needed for radon to get into equilibrium and consequently, radon concentration is highly susceptible to ventillation. With strong draught radon concentration is lower and with poor ventillation 100-fold highler than thoron concentration. Therefore, radon content or the radon/thoron ratio is a sensitive indicator of the ventillation of the place in question.

Ions. Radioactive radiation ionises cave air. Naturally negative and positive ions equally form. At the same time, part of the aerosol is also ionised, mostly of negative charge, due to the Lenard effect (Waterfall effect). Consequently, the aerosol, radioactivity, large and small ions together built up a subsystem within cave climate. This subsystem is influenced by ventillation by many channels and thus ionconcentration is highly sensitive to draught. As a result of effects and interactions a negative field charge is found in the cave space; the ionisation of the aerosol is of lower extent than it would be without ionised gas, but in the originally bipolarly ionised gas negative unipolarity is generated, i.e. negative surplus for small ions. The result of negative field charge is field strength of up to 100 V per m by calculations (which equals the field strength near the ground in fair weather).

It is evident that the system of speleoclimate including numerous elements and effects is complicated enough even in this simplified form. Still it is not the complexity of the system but the geometry of the cave, which cannot be described mathematically, that prevents the obtaining of correct results in a concrete case from theoretical models. The theory can only give orientation. The outline of the system of effects may help to reveal the basic relationships.

Finally, in Fig. 9. the mean values and ranges of some elements of outside, dwelling and cave climate are compared. When the chart was made, the values customary in caves were indicated along a straight line. The theoretical values for the unventillated cavity are indicated by small dots and thus it is also visible in what direction outside slimate influences speleoclimate.

It is obvious that the speleoclimate is only partly quiet and stable. Some elements present more definite extremities in the cave than in open air. With regard to this I propose to introduce the concept of speleometeorology in addition to speleoclimatology, since daily and day-today changes, i.e. weather fall into the field of meteorology. I hope from all what has been said it can be concluded that well-measurable and precisely observable weather also exists in a cave. Once in the future - relying on outdoor weather forecasts - a prognosis for cave conditions could also be made.



8. Comparison beween cave-, flat- and outward-climate

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ANALYSIS OF AIR FLOW AND PRESSURE DATA RECORDS OF VASS IMRE CAVE

HOLL, Balazs - KERDO, Peter

Experimental investigation of air pressure difference betwen the surface and a particular reference point of the Vass Imre Cave was made in 1988 by Mr. Miklós Gádoros with the collaboration of the Papp Ferenc Speleological Research Group. The paper presented before describes the method of measurements via a pneumatic tube from the cave reference point to the entrance by means of a U-manometer gauge according to Figs. 1. Reading accuracy was enhanced by a micrometer gauge and a mirror.

The analysis of invidual data records led the Authors to the conclusion yhat this phenomenon calls for a continous monitoring of the very low pressure difference and a respective specific apparatus. This consists of a large area metal membrane transducer with optoelectronic displacement reading and the associated electronic amplifier unit. Continous records were made at a surface laboratory by means of two different-speed chart recorders. The unit was connected with a several hundred meter cable to the laboratory. The fast chart recorder was set to 0.2 mm pro sec speed in order to display the fast response, while a 20 mm per hour recorder enabled the daily variation analysis. The pressure transducer was calibrated by means of U-manometer gauge. In this experiments we used a pneumatic tube line from the cave to the surface.

At the cave reference point a sensitive hot wire anemometer gauge was simultaneously installed for air flow data readings. First experiments started in the early morning of 31 December '88, where surface temperature barometric pressure, wind speed and direction, wind speed maxima simultaneously recorded.

The results are presented in Fig. 2. The record below represents the cave-surface pressure difference, the middle one the air flow in the cave and the upper one the surface temperature . As it was expected there is a strong correlation between the in-cave air flow and pressure and the respective responses are similar. A strange sinusoidal oscillation, however, is superposed period was meteorologically a very quiet one. (Fig. 3.) The 6^h morning temperature reading was -4 centigrade increasing 1.5 grade only till morning 10 h. The surface temperature was about 13 centigrades below that of the cave in average.

During this period the barometric pressure dropped by about 200 Pascal, which corresponds to about 1,5 mm Hg on the Mercury column of Toricelli scale. (Fig. 3.)

Surface wind speeds were 0.9 m pro sec in average.

The next records are from 15 March, '89. Here the upper record represents the cave-surface pressure difference, the second one as well the differential pressure between the two reference points of the cave, the third one the surface temperature, the fourth one the air flow in the cave. It is obvious that the pressure response is very different, compared to the January records. The reason lines in the very different meteorological situations. The surface temperature curve crossed several times the cave temperature level of 6-10 °C, and surface wind speed spikes

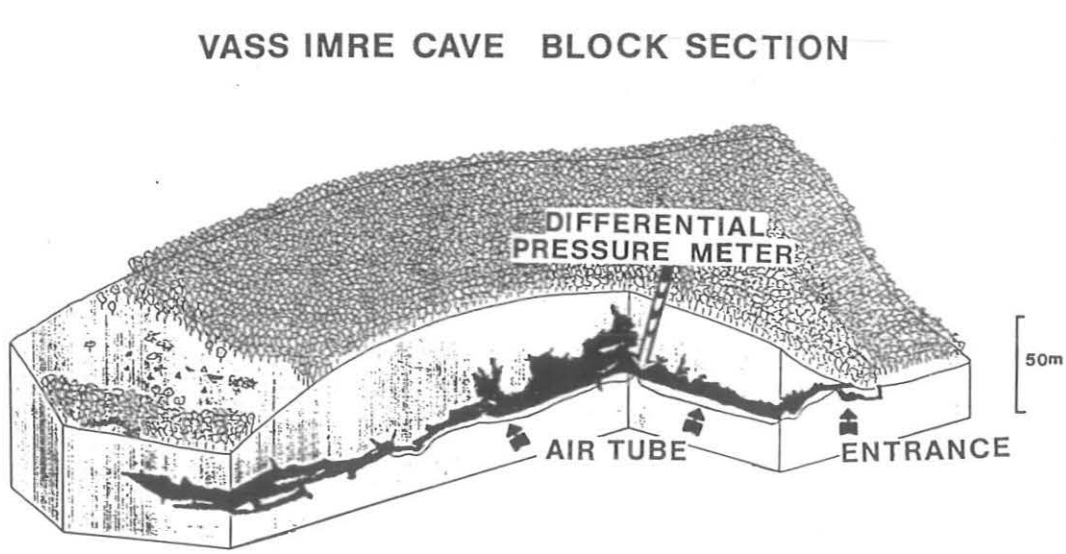


Fig. 1.

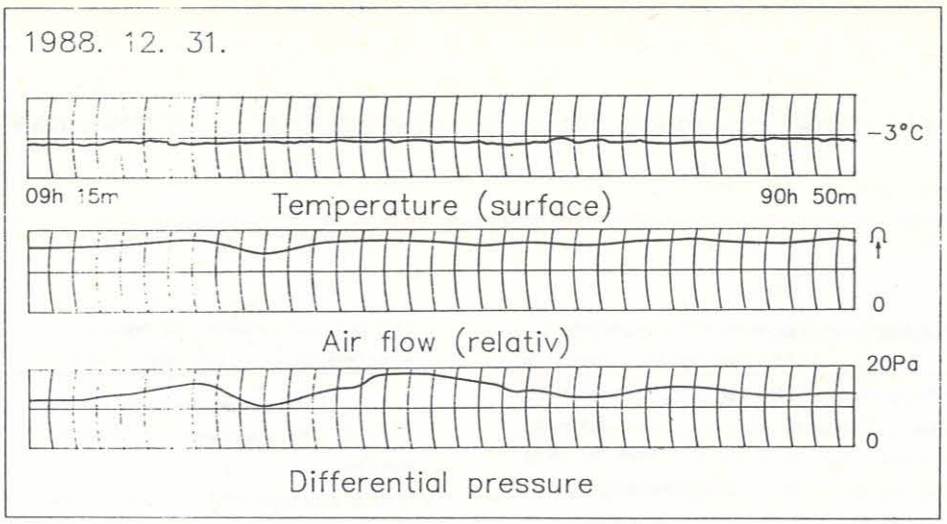


Fig. 2.

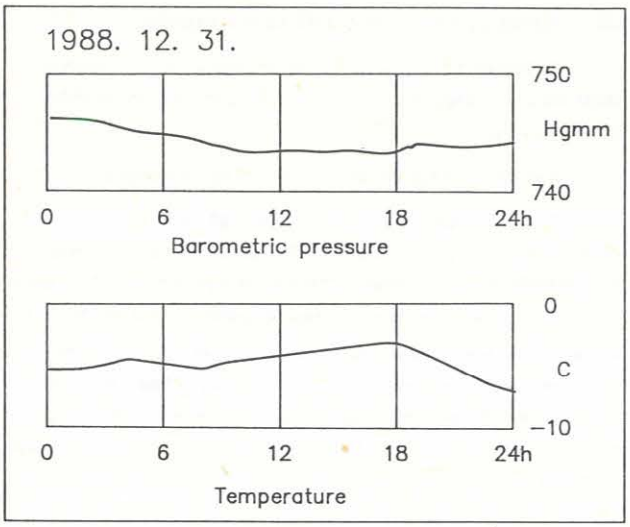


Fig. 3.

reached 5 to 7 m per sec. Surface barometric pressure, hower, exhibited a very little and slow variation. (Fig. 4.)

Finally we analysed the last period of the day's record. The pressure is getting smooth, the air flow of the cave stops, the underground pressure difference dimishes below the measurable values. (Fig. 5.) During this period the surface wind speed dimishes as well, the temperature decreases to about 7-8 centigrades while the cave temperature is still between 6 to 10 centigrades.

The records led us to suppose a long periodic oscillatory behaviour of the cave. The Vass Imre cave has a main corridor of about 600 meters in lenght with various hals, narrow parts. This cave geometry allows air flow oscillations at the respective characterristic resonance frequencies. It is supposed that the January records display the resonance ocillation at the characteristic frequencies, while the meteorological situation was extremely quiet, or in other words it was noiseless. In contrast, however, the March record is characterized by strong wind speed spikes, large surface temperature level. This situation was not quiet, it was a noisy period.

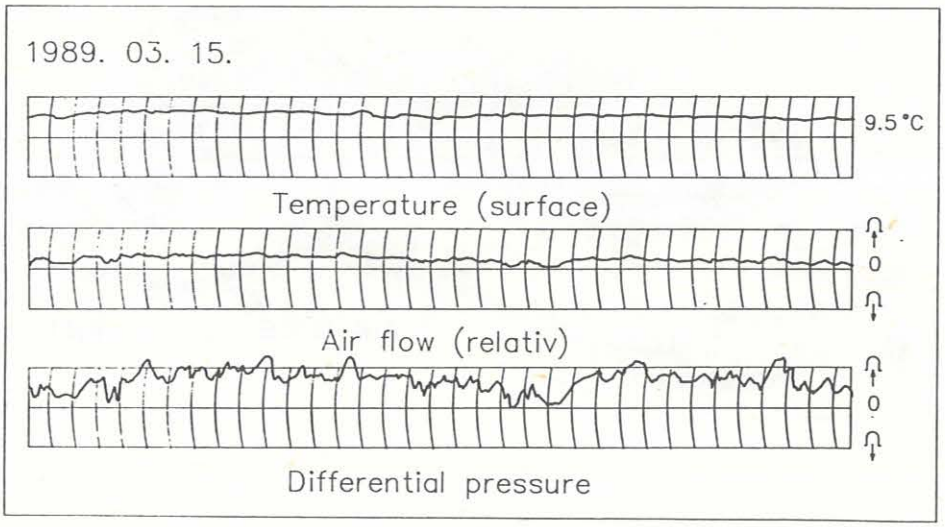


Fig. 4.

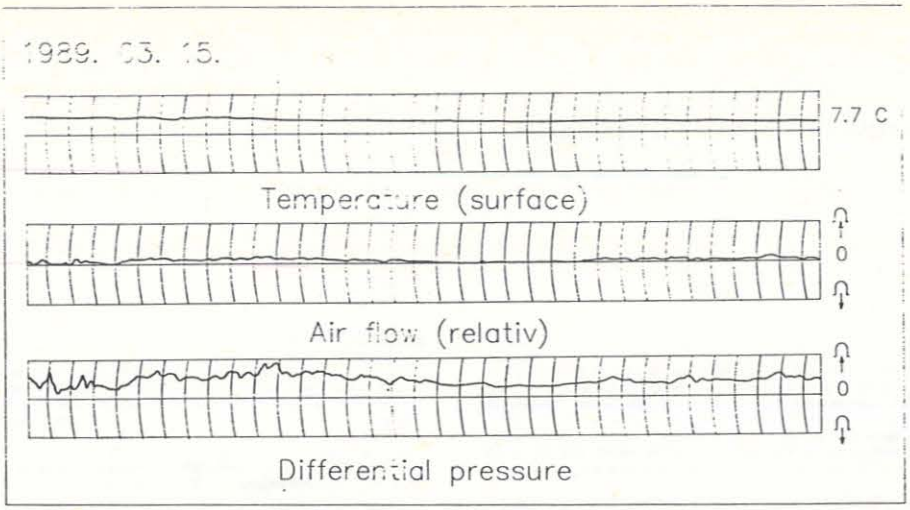


Fig. 5.

In order to verify our supposition, the periodic times of oscillations were analyzed on both, noisy and quiet records. The respective data were compared.

The analysis was carried out by means of digitization of chart records for computer data processing. We made an on-line acces to a Hewlett-Packard spectrum analyser memory. This instrument give directly the Fourier spectrum of the data (Figures 6. and 7.) present the results. It is obvious that the noisy spectrum has the same peak frequencies as the quiet one from January among higher frequency peaks. We concluded that the low frequency resonances are characteristic to the cave itself.

Finally it is to be mentioned, that the recent investigation is on its very beginning; it needs more data acquistion and we look for a more refined measuring system with more elaborated methods of data evaluation. It is recently clear, however, that characteristic features of cave pressure, air flow and temperature can be analyzed by a complex dynamic study of this phisical system.

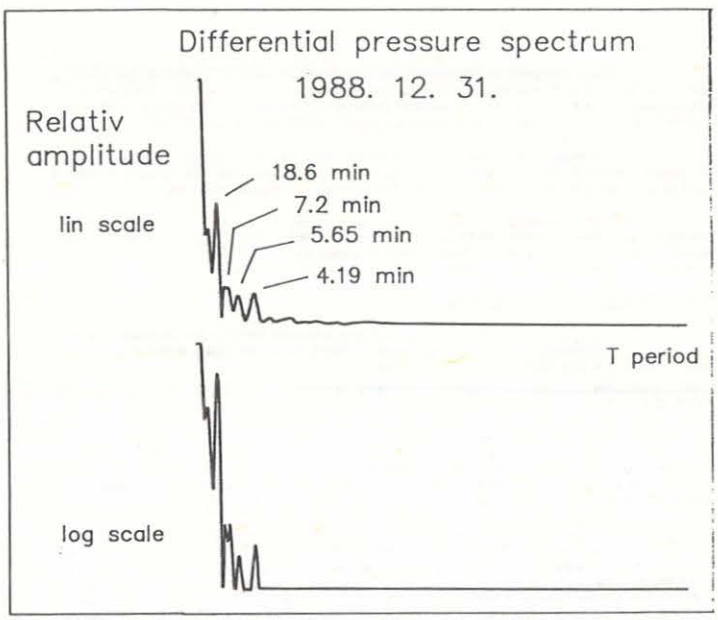


Fig. 6.

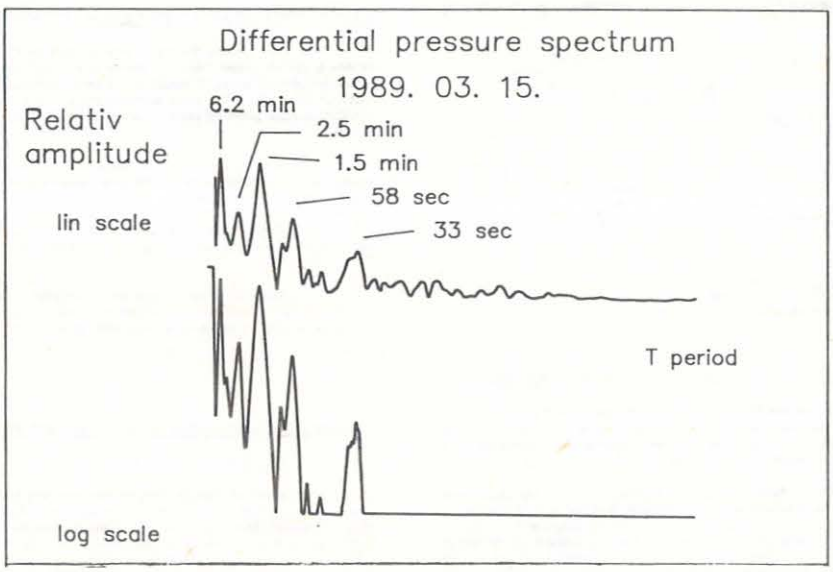


Fig. 7.

LES KARSTS HYDROTHERMAUX D'ALGERIE

COLLIGNON, Bernard

RESUME

Les phénomènes hydrothermaux (sources thermales ou carbogazeuses, dépôts de travertins) sont particulièrement abondants dans le nord de l'Algérie. L'action de ces fluides chauds et riches en gaz carbonique et en sels dissous a modelé à grande profondeur des formes karstiques et des minéralisations articulières . Certaines grottes portent encore la trace de cette influence bien qu'elles soient actuellement peu ou pas thermales. Elles nous permettent d'étudier in situ d'anciens réservoirs géothermiques carbonatés. Cette note réunit les observations qui ont ainsi été réalisées en Algérie. Elle dégage une typologie de ces phénomènes pour pouvoir les identitifer dans des grottes actuellement non thermales.

MOTS CLES : karst - thermalisme - minéralisations - coupoles - dissolution - quartz - gypse - aragonite - hydrochimie - 13 C - Algérie

ABSTRACT

There are many thermal springs in northen Algeria. The hot waters brought carbon dioxyde and salts. They hollowed very special karstic forms and deposed typical minerals. Some caves wich are not presently thermal show the marks of the paleo-thermalism. We can study in these caves old geothermic reserves. This paper collect all the informations collected in such algerian caves. It purpose a typology of the thermal karst.

KEY WORDS : karst - thermalism - minerals - cupolas - solution - quartz - gypsum - aragonit - hydrochemistry - 13 C - Algeria

1. LES SOURCES THERMALES ET CARBOGAZEUSES EN ALGERIE

Une grande partie de l'Algérie est constituée de régions arides ou désertiques. Les sources y sont donc beaucoup moins nombreuses que ce que laisserait supposer l'étendue du pays (2 000 000 km^2). En pratique, plus de 95 % de ces sources sont d'ailleurs rassemblées dans une étroite bande côtière d'environ 100 000 km^2 qui reçoit la plus grande partie des précipitations atmosphériques.

Une fraction importante de ces sources présentent de fortes anomalies de température. On en compte une centaine dont la température dépasse 25 °C, parmi lesquelles une trentaine jaillissent à plus de 40 °C. Un grand nombre de ces sources thermales sont fortement carbogazeuses.

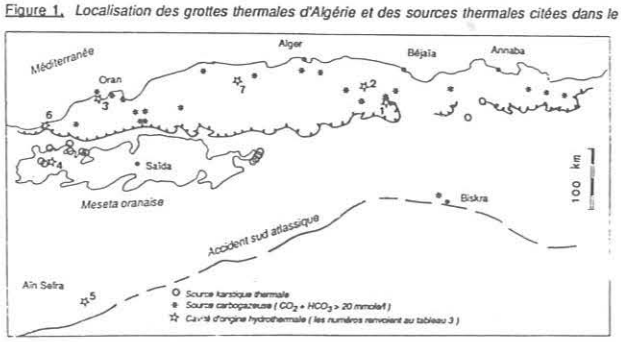
Leur distribution n'est pas aléatoire. Elle correspond étroitement à celle de l'activité sismique (COLLIGNON, 1983d ; BLAVOUX et COLLIGNON, 1988). Cette distribution se limite presque exclusivement à la partie "alpine" de l'Algérie, celle qui s'étend au nord de l'accident sud-atlassique et qui a subi de puissantes déformations pendant l'orogénèse alpine (fig. 1).

2. LES SOURCES KARSTIQUES THERMALES

Une vingtaine de sources thermales d'Algérie présentent les caractères communs suivants :
- des débits inhabituellement forts pour des sources thermales, surtout en région aride : plus de 10 l/s pour 15 sources et plus de 50 l/s pour 8 d'entre elles ;
- des températures à l'émergence comprises entre 24 °C et 34 °C, soit une anomalie thermique modérée (de 8 °C à 20 °C) ;
- un faciès chimique banal, typique d'un aquifère karstique (tableau 1 et fig.2) ; ce sont des eaux bicarbonatées, calciques et magnésiennes, pauvres en chlorures, en sulfates, en silice, en gaz carbonique et en métaux lourds et contenant des quantités non négligeables de nitrates (de 7 à 20 mg/l, soit beaucoup plus que ce que l'on rencontre dans toutes les autres sources thermales);
- des teneurs en carbone-13 qui les rattachent également aux eaux les plus banales du karst plutôt qu'aux eaux d'origine profonde (soit un delta ^{13}C compris entre -1,1 % et -1,2 % p.r. PDB - tableau 2).

L'ensemble de ces caractères indique des aquifères karstiques de moyenne profondeur (entre 300 et 1000 m ; BLAVOUX et COLLIGNON, 1988). Ils sont hydrologiquement très actifs (c'est-à-dire que la spélogénèse continue à s'y dérouler avec son cortège de phénomènes de dissolution et de concrétionnement). L'alimentation en eau de ces aquifères se fait directement à partir des plateaux karstifiés avoisinnants (Monts de Tlemcen, Djebel Nador, massifs néritiques constantinois). Il y a peu de mélange avec des écoulements superficiels car ces aquifères sont partiellement captifs à proximité des émergences. Ceci se manifeste par une grande stabilité des propriétés physico-chimiques tout au long de l'année.

Figure 1. *Localisation des grottes thermales d'Algérie et des sources thermales citées dans le texte.*



3. LES AUTRES SOURCES THERMALES CORRESPONDENT-ELLES A DES RESERVOIRS KARSTIQUES ?

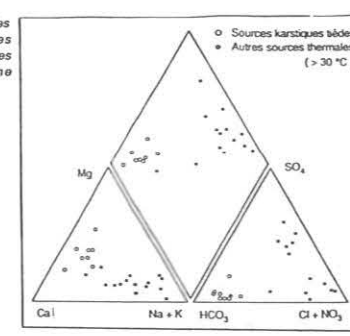
Les autres sources thermales ont des faciès chimiques variés, qui ne sont pas typiques du karst. Elles contiennent notamment de fortes quantités de silice qui impliquent des températures assez fortes au niveau du réservoir (de 30 °C à 130 °C selon les géothermomètres à silice classiques). De telles températures correspondent à des profondeurs probables comprises entre 400 et 3000 m.

Dans les régions concernées, (le Nord de l'Algérie), on trouve encore à ces profondeurs une majorité de terrains sédimentaires du Secondaire et du Tertiaire. Il s'agit surtout de roches détritiques (grès, argiles, marnes) et dans une moindre mesure de roches carbonatées (calcaires et dolomies). D'un point de vue structural, le nord de l'Algérie (le Tell) est caractérisé par de vastes nappes de charriage, superposées les unes aux autres et dont la base repose souvent sur une semelle d'évaporites triassiques. Ces évaporites ont également été injectées dans de nombreuses failles et elles bourrent le coeur de nombreux plis diapirs.

Le faciès chimique de ces eaux thermales reflète bien la nature sédimentaire des magasins (tableau 1 et fig.2). Il existe notamment de très bons équilibres $(Na+K)/Cl$ et $(Ca+Mg)/(HCO_3+SO_4)$. Les fortes charges en chlorures et en sulfates sont le résultat du lessivage de terrains évaporitiques du Trias.

Parmi ces sources, il en est certainement qui correspondent à des réservoirs karstiques, mais l'hydrochimie seule ne permet pas de les discerner car elles ont traversé des terrains sédimentaires variés dans lesquels elles se sont saturées en silice et auxquels elles ont emprunté des quantités souvent assez fortes de chlorures et de sulfates. Quant aux sources carbogazeuses, elles témoignent d' un mélange avec des fluides d'origine très profonde (attestés par des delta ^{13}C qui sont supérieurs à - 0,8 %). Ce mélange se produit sans doute près de l'émergence, souvent située sur une faille active, et il masque la composition carbonatée antérieure de l'eau.

Figure 2. *Diagramme de Piper des sources thermales karstiques d'Algérie et des sources associées à des cavités d'origine hydrothermale ou carbogazeuse.*



4. LES CAVITES LIEES A L'ACTIVITE THERMALE ET CARBOGAZEUSE

Les grottes thermales actives nous sont difficilement accessibles, parce qu'elles sont situées à des profondeurs énormes et que la température y est insupportable (nous avons pu constater qu'une température de 32 °C constitue une limite supérieure pour les explorations de spéléologie sportive ; COLLIGNON, 1983a). Une seule exception notable en Algérie : la résurgence thermale de Hassi Dermam (26°C) où nous avons pu plonger jusque -52 m (au-delà, la grotte se poursuit d'ailleurs largement vers le bas).

Mais si les grottes thermales les plus actives nous sont physiquement interdites, il existe en Algérie de nombreuses cavités d'origine hydrothermale que le jeu de l'érosion et de la tectonique a mises à notre portée (tableau 3).

Ces cavités nous donnent de nombreuses indications sur l'aspect et la structure des aquifères karstiques très profonds qui peuvent constituer des réservoirs géothermiques économiquement intéressants.

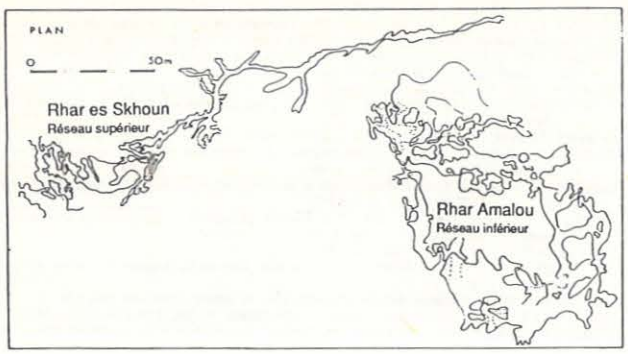
Nous allons en détailler les aspects les plus remarquables, en dégageant les caractères spécifiques qui peuvent servir de critères d'identification pour mettre en évidence d'anciennes influences thermales ou carbogazeuses dans des grottes actuellement "froides".

5. SIGNATURE DES INFLUENCES THERMALES ET CARBOGAZEUSES DANS LES GROTTES ALGERIENNES

5.1. Structure des réseaux

Plusieurs réseaux d'origine manifestement hydrothermale sont constitués par un entrelac de galeries de pente très variées, avec des diverticules latéraux se terminant en cul-de-sac. Cette structure divagante s'étend dans toutes les dimensions de l'espace (fig.3 et 4). Elle contraste avec les cavités habituelles de la zone vadose où prédominent les puits verticaux et les galeries horizontales. Une telle structure est la marque d'une génèse en régime noyé, sur une importante dénivellation. C'est donc un trait commun à de nombreux karsts hydrothermaux (JACUKZ, 1978), sans que la température des eaux en soit la cause directe.

Figure 3. Plan de deux réseaux d'origine hydrothermale des Bibans (Algérie). On remarquera l'extraordinaire développement des coupoles coalescentes.

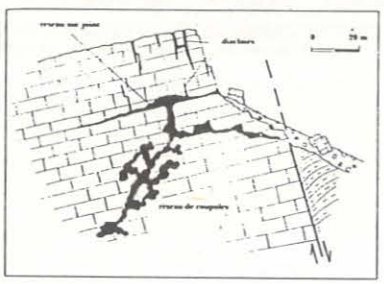


5.2. LES FORMES D'EROSION

Les parois des galeries sont taraudées d'innombrables coupoles coalescentes, de taille métrique. Ces coupoles se développent de manière isotrope, sur toutes les parois, quelles que soit leur orientation (COLLIGNON, 1983a et c). Elles ne présentent pas d'allongement significatif dans le sens des galeries. Il s'agit de formes de dissolution lente, peu influencées par la direction globale des écoulements.

Elles résultent de processus de dissolution s'étendant sans grands changements pendant de très longues périodes. Chaque coupole matérialise une ancienne cellule de convection (MULLER et SARVARY, 1977). Des formations analogues ont été abondament décrites ailleurs (KUNSKY, 1950 ; JACUKZ, 1978).

Figure 4. Coupe à travers le réseaux de Rhar Amalou mettant en évidence le réseau hydrothermal composé de coupoles emboîtées et les réseaux plus récents qui suivent les joints de strates et les diaclases.



5.3. L'état de la roche

Dans plusieurs réseaux algériens, la roche est profondément altérée. Elle semble avoir subi une attaque chimique en profondeur, qui a laissé subsister les éléments les moins solubles (dolomite, quartz, limonite, ankérite ; SAINT OURS, 1960 ; COLLIGNON, 1982). Le mécanisme d'une telle altération n'est pas clair. Il pourrait s'agir d'une corrosion très lente par des eaux chargées de CO_2, mais circulant trop lentement pour pouvoir évacuer les résidus insolubles.

5.4. Les minéralisations

5.41. Quartz

Les grottes des Bibans contiennent des cristaux de quartz bipyramidés. Ils se trouvent dans des niches, enchassés par des cristaux de calcite. Ils ont dû se former à très haute température. En effet, ils contiennent des inclusions fluides avec une part de phase gazeuse importante à la température ordinaire. C'est justement l'étude de telles inclusions fluides qui avait permis à STALDER et TOURAY (1970) de montrer que des cristaux de quartz de grottes des Alpes s'étaient formés à plus de 200 °C.

5.42. Croûte de gypse saccharoïde

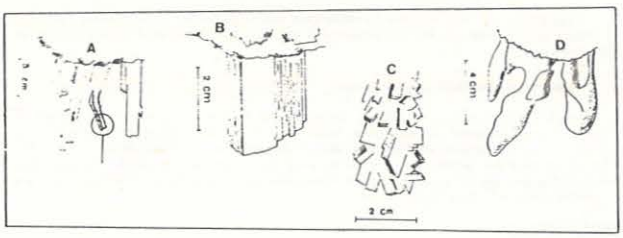
Les dépôts de gypse atteignent une épaisseur et une extension très considérable à Rhar es Skhoun (fig.3). Ils tapissent toutes les parois et se sont certainement déposés en régime noyé, contrairement aux croûtes décrites par EGEMEIER (1981), qui correspondent à une altération du calcaire par des vapeurs d'H_2S. Ce gypse est probablement une formation secondaire par les eaux ayant lessivé des évaporites triassiques. Les conditions physico-chimiques de ce dépôt ne sont pas claires.

Figure 5. Coupe à travers une galerie de Rhar es Skhoun montrant l'organisation des dépôts de gypse. 1-Croûte de gypse saccharoïde en place, recouvrant toutes les parois. 2-Buissons de gros monocristaux de gypse. 3-Accumulation secondaire de gypse éboulé.

5.43. Monocristaux et stalactites de gypse

Les beaux monocristaux de Rhar es Skhoun qui sont enchassés dans certaines croûtes de gypse ne sont pas orientés au hasard : ils sont tous inclinés vers le bas. Cette marque de l'influence de la pesanteur indique une génèse hors de l'eau, postérieure au dépôt du gypse saccharoïde. C'est une formation assez analogue à celle des stalactites de gypse de Kef el Kaous (COLLIGNON, 1984). Elle n'est pas directement liée au thermalisme, mais à la proximité de dépôts de gypse.

Figure 6. Quelques exemples de minéralisations de gypse des Bibans (Algérie).



5.44. Duvet et aiguilles de gypse

Les formes de gypse les plus délicates (aiguilles, feutre, fleurs de gypse) sont fréquentes dans les anciennes grottes thermales mais on peut en observer aussi dans de banales rivières souterraines. Elles se forment dans l'air. Leur génèse n'est donc pas liée à une température particulièrement forte mais à la percolation d'eaux très chargées en sulfates.

5.45. Les prismes d'aragonite

A Kef el Kaous et à la grotte de l'Aïdour, on observe de l'aragonite massivement cristallisée en prismes hexagonaux translucides. D'autres indices montrent qu'il s'agit d'anciennes grottes thermales noyées. Il est donc logique d'établir un lien entre le thermalisme et cette forme d'aragonite, d'autant plus que ce minéral est un dépôt courant des sources de haute température, où il constitue une forme de carbonate de calcium plus stable que la calcite (ROQUES, 1964 ; CABROL, 1978). Des formations aragonitiques abondantes ont déjà été décrites dans les grottes thermales de Hongrie (KUNSKY, 1950 ; JACUKZ, 1978) et de Tchécoslovaquie (SKRIVANEK, 1959).

5.46. Les aiguilles d'aragonite

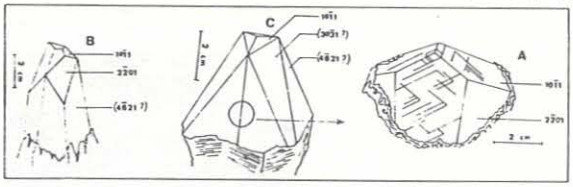
Il s'agit d'une forme beaucoup plus courante que les prismes et qui peut être associée à d'autres phénomènes que le thermalisme. ROQUES (1965) et CABROL (1978) ont particulièrement bien montré le rôle que pouvaient jouer certains éléments traces (Fe, Sr) dans le développement de l'aragonite, en bloquant celui de la calcite. Cette forme d'aragonite se rencontre donc dans des grottes non thermales et elle ne constitue pas, au contraire de l'aragonite prismatique, un indicateur fiable du paléothermalisme.

Il est cependant indéniable que l'aragonite aciculaire soit une forme courante des grottes thermales algériennes. Il est difficile de distinguer ici ce qui, de la forte température ou de la composition chimique particulière des eaux thermales, a joué le rôle le plus important.

5.47. Les monocristaux de calcite

Plusieurs grottes des Bibans sont tapissées d'énormes cristaux de calcite (rhomboèdres ou scalénoèdres qui peuvent atteindre 10 kg). Ces minéralisations s'étendent sur une grande dénivellation et elles ont parfois été recoupées par la formation des coupoles. Ce sont donc des minéralisations de grande profondeur. L'influence de la température de l'eau est difficile à établir, mais celle du dégazage d'eaux très chargées en CO_2 est probable.

Figure 7. Quelques exemples de monocristaux de calcite de Rhar es Skhoun (Bibans, Algérie).

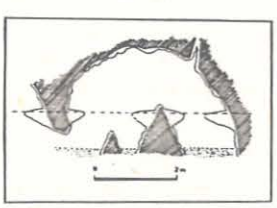


5.48. Les croûtes de calcite

Il s'agit d'incrustations continues, en minces couches concentriques, qui recouvrent uniformément toutes les parois, les anciennes concrétions de la zone vadose et les blocs éboulés (COLLIGNON, 1984). L'aspect extérieur évoque des cumulus de beau temps. HILL et FORTI (1986) les dénomment d'ailleurs "clouds".

A Kef el Kaous, on peut clairement voir que la calcite s'est déposée à faible profondeur (entre 0 et 10 m) , dans des bassins d'eau calme. On trouve le même type de minéralisation dans les anciens griffons carbogazeux de Aïn Ouarka. Cette forme est donc probablement liée au dégazage rapide d'eaux très chargées de CO_2 qui arrivent à faible profondeur. Elles sont alors parfois associées à des voiles de calcite, comme cela avait été noté par FORTI et UTILI (1984).

Figure 8. Les croûtes de calcite de Kef el Kaous se sont déposées en régime noyé (sur toutes les parois) et à faible profondeur (banquette marquant l'ancien niveau de la surface de l'eau).



5.4§. Les voiles de calcite et les stalagmites coniques

Les eaux très carbogazeuses se dégazent en arrivant à faible profondeur. De la calcite peut alors se former à la surface de l'eau, en un mince voile qui grandit rapidement (HILL et FORTI, 1986). Au droit des points de chute de gouttes d'eau, des lambeaux d'anciens voiles de ce type se sont accumulés au fond de quelques bassins de Kef el Kaous. A certains endroits, ils ont édifié des stalagmites coniques semblables à celles décrites en Italie et aux USA (FORTI et UTILI, 1984 ; HILL et FORTI, 1986).

5.5. Les dépôts détritiques

Les grottes thermales d'Algérie ne contiennent pas de dépôts détritiques anciens. Ceci est à mettre en rapport avec l'extrême lenteur des paléo-circulations qui ne devaient avoir aucune capacité de transport de sédiments.

5.6. Les dégagements gazeux actuels

Quand ces dégagements existent, ils constituent bien entendu un indicateur direct de l'activité hydrothermale. C'est assez rare en Algérie. Dans les deux cas où ces dégagements sont intenses, l'exploration de la grotte est pénible, voire dangereuse (ARAMBOURG, 1912 ; COLLIGNON, 1983a). Nos analyses de terrain n'ont pas permis de mettre en évidence une composition atmosphérique particulière, mais il est probable que des dosages plus précis décèleraient les mêmes composants gazeux qu'aux sources thermales voisines : CO_2 et H_2S.

6. CONCLUSIONS

A QUEL TYPE DE PALEO-AQUIFERE CORRESPONDENT LES CAVITES D'ORIGINE HYDROTHERMALES ACTUELLEMENT OBSERVEES ?

Trois arguments plaident en faveur d'une origine non purement karstique des fluides qui ont façonné les cavités étudiées :

- les sources thermales qui y sont parfois encore associées n'ont pas un faciès typiquement karstique; elles sont généralement fort chargées de gaz carbonique et de silice et elles ont des delta ^{13}C largement supérieurs à -0,8‰;
- les minéralisations de gypse et de quartz qui y sont fréquentes indiquent des fluides anciens riches en silice et en sulfates ;
- certaines formes de minéralisations carbonatées (croûtes, stalagmites coniques, voiles flottants) indiquent bien l'action d'eaux carbogazeuses.

A QUEL TYPE DE CAVITES DONNENT NAISSANCE LES SOURCES KARSTIQUES TIEDES ACTUELLES ?

Nous n'avons accès qu'à la résurgence de Hassi Dermam, qui est tapissée par des croûtes de calcite probablement héritées d'une période où la source était carbogazeuse. En fait, il est probable que les aquifères karstiques de moyenne profondeur (300 à 1000 m) ne contiennent pas de minéralisations particulières. Leurs seuls caractères particuliers sont les formes de creusement : développement tridimensionnel et omniprésence des coupoles.

CERTAINES SOURCES CARBOGAZEUSES SONT-ELLES ASSOCIEES A DES AQUIFERES KARSTIQUES ?

Il est probable que certaines sources carbogazeuses correspondent à des aquifères karstiques. Le CO_2 ne se mélange alors à l'eau qu'à proximité de l'émergence, durant la phase de remontée des eaux et sans qu'un équilibre chimique ne soit atteint avec le réservoir carbonaté. Dans ces aquifères profonds, se forment les minéraux exceptionnels que nous avons observés dans certains réseaux (monocristaux de calcite, de quartz). Cependant, il est difficile de distinguer ces sources de celles qui sont associées à des réservoirs gréseux à partir de simples critères chimiques ou isotopiques.

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N°	Massif	Cavité	X	Y	Z	Cavern.	Biblio	a	b	c	d	e	f	g	h	i	j	k	l	m	Autres minéraux
1 1	Bibans	Rhar es Skhoun	649.6	319.2	633	175	5 - 10 - 122	+	+	+	+			+	+	+	+	+	32	132	
1 2	Bibans	Rhar Amalou	647.2	317.3	688	22	13 - 12	+	+	+	+	+	+		+	+	+	+	20	132	
1 3	Bibans	Rhar Mediraba	651.5	321.2	700	55	6 - 7 - 8 - 12	+	+	+	+					+			25	132	
1 4	Bibans	Rhar Sidi Bakou	649.5	319.3	700	80	12 - 13	+	+	+	+							+	26	132	
1 5	Bibans	Rhar Zénédia	646.6	316.9	640	150	12 - 13	+			+	+			+	+			20	132	
1 6	Bibans	Mines Bibans	652.1	322.9	560	?						+			+	+				133	
2	Djurdjura	Anou Boussouil	633.8	353.1	1700	3000	10 - 17	+		+	+	+							12		ankérite
3	Mts acio	Grotte Aïdour	-0°40'	35°44'	350	2200	15/-28		1		+	+	+	+					37	15	limon./magnésite
4 1	Tlemcen	Hassi Dermam	137.4	159.8	1000	2200	-74			+	+							+	26	28	
5	Mts KSOUR	Aïn Ouarka	-0°11'	32°44'	1100	1500	-5			+								+		207	
6	Traras	Kef el Kaous	104.4	219.3	330	1410	3-10/+30		19	+	+	+	+	+	+	+	+	+	+	19	4 halite
7	Ouarsenis	Mines Rouina	1°46'	36°12'	420	?			29	+	+	+						+	+		

Tableau 3. Inventaire des cavités d'origine hydrothermales d'Algérie, avec leurs coordonnées, leur extension et leurs principaux caractères liés au thermalisme.
a - coupoles ; b - développement tridimensionnel ; c- roche altérée ; d - quartz ; e - arag. aciculaire ; f - arag. prismatique ; g - gypse aciculaire ; h - gypse saccharoïde ; i - stalactites et monocristaux de gypse ; j - croûtes de calcite ; k - monocristaux de calcite ; l - température ; m - code de la source thermale associée.

STATION	Code	Temp	SiO2	NO3	HCO3	SO4	Cl	Na	K	Ca	Mg
AIN ES SKHOUN	7	26	12	14.5	440	750	540	320	1,3	8,7	36
AIN SKHOUN	8	32	15	11	1280	740	465	320	2,8	65	35
AIN THAMIMINE	9	25	11,5	?	1350	240	530	330	1,2	72	35
H.SIDI ABDELLI	10	34	14	7,3	1280	880	1300	770	2,2	90	34
H.SIDI RAHO	24	31	15,5	17	440	350	940	650	4	120	35
RAS EL HAMMAM	26	26	8,6	12	470	280	420	270	2	110	24
HASSI DERMAM	28	25	11	21,23	410	420	320	330	1,7	2,8	92	41
AIN KHADRA	115	26	12	1,32	?	?	710	2100	1250	2,1	51	35
AIN FRETESSA	116	25	12	?	?	?	770	2150	1220	2	49	34

STATION	Fe	Sr	Mn	Ni	Li	S	CO2	F
AIN ES SKHOUN	0,05	0,15	0,01	0,07	?	?	1250	0,02
AIN SKHOUN	0,05	0,18	0,02	0,12	0,07	?	3?0	0,2
AIN THAMIMINE	0,07	0,14	?	?	0,01	3?0	?	0,17
H.SIDI ABDELLI	0,9	0,19	0,02	0,25	?	?	550	0,03
H.SIDI RAHO	0	0,13	0,01	?	?	?	320	0,02
RAS EL HAMMAM	0	0,11	0,01	?	?	?	270	0,13
HASS. DERMAM	0,18	0,18	0,01	?	?	?	300	0,02
AIN KHADRA	0,05	0,52	?	?	?	?	?	0,17
AIN FRETESSA	0,26	0,49	?	?	?	?	?	0,17

Tableau 1. Composition chimique (en ppm) des principales sources thermales karstiques de la marge algérienne.

STATION	Temp (°C)	CO2(ppm)	HCO3(ppm)	13C(‰)
Forages dans le karst des Monts de Tlemcen				
AIN FEZZA	18,5	80	355	-1,193
SAF SAF	22	46	380	-1,153
SABRA	28,5	40	405	-1,112
Sources karstiques thermales				
RAS EL HAMMAM	25,5	37	410	-1,191
AIN EL HAMI	26	26	330	-1,119
HAMM S.ABDELLI	34	55	380	-1,116
Sources thermales carbogazeuses à gros débit				
HAMM B.HANIFIA	66	980	631	-0,421
AIN EL HAMET	52	900	1055	-0,479
AIN M'KEBERTA	26,5	2340	1805	-0,445
AIN FRANIN	40	500	1150	-0,364
TENES	35	220	1239	-0,553

Tableau 2. Composition isotopique d'eaux thermales algériennes comparée à celle des aquifères karstiques exploités par forage ($\delta^{13}C$ exprimé en ‰ p.r. PDB).

SPELEOGENETISCHE GRUNDMUSTER IN EINEM NORDALPINEN KARSTSTOCK (DACHSTEIN, ÖSTERREICH)

KRAUTHAUSEN, Bernd

In dem vorgestellten Gebiet, dem Nordrand des Dachstein-Massivs in Oesterreich, sind Hoehlen von ueber 100 km vermessener Gesamtlaenge dokumentiert. Die Vermessungsdaten sind computergerecht aufgearbeitet und koennen somit zu statistischen Vergleichen genutzt werden.

Entstehung und Anlage von Karsthoehlen sind eng mit dem Vorhandensein **speleogenetisch wirksamer Inhomogenitaeten** verbunden. Es sind dies in erster Linie Kluefte s.l. sowie Schichtflaechen. Beide sind in Raumlage bzw. Verlauf von den lokalen tektonischen Gegebenheiten abhaengig.

Um **speleogenetisch besonders wirksam** zu sein, muessen sie primaer eine wasserwegsame Oeffnungsweite aufweisen.

Wir haben daher mit unseren Arbeiten versucht, die Hoehlensysteme am Dachstein-Nordrand in den dort gegebenen tektonischen Rahmen einzugliedern. Hierzu wurde u.a. eine luftbildtektonische Detailauswertung des Gebietes erstellt.

Die erste Anlage des tektonischen Grundmusters im Dachstein erfolgte bereits in der Trias. Bereits waehrend der noch fortdauernden Sedimentationsphase tritt ein NW-SE und NE-SW-gerichtetes Diagonalsystem offener Spalten auf, das wieder sedimentaer verfuellt wurde. Daneben besteht ein, wahrscheinlich juenger reaktiviertes N-S und E-W-System. Beide Systeme wurden waehrend der tertiaeren en-bloc-Heraushebung des Alpenkoerpers ganz oder teilweise wiederbelebt.

Als juengstes Trennflaechengefuege werden Entlastungskluefte angenommen, die alte, praeexistente Kluefte wiederbeleben koennen. Aus felsmechanischen Gruenden koennen aber auch neue Trennflaechen bei Ueberschreiten der Gebirgs-Zugfestigkeit entstehen, in diesem Fall i.Allg. oberflaechen- bzw. wandparallel. Bei Verminderung eines 'gespannten' Felskoerpers, z.B. durch Entfernung einer Eis-Auf- oder Gegenlast, koennen Kluefte und Schichtfugen, die vorher unter Druck geschlossen und speleogenetisch nicht wirksam waren, sich oeffnen und bevorzugte Verkarstungswege bilden.

Im zentralen Bereich des Dachsteinplateaus ist vor allem das NW-SE / NE-SW gerichtete Diagonalsystem an der Oberflaeche durch die Karstgassen und richtungsorientierten Karsthohlformen dominant (Abb.1). Diese Richtungen sind besonders in den randferneren Teilen der Mammuthoehle repraesentiert.

Abb. 1 Statistische Verteilung von Karstgassen und großen, richtungsorientierten Karsthohlformen im N-Teil des Dachsteinplateaus. – 100 % = 48 km.

Im Randbereich hingegen tritt das Diagonalsystem zurueck. Hinzukommen eine sehr starke N-S-Komponente und ein lokal stark hervortretender, E-W-gerichteter Ast (Abb. 2 und 3). Die aktuelle Entwaesserung der vadosen Zone (S -> N) und Teile der grossen Hoehlenraeume der Hirlatz- und Mammuthoehle folgen dieser tektonischen Vorgabe.

Abb. 2 Statistische Verteilung der Richtungen der Luftbildlineamente am N-Rand des Dachsteins. – 100 % = 204 km.

Abb. 3 Statistische Verteilung der Richtungen von Luftbildlineationen im Bereich Mittagskogel – Kruppenstein. – 100 % = 21,5 km.

Die synoptische Betrachtung des Dachstein-Nordrandes und der Hirlatzhoehle verdeutlicht eine auffallende Parallelitaet zwischen der Morphologie und der Anlage der Hirlatzhoehle (Abb. 4 und 5).

Abb. 4 Richtungen des Dachstein-Nordrandes. Ermittelt aus den 1000-, 1200-, 1400- und 1600 m-Isohypsen. – 100 % = 46 km.

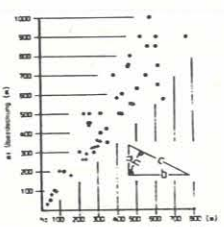
Abb. 5 Richtungen des Gangverlaufes der Hirlatzhöhle. – 100 % = 26,5 km.

Der Gebirgsrand ist in Bergsporne und -einschnitte gegliedert. In Hirlatzhoehle und - staerker noch - in der Mammuthoehle liegen die labyrinthischen Teile bevorzugt unter den Bergspornen.

Wir nehmen daher an, dass **oberflaechenparallele Trennflaechen am Gebirgsrand** eine wesentliche speleogenetische Rolle spielen. Dieses laesst sich vor allem aus der besonderen tektonischen Situation im Gebiet der Mammuthoehle ableiten: der Hauptteil der Hoehle liegt unter dem exponierten und von Steilwaenden flankierten Mittagskogel; ausserdem fallen die Schichten mit ca. 20 bis 35 Grad gegen N, also talwaerts.

Diese Verhaeltnisse sind Ursache fuer Abloesen und Abgleiten ganzer Schichtpakete, wodurch bereits grossvolumige Primaerhohlraeume entstehen konnten. Es gibt darueberhinaus Hinweise, dass die Bergsporne selbst sich durch Abgleiten en bloc vom Gebirgsmassiv entlang E-W-gerichteter Trennflaechen abgeloest haben.

Weitere Indizien fuer unsere Annahme, dass die grossen Hoehlensysteme am Dachstein-Nordrand in engster Beziehung zur Morphologie und zum tektonischen Muster stehen, sehen wir in den aktuellen Entwaesserungsverhaeltnissen (vgl. dazu Referat 'Speleologie und Entwaesserung eines nordalpinen Karststockes'),und darin, dass die Hoehlen nur geringtief in den Gebirgsstock hineinreichen. So betragen die mittleren, kuerzesten Entfernungen Hoehle - Erdoberflaeche nur 200 bis 300 m.



h: kürzeste (Schräg-)Distanz Höhle – Erdoberfläche interpoliert nach beigefügtem Schema
a: Überdeckung (aus Karte)
b: Horizontaldistanz zur nächstgelegenen Höhenkote (aus Karte)
c: aus (a) und (b) gemäß obiger Zeichnung interpolierte Erdoberfläche
+ Werte aus Mammuthöhle
• Werte aus Hirlatzhöhle

Abb. 6 Verhältnis Überdeckung zu Tagferne der Hohlenräume von Hirlatz- und Mammuthöhle.

SPELEOLOGY IN KOREA WITH SPECIAL REFERENCE TO BIOLOGICAL SURVEYS

LEE BYUNG-HOON

1. History and Current Activities.

Korean caves are mainly located in limestone areas in mid-eastern part of the peninsula as well as in the southernmost volcanic island, Jeju-do(Fig.1).

The first record of Korean caves,however,can be found from Mori's report (Mori,1930) who investigated Dongryong-gul cave,now in North Korea, in 1929. For cave organisms, meanwhile, it is with a Diplopodan arthropod, Antrokoreana gracilipes Verhoeff,1938 that was known first from Korean caves and in 1938 Sato surveyed Dongryong-gul cave and collected an Amphipod, Pseudocrangonyx asiaticus, (Sato,1939). It was not until 1966, however, that more knowledge of cave organisms came to light by Koreo-Japanese joint investigation of 23 caves and 49 wells from South Korea. The survey resulted in 24 papers written by 27 animal taxonomists from 7 different countries, which, eventually, uncovered 101 species, including 56, new to science, and they were all in 71 genera of 50 families in 3 animal phyla.

The joint investigation organized and performed under the leadership of S.-I.Ueno of the National Science Museum of Tokyo made a milestone in Korean biospeology by raising greater interests in cave organisms and subterranean ecosystems in Korea. It was followed by, for instance, a study of a few limestone caves by two Korean biologists resulting in a list of 48 animal species (Choi and Namkung,1966) and in August of the same year the Korean Caving Association was founded which certainly was the first organization ever created for cave study and preservation in the country. Two years later, in 1968, the Association made a survey of 13 lava caves in Jeju-do island and published 49 animal species as the first record from lava caves of the country (Korean Caving Association, 1970). Afterward, Lee, the present writer, as member of cave survey team of the National Science Museum of Korea, published five species of springtails, including one new to science, from 7 limestone caves, with a list of 92 Korean caves (Lee,1974). In 1975 the Korean Association for Conservation of Caverns (KACC), formerly the Korean Caving Association, carried out a survey of the limestone area and listed about 30 animal species from each cave (KACC,1975). In the meantime, however, the Cave Exploration Club of Dongguk University, founded in 1970, was known to have reported 66 species of 15 animal orders from more than 150 caves in the country (DUCEC, 1975-1976). Later again KACC undertook an investigation of Seongryu-gul cave at Uljin in 1977 and, a few years later, Gosudong-gul at Danyang (KACC,1977,1980).

In the meanwhile, the Speleological Society of Korea was founded in 1973, which has been issuing its journal, undertaking a number of exchange visits and surveys with their Japanese colleagues. In parallel with the Society's programs KACC kept making a series of efforts of survey of some important caves designated as natural monuments of the country (KACC, 1979a), that is, for Baegryong-gul, Nam-gul and Nodong-gul caves (KACC, 1979b,1980).

Fig. 1. Principal localities of Korean caves. (G:Gun meaning county)

On the other hand, upon the invitation of the International Union of Speleology (IUS) the present writer made an application for membership to IUS and, in 1977, at the 8th International Congress of Speleology in Sheffield, England, the Republic of Korea was affiliated to the Union by the approval of the General Assembly. In connection with this international effort of developing cave science it may be worth mentioning that a seminar was organized during the 16th Pacific Science Congress in Seoul in 1987 with the title of "Research and Preservation of Subterranean Ecosystem". It was represented by speakers of IUS and four different countries; Austria, Japan, New Zealand and Korea, and held open under the joint auspices of the Korean Society of Systematic Zoology and Section J-1 (Insect Taxonomy) of the Congress (XVI Pacific Science Congress,1987). At domestic level, meanwhile, the Kangweon National University Cave Investigation Club (KNUCIC) was established in September 1987 for exploring and studying caves and issued its first annual report in 1989 (KNUCIC,1989). Some recent developments, moreover, in cave study may deserve our attention. They are surveys by two provincial governments, Samcheog-gun County of Kangweon-do Province and Jeju-do Province. The former Province, embodying major limestone areas of the country, launched a survey of Daei-ri cave system, giving a list of 54 animal species from six caves of the area concerned (Samcheog-gun, 1987), whereas the latter undertook a general study of Bilemod dong-gul, a lava cave system, enumerating 18 animal species in 14 families of 5 classes (Jeju-do,1989), in addition to a variety of geological details respectively.

As recently as early August,1989, "The Korean Society for the Study of Subterranean Ecosystem" was established and it nominated the present writer as national delegate representing anew the Republic of Korea to the International Union of Speleology.

The above accounts describe only cave surverys by organizations or institutes. There have been, however, cave surveys carried out on individual basis, and, for cave organisms, they are as follows: opiliones (Suzuki, 1966), spiders (Paik and Namkung,1967), Galloisiana (Namkung, 1974a,b, 1982, 1986), springtails (Lee and Park,1986; Lee and Thibaud,1987), bats (Oh,1977; Park and Won,1978; Oh,1979; Oh and Kang,1979; Kang et al,1985; Oh,1985; Park,1988) and microfungi (Min, 1980, 1988). Some ecological as well as environmental observations were also made (Lee and Namkung,1971; Im,1975a,b; Oh,1979; Im,1980; Im,1983). Recently Namkung published a work entitled "The Limestone Caves and Their Fauna in Kangwon-do Province" in which he enlisted 141 animal species in 30 orders from 9 classes (Namkung,1987). On the other hand Yoon drew special attention by dealing with pollution of cave inhabiting bats by organochlorine compounds (Yoon,1987). In connection with bat study reproductive biology by histological approaches (Oh,1979, 1985) as well as chromosomal and faunal studies were also made (Park and Won,1978; Park,1988).

As regards geological studies of caves efforts were made mainly by Suh(Suh, 1966), Hong(1976), Kim(Kim, 1977, 1982), Suh(Suh, 1983), Woo and Won(1989) among others. Cave photography,on the other hand,has also been actively pursued by Suk and dramatically materialized with the publication of "Korean Caves" with commentaries by M.S.Suh and J.Namkung(Suk,1987).

2. Inventory of Korean Cave Animals

Now we list the Korean cave fauna as follows. Picking out the data for the list from numerous publications a stict policy of taking only those with references was adopted because only they are likely to imply the author's responsibility as well as reliability of the data. The year of nomenclature following the scientific names were not given but for species recently described.

2.1. Platyhelminthes

From this phylum is known only Turbellaria from Korean caves and they are Dugesia japonica Ichikawa et Kawakatsu,1964, and Phagocata sp. of Planariidae and Sphalloplana coreana Kawakatsu et Kim, 1967 of Kenkiidae. They were collected from Gwaneum-gul and Hwanseon-gul caves. S.coreana is considered troglobiont, being blind and milky white in body color while the former two may be troglophiles, having been found also outside caves. The occurrence of this genus in Korea, having been so far known only from North America and Siberian Altai should be the first record for the Far-East.

2.2. Arthropoda

Class Crustacea

Subclass Ostracoda

Order Podocopa

The Korean forms so far collected are identified to be Candona morimotoi McKenzie,1972 Cypridopsis coreana coreana McKenzie,1972 with triangular shell in addition to a third form, Cypridopsis coreana elongata McKenzie,1972 with elongate triangular shell,all from limestone caves,located near each other in three different provinces in contact. So far the group Cypridae , to which the above three forms belong, are known to normally inhabit subterranean waters and characterized by transparent shell, as well as blindness. This family is hitherto reported only from North Amreica, Europe and Japan. It certainly is too early to outline a general picture of its Korean fauna due to poor knowledge yet available of their distribution in the country.

Subclass Copepoda

Order Harpacticoida

The Korean subterranean Copepods include 6 species in 5 genera of Canthocamptidae; Canthocamptus morimotoi Miura,1969, Bryocamptus zschokkei(Schmeil), B.minutus Claus, Attheyella coreana Miura,1969, Gulcamptus uenoi Miura,1969 and Epactophanes richardi Mrazek, as well as Parastenocaris nipponensis Chappuis of the family Parastenocaridae. They are from 9 limestone caves in the mid-eastern part of the peninsula. Three species of the former family were found new to science and also deficeint of nauplius eyes (Miura,1969). The one in the latter family was collected from an artificial well and is somewhat amazing by having so far been known only from Japan. The

Harpacticoids from Korea, therefore, numbers 7 species in 6 genera.

Subclass Malacostraca
Order Bathynellacea

From 5 Korean limestone caves and 4 wells were collected 6 species and subspecies in 3 genera, all of them as new to science. They are Bathynella uenoi Morimoto,1970; B.minuta Morimoto,1970, B.fodinarum Morimoto,1970, Bathynella rufa Morimoto,1970, Allobathynella coreana Morimoto,1970 (Family Bathynellidae), and Parabathynella gracillima natuda Morimoto,1970 (Parabathynellidae). These new taxa have increased its number of species in the family from 15 , all from Japanese archipelogoes, to 21 in the Far-East. The six species are all lacking eyes and among them the first three Bathynella species comprise part of B.morimotoi group in Japan and it is the case with remaining three in which Allobathynella coreana, B.rufa are all allied to a Japanese species and furthermore Parabathynella g. m. has its nominal subspecies in Japan too. All these data are highly suggestive of their quite close relationship to Japanese fauna, which should give clues to origin and dispersion of actual forms in Japan.

Order Isopoda

We have so far 4 species of either Parasellidae or Asellidae of the Suborder Asellota, collected from Korean caves and wells. The three speces of Parasellidae includes Mackinia troglodytes Matsumoto,1957, M.coreanus Matsumoto,1967, and M.japonica dilatata, all with elongate body and antennae but without pigment and eyes, being considered, therefore, troglobionts. Only the first one ,however, was collected from limestone caves and the remaining two as well as a fourth species of Asellidae, Asellus hilgenforfii Bovallius, certainly a troglophile, were collected from wells in Daegu, Daejeon and Seoul.

It may be noted that the genus Mackinia had contained only one species from Japan until the survey in 1966 in Korea made some new additions.

Order Amphipoda

The Korean fauna of this group is represented by Gammaridae including Psuedocrangonyx asiaticus Ueno,1934, P.coreanus Ueno,1966, and Gammarus pulex sobaegensis Ueno,1966. They are all from a number of limestone caves and wells (Ueno,M.,1966). Of these P.asiaticus should be monumental being the first cave organism ever recorded from korean caves. This species and P.coreanus are blind and considered troglobiont. As regards G.pulex which, with its body color, is certainly a troglophile, its variation in different regions in Korea were intensively studied by Kim and Lee with specimens from montane streams (Kim and Lee,1977; Lee and Kim,1980). On the other hand, one of the typical cave forms in Central Europe, Niphargus, has never been located from the Far-East.

Class Diplopoda

The Korean forms are restricted to Orders Polydesmoidea and Juliformia, represented by 6 species: Oxidus gracilis Koch (Stronglysomidae), Epanerchodus kimi Murakami et Paik,1968, E.bifidus Takakuwa,1954, E.clavisetosus Murakami et Paik,1968 (Polydesmidae) (Order Polydesmoidea) and Skleroprotopus laticoxalis longus Murakami et Paik,1968 and Antrokoreana gracilipes Verhoeff (Murakami and Paik,1968).

It is quite intriguing from evolutionary point of view that troglobiontic Skleroprotopus and Antrokoreana are restricted to limestone caves in the peninsula whereas Epanerchodus, a troglophile, are observed only from lava caves of Jeju island.

Class Chilopoda

This group from Korean caves includes Scolioplanes maritimus japonicus Verhoeff (Geophilidae, Order Geophilomorpha), Esatigmatobius longicornis Takakuwa (Henicopidae, Order Lithobiomorpha) and Thereuonema hilgendorfi Verhoeff (Scutigeridae, Order Scutigeomorpha). It is only E.longicornis that is considered troglobiont being light in color and blind although absence of eyes are common characteristics of Lithobiomorpha (Murakami and Paik,1968). It may be noted that Chilopoda rarely evolved cave adapted forms throughout the world.

Calss Arachnida
Order Pseudoscorpionida

This group is known to have evolved many cave forms, and among about 2000 species over the world approximately one sixth is from caves , most of them belonging to Suborders Chthoniinea and Neobisiinea (Vandel,1964).

First finding of Pseudoscorpiones from Korea was with the collection of 3 species in 2 genera from 5 caves by 1966 survey (Morikawa,1970) and Allochthonius dentifer Morikawa,1970 is blind whereas A.opticus coreanus of the same family, Chthoniidae, is with 4 eyes. In addition, the Korean collection of the genus Allochthonius was the first record outside Japan which is the type locality of the genus. In view of wide distribution of A.opticus in Japan the Korean form A.opticus coreanus may also have spread over the country (Morikawa,1970). The remaining one species is Neobisium magnum chejuense Morikawa,1970 of Neobisiidae with 4 eyes , which was found from lava caves in Jeju island whereas the former two were from limestone caves in the peninsula.

Order Opilionida

This group from Korean caves contains 4 species with 2 subspecies in 4 genera which fall into 3 families. They are Kaolinonychus coreanus coreanus (Suzuki,1966), K.c.longipes (Suzuki,1966) of Triaenonychidae, and Sabacon habei Suzuki,1965, Ischyropsalis coreana Suzuki,1966 of Ischyropsalididae and Opilio pentaspinulatus Suzuki of Phalangiidae. All the first three species are from limestone caves while the last one is from lava caves in Jeju island. Kaolinonychus is remarkable by being unique to Korea. Furthermore its Family, Triaenonychdae to which it belongs with 4 additional genera from Japan had previously been known only from Africa, North America, Australia and Southern Pacific. Its occurrence from the Far-East, Japan and Korea, therefore, should comprise a disjunct group and may be worth studying from biogeographical and evolutionary point of view.

Order Araneae

Spiders from Korean caves were recorded first with 2 species (Choi and Namkung,1966), then another 2 species (Paik and Namkung,1967) and later 19 species of 9 families (Paik et al.,1969) with additional 2 species (Paik and Namkung,1971), which numbers in total 21 species in 10 families. Among these troglobionts are restricted to 5 species of Leptonetidae and there are another 5 species only from caves, which enumerates 10 as cave forms and ,therefore, about half the total 21 speceis on record. It must be quite interesting to see that troglobiontic Leptoneta species are restricted to limestone areas and have never been located from lava caves of Jeju island.

Spiders from Korean caves are listed as follows.

Leptonetidae - Leptoneta coreana Paik et Namkung,1969; L.hogyegulensis Paik et Namkung,1969; L.soryongensis Paik et Namkung,1969; L.yongdamgulensis Paik et Namkung,1969; L.simbogulensis Paik,1971
Theridiidae - Theridion tepidariorum Koch
Nestiscidae - Nesticus coreanus Paik et Namkung,1969 ;N.quelpartensis Paik et Namkung,1969
Linyphiidae - Lepthyphantes cavernicola Paik et Yaginuma,1969; L.nasus Paik,1965; Nengea coreana Paik et Yaginuma,1969
Micryphantidae - Jacksonella sexoculata Paik et Yaginuma,1969
Pholcidae - Pholcus crypticolens Boesenberg et Strand
Argiopidae - Neta menardi(Latreille)
Argyronetidae - Dolichocybaeus whanseunensis (Paik et Namkung,1967)
Agelenidae - Cybaeus mosanensis Paik et Namkung,1967; Blabomma uenoi Paik et Yaginuma,1969; Cicurina japonica (Simon); Coelotes coreanus Paik et Yaginuma,1969; Coelotes songminjae Paik et Yaginuma,1969
Symphytognathidae - Conoculus simboggulensis Paik,1971

Order Acari

Mites from Korean caves numbers 5 species of 4 families. The first record was made from Kosi-gul cave in limestone area and were Epidamaeus uenoi Aoki,1966 and Damaeus coreanus Aoki,1966. They are found as fungivores from rotten legs, not considered, therefore, cave adapted. They may be meaningful, however, in that Damaeidae, represented by the two species, are first record for the Far-East and also the first Suborder Cryptostigmata for Korea. Further collection involved Berlesiana uenoi Ishikawa,1968 of Epicriidae, Rhagidia longisensilla Shiba,1969 (Rhagiidae) and Soldamellonyx chappuisi Walter of Halacridae which is from subterranean waters and considered only troglobiont among the Korean collections (Imamura,1968).

Class Insecta
Order Protura

Little is known of Protura from Korean caves except Nipponentomon nippon (Yoshii,1933) from Kosi-gul cave in limestone area of the peninsula. This species was also collected later from forest soils of North Korea (Imadate,1973; Imadate and Szeptycki,1976). The South Korean specimens are considered trogloxene having been located from entrance of the cave as was the case with most "cave specimens" of Protura elsewhere, from France, Thailand and Japan for instance.

Order Collembola

Collembola from Korean caves numbers 22 species in 8 families and among them 14 species were described as new to science (Yoshii,1966; Lee,1974,1984,1986). The most cave adapted forms are Tomocerus gul Yoshii,1966 and Anurida plurichaetotica Yoshii,1966 which are completely blind. In addition, Tomocerus vigintiferispina Lee,1974 and Arrhopalites gul Yoshii,1966 are quite suggestive of strong cave adaptation in view of either very long setae or elongate claw and ocelli reduction in number. Far more extreme case, however, is found from Gulgastrura reticulosa Yoshii,1966 described as new genus from Kosi-gul cave, and later found also from Sanhodong-gul cave from the limestone areas. It reveals a complete loss of the 3rd antennal organ, ocelli and postantennal organ which most other Collembola do possess as typical sensory organs. On the other side of this regression, however, this species is exceptional by having developed an "apical organ" on antennal tip. All these remarkable character states led the present writer to check their temperature resistance and moulting cycle. The intermounting period determined was about 110 days which is almost twice as long as in other cave forms on record (Lee and Thibaud, 1987). It is suggested,therfore,that G. reticulosa deserves to be ranked to a new family in view of its extreme divergence as underlied by its overall character changes in morphology and biology.

The Collembola from Korean caves are as listed below.

Hypogastruridae - Gulgastrura reticulosa Yoshii,1966
Neanuridae - Micranurida pygmaea (Borner); Anurida plurichaetotica Yoshii,1966; A. plurichaetotica decipiens Yoshii,1966
Onychiuridae - Onychiurus uenoi Yoshii,1966; O. brevispinatus Yoshii,1965; O.izuruensis Yoshii,1966; O.flavescens Kinoshita; O.yongyeonensis Yoshii,1966; O.polychaetosus Lee et Park,1986; O.longisetosus Lee et Park,1986; O.oblongatus Lee et Park,1986
Isotomidae - Folsomia candida (Willea)
Entomobryidae - Sinella dubiosa Yoshii
Oncopoduridae - Oncopodura gul Yoshii,1966
Tomoceridae - Tomocerus gul Yoshii,1966; T.leei Yoshii,1966; T.diversispinus Yoshii,1966; T. vicinus Yoshii,1966; T.vigintiferispina Lee,1975; T.kinoshitai Yoshii
Sminthurididae - Arrhopalites gul Yoshii,1966

Order Orthoptera

This group from Korean caves are represented only by Rhaphidophoridae of the Suborder Grylloacridoidea, including Diestraumena japonica Blatchley, Tachycines coreanus Yamasaki,1969 and T.uenoi Yamasaki,1969, the last two as new to science while the first one as new record for Korea, which, all with developed eyes, however, are considered troglophiles.

Order Notoptera

As one of the most typical relictual insects this order, in Korea, is represented by Galloisiana biryongensis Namkung,1974, G.kosuensis Namkung,1974 and G.magnus Namkung,1986, all from limestone caves of the country.

Order Coleoptera

Cave forms are generally found from only two Suborders, Caraboidea and Staphylinoidea and this is the case with Korean cave beetles too, all from limestone areas. A specis of Ptinoidea, Psudeurostus hilleri (Reuter) is trogloxene, collected from a lava cave.

Here Caraboidea is represented by tribe Trechini of Trechidae, containing one Trechus and 4 Karasawatrechus species. The last four species are lacking eyes, wings and body pigments and comprise a monophyletic group with those in Japan after their authors.

Another Suborder Staphylinoidea contains Catopidae, Staphlinidae and Corylophidae. Of Catopidae only Bathiscinae is known to produce troglobionts. Since all members of the Subfamily are lacking wings and body pigments and even epigean forms often are blind they are considered preadapted already for cave life (Vandel, 1964). The Korean cave species Coreobathyscia marks the first Bathiscinae member ever found outside caves of Mediterranean area. (Szymczakowski,1975).

As for Staphlinidae only two species were identified from limestone areas and we have two additional undetermined genera (Watanabe,1969). Staphylinidae are rarely found from caves and are considered trogloxenes. Another species belonging to genus Lewisium ,Corylophidae, is also collected from a limestone cave whereas a Pseudurostus species; Ptinidae was discovered from a lava cave in Jeju island, which certainly is a trogloxene.

Cave beetles from Korea are as follows.

Suborder Caraboidea
Trechidae, Trechinae-Trechini - Trechus ephippiatus Bates; Kurasawatrechus glabratus Ueno et Namkung,1968; K.latio Ueno et Namkung,1980; K.longipes Ueno et Namkung,1968; K.setiger Ueno et Namkung,1968
Suborder Staphylinoidea
Catopidae, Bathysciinae - Coreobathyscia solivaga Szymczakowski,1975
Staphylinidae - Psephidonus lestevoides (Sharp)
Paraleaster coreanus Watanabe,1969
Corylophidae - Lewisium japonicum Matthew
Suborder Ptinoidea
Ptinidae - Pseudeurostus hilleri (Reitter)

Order Diptera

We have only 3 species of pupiparous Calyptrate Dipterans: Brachytarsina kanoi Maa,1967 (Streblidae) as parasite of bat, Rhinolophus ferroequinum korai and R.f.quelpartis, Nycteribia uenoi Maa,1968 (Nycteribiidae) from a Myotis sp. and Nycteribia pleuralis Maa,1968 from Myotis mattereri amurensis.

2.3. Vertebrata

Class Mammalia

Order Chiroptera

Korean bats include 22 species of 3 families and those from caves are but 9 species, 5 genera in 2 families (Kim,1967; Imaizumi and Yoshiyuki, 1969; Park and Won,1978; Park,1988). They are as follows.

Family Rhinolophidae - Rhinolophus ferrum-equinum koreni Kuroda

Family Vespertilionidae - Myotis daubentonii ussuruensis Ognev; M.mattereri amurensis Ognev; M. formosus tsuensis Kuroda; M. macrodactylus Temminck; Eptesicus serotinus pallens Miller; Plecotus auritus ognoi Imaizumi and Yoshiyuki, 1969; Murina leucogaster intermedia Mori.

3. General Review and Future Needs of Korean Biospeology

Putting all the above accounts together in taxonomical terms they can be enlisted into 118 species in 55 families of 7 animal classes (Tab.1). Out of them 64 species are considered troblobionts, hence, about 54%, and arthropods amounts to 108 species, 93%, of which Araneae and Collembola being predominant by enumerating about 20 species (20%) each. Among the taxa of more than 10 species uncovered the ratio of cave adapted forms (troglobionts) to whole number of each taxon from caves were the highest in Araneae and Collembola with 48% and 77% respectively.

It should be too early, of course, to pursue a general picture of Korean cave fauna. Several points, however, can be made clear from the data avaialbe so far. A remarkable disjunctness of some groups are noticed, for instance, in some Turbellaria, Opilionida and Bathyscinii of Coleoptera. In addition, Korean cave animals shows an endemicity of 62% on the whole. Even stronger endemicity was revealed with Kaolinoy of Opilionida and Gulgastrura of Collembola, which genera were new to science when described and still remain unique to Korea.

In the light of status knowledge of Korean fauna it may be emphasized that more informations should be made avaialble through intensive study of cave organisms in terms of diversity and distribution in particular. It is surprising that we are still totally lacking informations of many important cave organisms like Protozoans, Nematodes, Annelids, Gastropods, Decapods, Tichopters, Pisces and so on. Soley on the basis of detailed faunistic background will it be made possible to trace the dispersion routes, their evolutionary process and characterize the fauna in the North-East Asia. In order to achieve this goal, however, more supporting evidences should be provided, in addition to basic morphology, from physiology, genetics, behavior and other biological disciplines, in relation to geocorphogenetic process and biotic community outside caves.

Table 1. Status of Subterranean Fauna of Korea

TAXA/CATG.	Class	Fam.	Gen.	Sp.	Ssp.	Tb.	Sp.n.	Ssp.n.	Edm.Sp.
PLATYHELMINTHES									
Turbellaria	1	2	2	2		1	1		1
ARTHROPODA	5								
Ostracoda		1	2	3	2	2	1	2	1
Copepoda		2	6	7		6	3		3
Bathynellacea		2	3	6	1	6	5	1	5
Isopoda		2	2	4	1	3	2	1	2
Amphipoda		1	2	3	1	2	1	1	1
Diplopoda		3	4	6	1	2	3	1	3
Chilopoda		3	3	3	1				
Pseudoscorpionida		2	2	3	2	1	2	1	2
Opilionida		3	4	5	2	1	1	2	1
Araneae		10	14	21		10	17		17
Acarina		4	5	5		2	3		3
Protura		1	1	1					
Collembola		8	9	22	1	17	15	1	15
Orthoptera		2	3	6		5	5		5
Coleoptera		5	7	10		6	6		6
Diptera		2	2	3			2		2
VERTEBRATA	1								
Chiroptera		2	5	8	6			3	
TOTAL	7	55	76	118	18	64	67	13	67

Abbrv.: Tb.:Troglobiont, Edm.Sp.; Endemic Species

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THEORETICAL INVESTIGATION OF THE DEVELOPMENT OF SPHEROIDAL NICHES OF THERMAL WATER ORIGIN - SECOND APPROXIMATION

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The development thermal spheroidal niches by condanse water corrosion was first suggested by Müller /1974/ and he alsó provided a qualitative description for cavity formation. A nuverical analysis of the growth rates of niches was performed by Szunyogh /1982/ and he arrived at a relationship for the reaming ofalready formed spheroidal cavities in function of the physical and chemical parameters of the enclosing rock, the carbon-dioxide content of cave air and temperature of the thermal-water lake. Fubsequently - on the basis of the results - a discussion followed on the issue whether the cavities formed from steam precipitation above water table or by other mechanisms below water table. Among others, it was undecided whether the sphere is really the 'ideal shape' of condense water precipitation /Müller, 1974/ and what steps its evolution from a chimney reaching up in the ceiling fllows.

In the present paper our intention was to set up a system of equations which provides approximate numerical answers to the questions. To this end /in second approximation/ we studied a model not restricted to cases of spherical symmetry. In the first approximation /Szunyogh, 1982/ the rate of enlargement depended on the CO_2 content of air only to a small extent /by cube-root/ and was slow /5 to 20 μm per year/ as the poor thermal conductivity reduces the rate of condensation. These support the assumption that the growth of the spheroidal niche is primarily controlled by heat distraction by the rock. In this second approximation this factor is regarded fundamental and convection in cave air is assumed to ensure permanent vapour and carbondioxide contents over the niche surface. /At present it is not possible to decide to what extent this simplification modifies the conclusions from the second approximation/.

Analysing the equations several, so far unknown properties of condense-water-corrosion cavity formation can be ravealed and expressed in numerical forms.

The 'ideal shape' was determined and its 'stability' examinde. The niche shape is considered ideal if formed without the influence of other factors /air current, rock inhomogeneity, intermittent inundation, erosion, temperature anomalies and others/ by condense water corrosion. In reality this situation is rather uncommon, but this gives tne 'skeleton' of any cavity formed by condense-water corrosion. Comparing the ideal shape with the actual shape of spheroidal niches, the issues of the above debate can be settled.

The 'stability' of the niche shape means whether a small disturbance in cave shape is reduced or even more accentuated during further solution.

Mathematically the problem can be grasped as a function of niche surface, which satisfies /with the related physical properties/ the laws of conservation of mass and energy and of thermal conduction, vapour precipitation energetics and the equations for the hydrocarbon dissolution of limestone. Although in a general case the sought surface is not a mathematical sphere, below we retain the concept of spheroidal niche.

PHYSICAL FOUNDATIONS OF CAVITY FORMATION

Let us assume that a small chimney /crack/ stretches upwars from the cave ceiling, filled in by vapour of T_o temperature.

Air heats the rock and therefore the previousiy parallel isotherms in the latter become denser above the chimney and sparser in the vicinity of the entrance /Fig.1/. Thus the thermal gradient varies from place to place. In a time unit the amount of heat released from the precipitation of water on the cavity surface can be conducted by the rock. As the heat conducted in time unit is proportionate to the thermal gradient, condensation becomes different in the different parts of the chimney. The water in contact with the rock bevomes aggressive through the influence of carbon-dioxide in the air. But the amount of dissolved $CaCO_3$ is proportional to the amount of water precipitated and consequently the rate of corrosion is also different in the different points of the cavity. In the upper part enlargement is more rapid, while near the chimney entrance /where the rock is heated and thermal gradient is reduced/ it is slowed down. This explains /with other agents - see Müller, 1974/ why spheroidal niches narrow down at bottom. As the niche broadens and changes its shape, isotherm surfaces are also distorted. This process involves the gradual alteration of the rate of corrosion in space and time. Consequently, the growth of the condense-water corrosion cavity is primariliy controlled by the interactions of the momentary niche shape and temperature distribution within the rock.

In the calculations the simplifying assumption was made that the seepage of the fluid film is slow enough to allow the saturation of the solution with $CaCO_3$ ea pr ci-itation. The rheological problems of precipitated water were also neglected, although they influence the mechanism of enlargement, but - in our opinion - do not modify the above picture fundamentally.

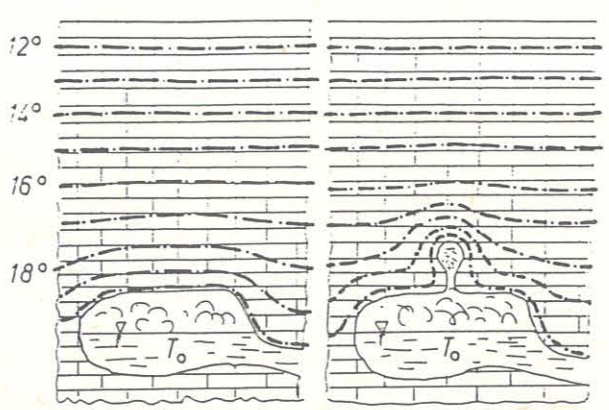

Fig. 1 Isotherms in the rock over cave chambers with smooth seiling /a/ and one with chimney /b/. T_o is lake water temperature

EQUATION SYSTEM FOR THE SHAPE OF SPHEROIDAL NICHES

The formation of the spheroidal niche was examined in spherical coordinate system /Fig. 2/. The orige is found at height H above the niche entrance. The location of any point P of the rock is determined by the distance τ from the origo /o/ and the angle ϑ of the straight line to the origo to the vertical. We assume cylindrical symmetry, but the conclusions are also valid for the case without symmetry. Niche surface is described by the function.

$$R = R(\vartheta, t)$$

where R is the radius drawn to any point of the surface,
ϑ is polar angle and
t is time.

For the time being $R(\vartheta,t)$ is unknown and our task is to construct its differential equation and its solution.

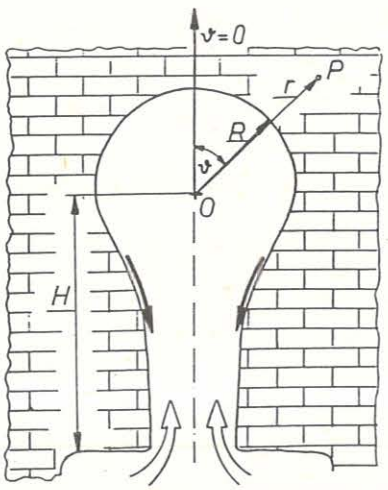

Fig. 2 Position of the coordinate system for describing the surface of the spheroidal niche

View a point Q is any ϑ direction in the niche /Fig. 3/. Its distance from the origo at t time is $R(\vartheta,t)$, growing by dR through solution during time dt /very short time/. Let us mark in environment Q a small surface element of dA area. During dt time water of mass dm_v precipitates and it dis solves a rock mass dm_k. The dissolved rock was removed from a prism/hachured in Fig. 3/ with ground area dA, heigh db and volume $dA \cdot db$. It can be seen from Fig 3 that

$$db = \cos\alpha \cdot dR,$$

where α is the angle between the normal $\vec{n}$ and radius R . Knowing the density ϱ_k of the rock / ϱ_k =2600

kg per m^3/:

$$dm_k = \varrho_k \cdot dA \cdot \cos\alpha \cdot dR. \qquad /1/$$

The mass of rock removed in solution is proportionate to the mass of solvent. After Ernst /1961/:

$$dm_k = \sqrt[3]{k \cdot p}\, dm_v \qquad /2/$$

where p is partial pressure of CO_2 in air,
k is coefficient /$0.748 \cdot 10^{-9}$ litre per bar at 20°C/ for $CaCO_3$ solubility /Jakucs, 1971/,

The mass of condensed water can also be estimated energetically:

$$\delta Q = L \cdot dm_v \qquad /3/$$

where δQ is heat released during condensation,
L is condensation heat of water /$2{\cdot}45 \cdot 10^6$ Joule per kg at 20°C/.

Passing over dA surface, δQ dissipates in the rock. According to the rules of heat conductivity and the conservation of energy:

$$\delta Q = -\lambda \cdot grad T \cdot \vec{n} \cdot dA \cdot dt, \qquad /4/$$

where λ is heat conductivity coefficient for limestone

/2-3 J per °K.m.s/,

T is rock temperature,
$\vec{n}$ is normal to the surface at point Q.
$grad T$ is temperature gradient at cavity surface.

Since cavity surface is isohermal, it is elementary to prove that

$$grad T \cdot \vec{n} = \cos\alpha \cdot (1 + tg^2\alpha) \cdot \frac{\partial T}{\partial \tau}\Big|_{\tau=R} \qquad /5/$$

Eliminating the variables dm_v, dm_k and δQ from the equations /1/-/5/

$$dR = \lambda \frac{\sqrt[3]{kp}}{\varrho_k L} (1 + tg^2\alpha) \cdot \frac{\partial T}{\partial \tau}\Big|_{\tau=R} dt \qquad /6/$$

is obtained for the dR enlargement of the surface point of the spheroidal niche in ϑ direction in dt time. dR can be produced

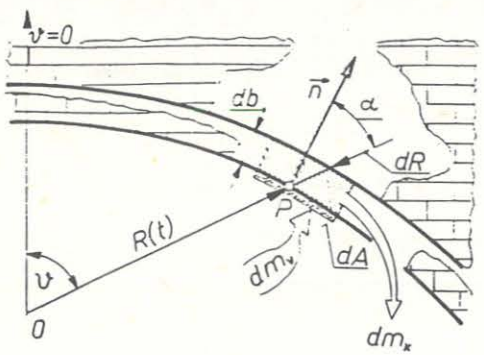

Fig. 3 Geometry of the dissolved elementary rock volume

ad partial derivate of R by t :

$$dR = \frac{\partial R}{\partial t} dt$$

According to differential geometrical formulae

$$tg\alpha = \frac{1}{R} \cdot \frac{\partial R}{\partial \vartheta}$$

So finally the $R(\vartheta,t)$ function for the surface of the spheroidal niche is determined by the non-linear, simple, partial differential equation

$$\frac{\partial R}{\partial t} = \lambda \cdot \frac{\sqrt[3]{k\,p}}{\varrho_k L} \left[1 + \frac{1}{R^2}\left(\frac{\partial R}{\partial \vartheta}\right)^2\right] \cdot \frac{\partial T}{\partial \tau}\Big|_{\tau=R} \qquad /7/$$

For the solution the initial shape of the niche /i.e. the quation of the chimney reaching up to the ceiling/ has to be known:

$$R(\vartheta,t)\Big|_{t=0} = R_0(t), \qquad /8/$$

as well as the distribution of temperature $T(\tau,\vartheta,t)$ around the cavity. This being a quasistationary process, temperature can be determined from the $\Delta t = 0$ heat conductivity differential equation, which has the following form in our case:

$$\frac{\partial}{\partial \tau}\left[\tau^2 \frac{\partial T}{\partial \tau} + \frac{1}{\sin\vartheta} \cdot \frac{\partial}{\partial \vartheta}\left(\sin\vartheta \cdot \frac{\partial T}{\partial \vartheta}\right)\right] = 0. \qquad /9/$$

The solution of /9/ is made unambiguous by the marginal conditions

$$T(\tau,\vartheta,t) = T_0 \qquad \tau = R(\vartheta,t), \qquad /10/$$

$$T(\tau,\vartheta,t) = T_k - (T_0 - T_k) \cdot \cos\vartheta \cdot \frac{\tau}{H} \quad \text{if} \quad \tau \to \infty \qquad /11/$$

as well as the initial condition

$$T(\tau,\vartheta,t) = f(\tau,\vartheta), \quad \text{if} \quad t = 0. \qquad /12/$$

/10/ expresses that on niche surface temperature is always T_0. The conditon /11/ shows that moving away from the niche temperature gradually declines towards open air /see Fig. 1a/. T_k is rock temperature at origo height. In /12/ $f(\tau,\vartheta)$ is rock temperature in the moment of cavity formation.

/7/ and /9/ are special mathematical marginal conditions, where the margin has a prescribed temperature, but changes its shape in proportion to the value of thermal gradient on the margin. The /7/ and /9/ system of equations cannot be analytically solved at random initial conditions. In some special case /dilatation of crack into a series of spheroidal niches; enlargement of niches of slightliy different shape from sphere/, however, it can be tackled without the application of advanced computer hardware.

MATHEMATICAL SIMULATION OF THE FORMATION OF SPHEROIDAL NICHE SERIES

If from the cave lake a long, narrow crack reaches up into the ceiling, no separate spheroidal niche forms, but a series of communicating niches develops /Müller 1974/. This development is shown in equation /9/, only temperature has to be determined from the planar $\Delta T = 0$ equation. This latter condition allowed the application of the so-called 'gum ,pdeá', through which the equation $\Delta T = 0$ can be solved under any marginal condition.

In Fig. 4 the changes of the cross-section of a H =70 cm high, 15 cm wide crack are shown in 5000-year intervals. In the model CO_2 content of air is 8 per cent /p=0.08 bar/, cave lake temperature is T_0 =20° m. It is seen that the section of the crack is first drop-shaped and enlarging the vault becoms a regular semicircle. The lower part of the cavity broadens at a slow rate.

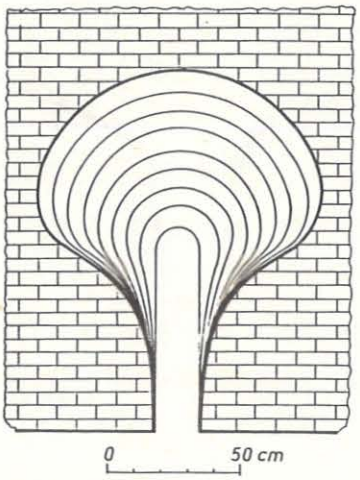

Fig. 4 Stages of broadening of a crack during dissolution /interval: 5.000 years/

Further growth does not modify proportions. It is stated that the 'ideal shape' is composed of a narrow entrance section, of walls broadening is a funnel shape and of a regularly semicircular vault. The central point of the semicircle is rising in the first 20.000 years, but then the process stops and only the radius increases. Under the same conditions the rate of enlargement is presented by Fig. 5 with the difference that the rock is considered aisotropic: in vertical direction heat conduction and dissolution parameters are different from the horizontal /which is characteristic of limestones/. It is visible that the vault of the entrance is not circular but regular ellipse.

With a slight intervention into the 'operation' ot the hypothetical model, let us suppose that 30.000 years after the start of corrosion a rock slab of 8 times 15 cm size is detached from the ceiling /Fig. 5b/. The mechanism of further enlargement becomes suddenly different. From the scar a niche of 40 cm diameter is produced remarkably repidly /within 10.000 years/ and it keeps on broadening. At the same time the rate of solution is reduced on the ceiling of the original passage.

After another 15.000 years in our model we assume another event of rock removal on the left wall of the passage /Fig 5c/. Niche development begins immediately and asymmetrically. The explanation lies in the fact that the rock body between the two cavities has heated up, its heat distracting capacity has been reduced and consequently condensation has stopped on the side of the niches close to each other. On the other hand, on the outer side the developing cavities press the isotherms together, thermal gradient increases there and condensation may accelerate. It seems if the spherical niches would 'repel' each other.

In 60.000 years the original crack develops into a flat, 2-m wide and 70-cm passage, a 'keyhole' of rather irregular shape. From its ceiling series of also irregular, elliptically vaulted spheroidal niches reach up to 0.3-0.6 m.

INSTABILITY OF THE SHAPE OF SPHEROIDAL NICHES

Let the vault of a cavity be a sphere of R_0 radius in good approximation /Fig.6/. The deviation from the sphere shape (ΔR) is littre compared to R_0 but changes from place to place in the function of ϑ

$$R(\vartheta,t) = R_0(t) + \Delta R(\vartheta,t) \qquad /13/$$

ΔR can be produced from the linear combination of sinal waves:

$$\Delta R = \sum_{n=0}^{\infty} \varepsilon_n(t) \cdot P_n(\cos\vartheta), \qquad /14/$$

where $P_n(\cos\vartheta)$ is an n -order sphere function,
$\varepsilon_n(t)$ is the amplitude of the n -order wave.

Let us examine with the help of the equation system /7/-/9/whether these waves smoot or increase in their amplitude after condence-water corrosion begins.

As it is known /Frank-Mieses, 1966/ the solution of the heat conduction differential equation /9/ can be arrived at by sphere function:

$$T(\tau,\vartheta,t) = T_k - (T_0 - T_k)\cos\vartheta \cdot \frac{\tau}{H} + \sum_{n=0}^{\infty} \frac{a_n(t)}{\tau^{n+1}} P_n(\cos\vartheta). \qquad /15/$$

The coefficients $a_n(t)$ are to be determined that the value at niche surface ($\tau = R$) should be T_0 simultaneously satisfying /7/. R taken from /13/ into the equations /7/ and /15/ - with regard to conditions /10/ and /14/ and taking advantage of $\Delta R \ll R_0$ and $\tau \ll H$ introducing: $\kappa = \lambda \frac{\sqrt[3]{k\,p}}{\varrho_k L}$

and finally the linear equation system

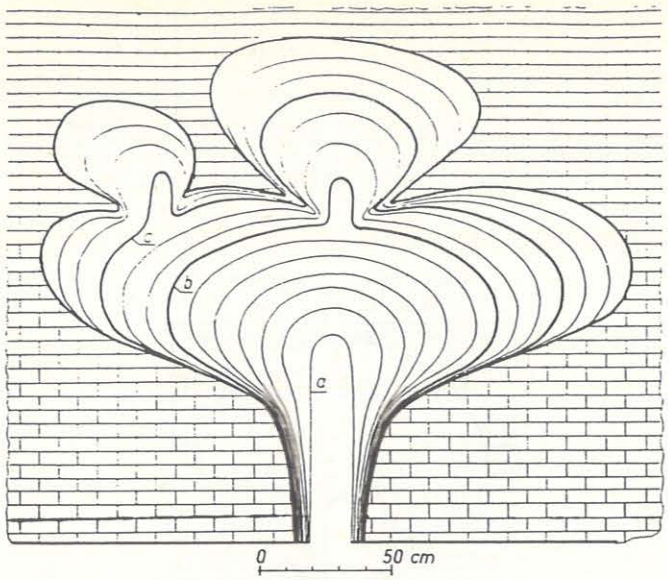

Fig. 5 Changes of the cross-section of a crack in anisotropic rock /interval: 5.000 years/

a. undisturbed growth
b. impact of a small detachment on further growth
c. interactions of two simultaneously developing chimneys

$$\begin{cases} \left[a_0 - (T_o - T_k)\cdot R_o^3 \right] + \sum_{n=1}^{\infty} \left[\frac{a_n}{R_o^n} - (T_o - T_k)\cdot \varepsilon_n \right] \cdot P_n(\cos\vartheta) = 0 \\ \left[\frac{dR}{dt} - K\,\frac{a_0}{R_o^2} \right] + \sum_{n=1}^{\infty} \left[\frac{d\varepsilon_n}{dt} - K\cdot \frac{a_n}{R_o^{n+1}} \right] \cdot P_n(\cos\vartheta) = 0 \end{cases}$$

is achieved. In the case of any ϑ the two equations can only be fulfilled if each of the quantities in brackets equals zero. Each gives a separate differential equation for $R_o(t)$ and $\varepsilon_n(t)$ resp.:

$$\begin{cases} \frac{dR_o}{dt} = K\,\frac{T_o - T_k}{R_o} & /18/ \\ \frac{d\varepsilon_n}{dt} = (n+1)\cdot K\cdot \frac{T_o - T_k}{R_o^2}\,\varepsilon_n & /19/ \end{cases}$$

Solving /18/ for $R_o(t)$ the enlargement of the regular sphere is arrived at /Szunyogh, 1982/:

$$R_o(t) = \sqrt{R_o^2(0) + 2K\cdot(T_o - T_k)\cdot t} \qquad /20/$$

And /19/ results in this solution:

$$\varepsilon_n(t) = \varepsilon_n(0)\cdot \left[1 + 2\,\frac{K}{R_o^2(0)}\,(T_o - T_k)\cdot t \right]^{\frac{n+1}{2}} \qquad /21/$$

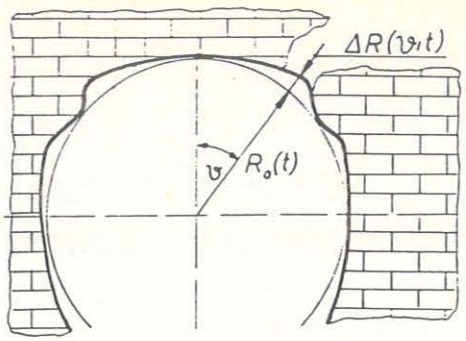

Fig. 6 Dimensions of a niche slightly deviating from spherical shape /marks/

Here $R_o(0)$ is the radius of the spheroidal niche in the t=0 moment and $\varepsilon_n(0)$ is the initial amplitude of wave n. According to /20/ the 'medial radius' of the spheroidal niche increases at an ever slower rate in time by a square-root function /Szunyogh, 1982/. /21/ on the other hand shows that the amplitudes of the sinal waves causing the deviation from the spherical shape grow at an ever growing speed by function with indices 1, 1.5, 2, 2.5 etc. Even if the deviation ΔR from spherical symmetry is small in the beginning it becomes larger with time. /Only in the case of a spherical vault, it can remain so./
The shape of condense-water corrosion spheroidal niches is unstable. This instability allows the conclusion that bizarre forms of no regularity do not only result from rock inhomogeneity, but they are brought about by the inherent laws of dissolution.
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STABILITY ANALYSIS OF THE ANNA CAVE, LILLAFURED

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The strength of the rock in which the Lillafüred Anna cave was formed is orders of magnitude less than for most of the Hungarian caves. Consequently the disintegration of the surfacee of cave systems is relatively rapid and the alterations are striking even during a human lifetime. The hundreds of cracks on cave walls evoked a feeling of uncertainty in visitors and therefore the Bükk National Park Directorate prohibited public access temporarily and ordered a report from the Central Institute for Mine Development to explore the system of cracks, to reveal the reasons for destruction, to judge the degree of danger and to plan necessary security devices. The investigations led to new results /in knowledge on the hierarchical system of cracks, the distinction between dangerous and non-dangerous cracks and flexible cave security techniques/, unknown to date in the international speleological literature. These are summarized below.

1. ROCK MECHANICAL AND STABILITY STUDIES IN THE ANNA CAVE

Rock mechanics and stability in the Anna cave was studied recently by Majoros /1976/, Lénárt /1981a,b,c, 1986/, Szlabóczky /1987/ and Szenthe /1987/. As the geomorphology and lithology of the cave was described by Lénárt /1981c/ in the 'Karszt és Barlang', only the most important statements are cited here.
The rocks of cave walls fall into three groups:
1. Loose, clayey and silty detritic travertine constitutes the lower parts of halls and artificial passages. Compressive strength: 0.09-0.113 MPa /0.9-1.13 kp per cm^2/.
2. Travertine precipitated on solid, spongy vegetation /e.g. mosses/ forms compact rocks with less hollows in many places. This is the ceiling of chambers and corridors and includes tree-trunk, leaf and root imprints. Strength is 0.514-2.62 MPa /5.41-26.2 kp per cm^2/ internal friction angle 23.7-39.4 degrees.
3. The third rock type is represented by dripstones precipitated from the water which soaked the tufa series subsequently. Spelecthems take the forms of stalactites and spheroids of hard and rigid rock.
The rock mechanics of the cave is influenced by the fact the tufa hill where the cave formed was reshaped into a cone with steep slopes by the incision of the Szinva and Garadna valleys. Consequently the stability of the travertine series accumulated on the sloping /dolomite/ bedrock was reduced and - as my observations show - slowly slides towards the valley floor.
In 1976 the cave surface was thoroughly examined by members of the Marcel Loubens Cave Exploration Group and the debris,aesthetically valueless but dangerous for collapse, was removed /Majoros 1976/. It is worth noting that when checking the cave five years later /Lénárt 1981a/ again large amounts of debris had to be removed. This proves that cave destruction is continuous.
The explanation for cracking and collapsing differs with the authors. Lénárt /1981b/ sees the main reason for destruction in recent movements and in thermal expansion and contraction caused by the unregulated hydrological conditions of the hanging gardens above the cave. In the opinion of Szlabóczky /1987/ the tufa hill cracked as a response to a stress above the elasticity limit of the rock. Szlaboczky presumes that this stress was seismic induced by a block of several hundred tonnes detsched from the waterfall channal in autumn, 1985. Szenthe /1987/ explains cave destruction with the gradual collapse of drainage ditches below the level of present floor and the resulting weakening of rock pillars.
Lénárt /1981b/ and Szenthe /1987/ call attention to the existance of where - due to the irregular shape of the cave - tension is concentrated /indetectable by calculations/ and local failure may occur.
Below a conclusion drawn from on-site observation is presented, a uniform mechanism capable of explaining any failure in the cave and of designing the most efficient security measures.
The observations and measurements were made from August 3 to October 20. 1987. taking 41 shifts underground /Szunyogh 1987/.

2. THE HIERARCHY OF CRACKS AND FAILURE MECHANISM

The cracks in the Anna cave can be referred into three groups by their size, age and origin:
- major /primary/ cracks /5/
- secondary cracks /42/
- local /tertiary/ cracks /204/.

The large cracks cross the whole rock series, followed in 20-40 m length, they are subparallel and WNW-ESE striked. They have zig-zag alignments and variable dip /they appear to twist/,the size of cracks in 2-5 m. The blocks on the northern side move away and down from those on the southern. The rate of subsidance ranges from 0 to 15cm. This movement indicates that the tufa hill was dissected by fractures into blocks of 6000 to 8000 tonnes and they are gradually sliding towards the Garadna valley. It is obvious that they slid in the past from displacements along joints. Present movements are also evident from the tight wedging-in of rock fragments in cracks /apparently hindering the motion of large blocks/, their clincking to knocking. In many places they induce fresh failures on the previously intact side of the crack. Another evidence for recent movements is the fresh fractures in the dripstone groups connecting the two walls of large cracks.
The fractures in the Anna cave are first of all manifested in large cracks. The 20-40 m long and 4-6 m wide blocks between these joints are incapable - because of rock heterogeneity and low strength - of uniform movement of a solid body and therefore on the slide towards

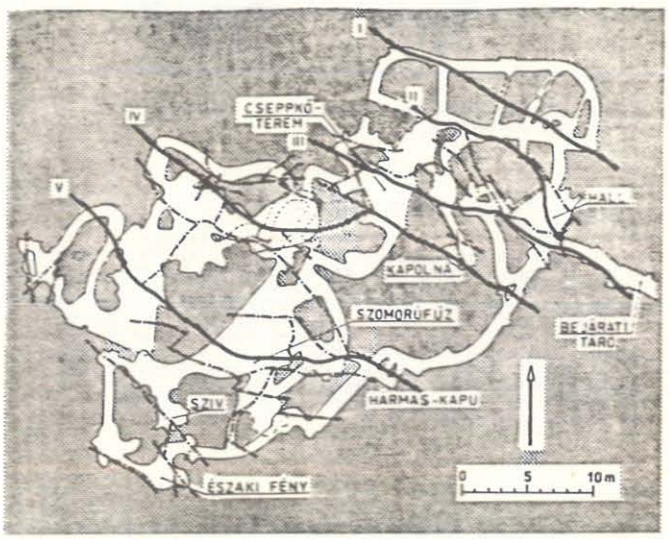

Fig. 1 Map of Anna cav with regional joints marked.
primary cracks
secondary cracks
/The map was drawn by author using maps by L. Lénárt and J. Kárpáti.

the valley they cracked in two or three places. Since these joints could only form after large cracks, they are called sacondary cracks. Each have a fresh surface without dripstone cover and crack size is 0.5-1 cm. Secondary cracks do not cross the whole tufa hill but generally connect two large cracks /see Fig.1 - their length is 5 to 10 m./ Their strike varies between NNW-SSE and NW-SE, so their angle with large cracks is 75- 5 d gr ss.
These two crack types are spread regionally, they extend over a major part of the cave and the same crack can be identified in several cave passages.
The surface of regional cracks is not smooth but rolling /their alignment is zig-zag/ and this displacements press the two walls of cracks locally causing local increase of tension. As a result of this failure rock fragments of various size are detached from the ceilings or walls of passages. This type of failure is of local nature as its extension does not exceed 0.5 to 1 m^3 /maximum 2 m^3/.
A precondition to their formation is that a primary or secondary crack should break the cave surface and thus these local cracks are tertiary in order.
The direction of tertiary cracks is controlled by the opportunities for movement of blocks and the geometry of passage surface. Because of the variable cave forms no unified system can caracteries it. Consequently, no rule can be discovered in the alinment of local cracks.
As it will be shown below, in oder to judge the degree of danger presented by a crack, it has to be referred into one of the three types.
The types of cracks outlined so far all formed in the upper part of the cave /in tufa/. But the movement along regional cracks also affects the stream accumulations at the bottom of passages and produces plastic deformations. This is evidenced by the system of aliding lines on the passage wall.

3. DANGEROUS AND NON-DANGEROUS CRACKS

The primary and secondary cracks are not usually dangerous in themselves since the size of blocks bordered by them is much greater than the cave hollows and in some points each block retains its support. The fact that such a crack is observed on the ceiling of one of the corridors or small chambers only means that two independent rock parts meet there.
Regional cracks could only cause collapses above large chambers, where the large open space allows a block to remain without any support and its balance is only maintained by friction /Cseppkő-terem, Hall/. Collapse danger is primarily due to tertiary local cracks as their size is much smaller than the cave hollows /bulk 0.5-50 kg/ and therefore falls may occur.
Primary and secondary cracks have to be detected, since the dangerous tertiary cracks develop along these. Local failures are favoured by rock inhomogeneities /dripstone crusts, tufa and stream deposits with highly differing properties/. Speleothems /in the vicinity of regional joints/ are particularly hazardous

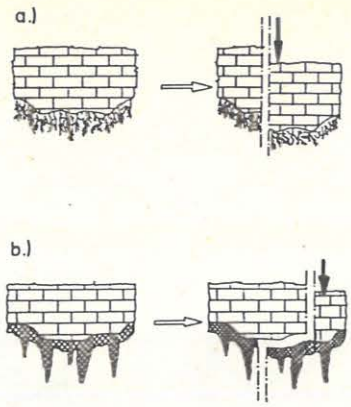

Fig. 2 Way of failure for rock surfaces crusted by tufa /a/ and dripstone/b/

as shown in Figures 2 and 3.
Fig. 2/a illustrates that on the surface of the passage affected by regional cracking and covered by tufa deposits the formations rifted along the joint, because their strength is low and equals to that of the enclosing tufa. If, however, the regional crack affects a dripstone cover /Fig. 2/b/, the rigid cover peels off the soft travertine and breaks at the weakest point /andnot along the line of the joint/. It is characteristic especially of the environs of the Cseppko-terem /Dripstone Chamber/ that the crust detacned over large surfaces /responds to knooking with a hollow sound/. Due to further novaments along regional cracks the detached dripstone plates may clinch and break.
Another type of tertiary joints affecting dripstone groups is observed in the Chapel /Fig. 3/. Here flowstones cover both the

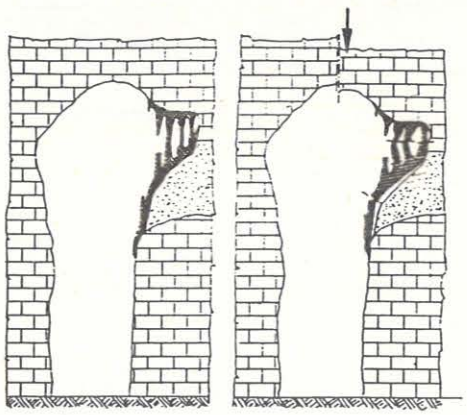

Fig. 3 The impact of displacements along joints on the passage wall crusted by dripstone

travertine and the passage wall of stream deposit /Fi. 3/a/. After the crack crossing the chamber formed and its N part subsided /right side of the figure/, the stream deposit of low strength was compressed /avoiding pressure/ and compressive tension increased in the dripstone crust. The rigid, crystalline dripstone could not resist this pressure and dulging out, it was detached from the rock /Fig. 3/b/ and the columns on the bent dripstone crust were crushed. Subsidiary tensions along primary joints resulted in the fracturing of the column of Hármas-kapu /Triple Gate/ /Fig.4/. The macrojoint no V cut the enclosing rock into two above the S end of the W column /Fig. 1/ and as a consequence the left pillar in Fig. 4 began to sink. Where the capital of the column rubbed against the right-side rock wall, an intricate network of tertiary cracks developed.
The destruction caused by regional joints is the largest where they only marginally affect the passage wall. On the W side of the Sziv-terem /Heart Chamber/ the secondary crack no V/5, for instance /Fig.1/, produced seven local cracks.
An example of collapse hazard directly resulting from regional joints /as opposed to tertiary ones/ is the Hall, where the ceiling is affected by two macrojoints and three secondary cracks. The primary cracks are dilated to 10-15 cm and consequently the vault effect is uncertain. The balance of the ceiling is ensured by surface roughness and friction. The danger of accidents is high since any fragment falling out from the vault max cause the cave-in of the whole chamber.

4. STABILITY OF THE SZOMORUFÜZ /WEEPING HILLOW/

The stability of the formation Szomorufüz has been studied for several years /Majoros 1976, Lénárt 1981, Szlabóczky 1987 and others/ but the reasons for its failure, the explanation of its

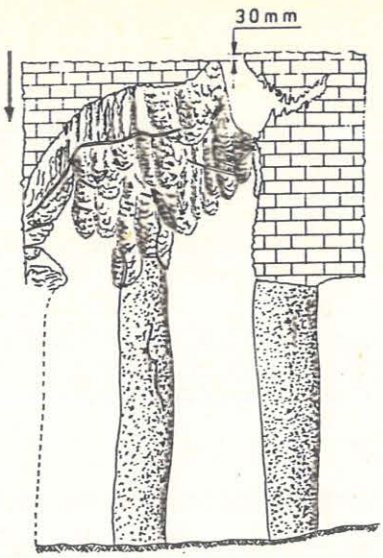

Fig. 4 Cracks in the formations above the pillars of the Hármaskapu

present balance cannot be revealed without analysing the hierarchy of cracks.
The Szomorufüz is a ca 2 m diameter dripstone balsony stretching out from the passage wall /Fig. 5/, cut through by a primary /no V/ and a secondary /V/2/ and 16 tertiary cracks.
Studying this formation the joints seem to be chaotic in arrangement, without any system. However, this is not the case.
The mapping of joints, the survey of the rate and direction of displacements allowed the reconstruction of the failures and the movements of fragments in the formation.

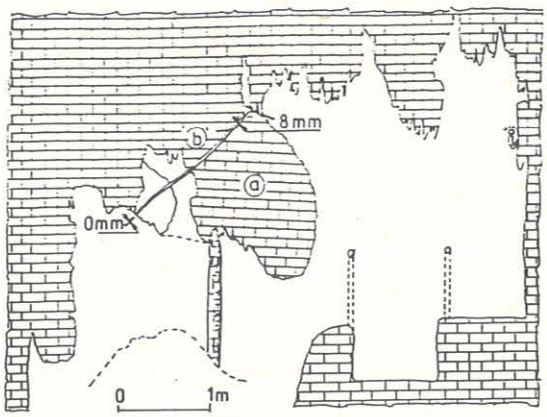

Fig. 5 Cracks in the Szomorufüz in E-W section

The spatial arrangement of joints and the mechanism of the novements of fragments can only be described if detaile ara neglected and the form is substituted by a body of simpler geotmetry /Fig. 6/. Thus the Szomorufüz is a horizontal cylinder with rounded end from the S /closer to the Reader/ side of which a slab is removed. Failure resulted from the location of macrojoint no V above it. The sinking of the rock wall to the N exerted a downward force /F_1 in Fig. 7/ and this force broke the Szomorufüz into three prieces. The fragments and the bordering cracks of the 'foliage' are shown in Fig. 7 /displacement are exaggerated/.

To the effect of the pressure along macrojoint V the block marked a in Figs 5 and 7 sank along the crack 1. At the rounded end this subsidence is 8 mm and it decreases gradually towards the site where console is fixed.
The block a dragged block c along and the letter was detached from intact rock along joints 2 and 3 and sank ca 7 mm. Only rock block b remained in place and functions as a stable console stretching out towards the chamber.
During subsidence, block a was pressed to a dripstone balcony E of the foliage and an F_2 force /Fig.7/ was generated. As a result, when sinking block a was forced to slide towards c. Since block c cannot move to W /it is supported by the SW wall of the chamber/, block a slid along the oblique joint 4.
Fig. 7 shows that block a is left without any support and fixed only by horizontal forces /of vault effect/. Since macrojoint V /which generated the fractures of the Hármas-kapu is active, it is expected that block a would sink further as it is in unstable

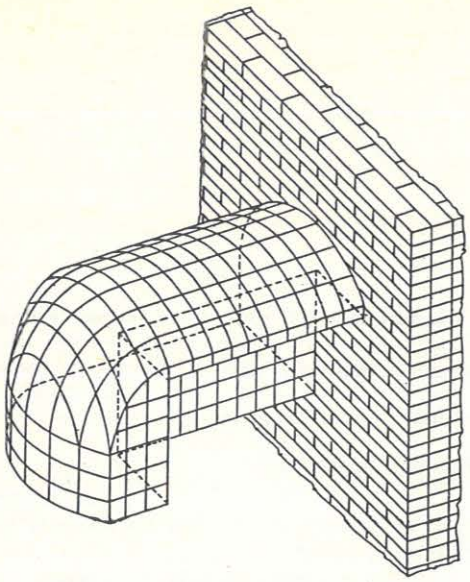

Fig. 6 A schematic aconometric representation of the foliage of the Szomorufüz from the upper pavement

position. /The 14 other cracks, which affect the foliage of the Szomorufüz, do not fundamentally modify this picture of failure. Their role is evaluated in detail by Szunyoghy /1987/.

5. VIEWPOINTS FOR SECURING THE CAVE CEILING

The revealed hierarchy of cracks and the distinguished dangerous and non-dangerous cracks called for special security devices different from the usual practice. The basic principles are the following:

1. The movementsalong regional joints occur today and in the future and there is no way to stop them. The forces which are keeping rock blocks of several tonne bulk bordered by primary cracks in motion and cause the further /secondary/ fragmentation of these blocks cannot be counterbalanced by a security system adjusted to cave size. Consequently, the injection of regional cracks the cementation of the cracked tufa hill and the restoration of the original situation of intact rock is not necessary and even harmful as in the place of the eliminated cracks new ones develop elsewhere.
2. If - due to a local crack - a rock fragment is in contact with both walls of a regional crack, the rock fragment should be fixed allowing a small space for novement. If it is not ensured, it would not be able to avoid movement along the regional joint and further cracks would be generated in it.

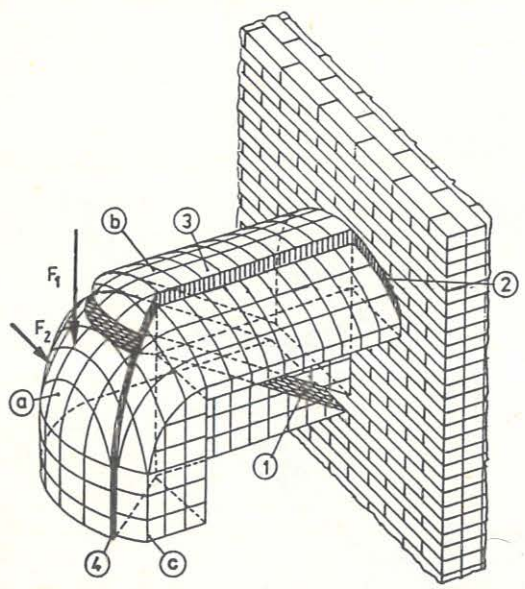

Fig. 7 The main cracks across the foliage of the Szomorufüz and the displacements of the resulting blocks

3. For each local failure it should be examined whather the forces generating the cracks are still active. It the broken fragment is still under the tension of regional jointing, further movement has to be expected and a security measure capable of vielding has to be applied. This yielding may mean only some millimetres since movements are slow /hundredthsof millimetre per year/.

4. Where the fragments of the ceiling affected by regional joints form a vault, the gaps between fragments should be filled with an elastic filling material /e.g. plastic foam/, which has a lower strength than neighbouring rocks. This ensures contact over a large surface between the elements of the vault and also to limited space for movement along regional joints is preserved.

5. Cave conservation necessitates that cracked and collapsing formations should not be removed, but stabilized by hidden devices.

Fig. 8 Yielding securing of detached dripstone by rock anchor

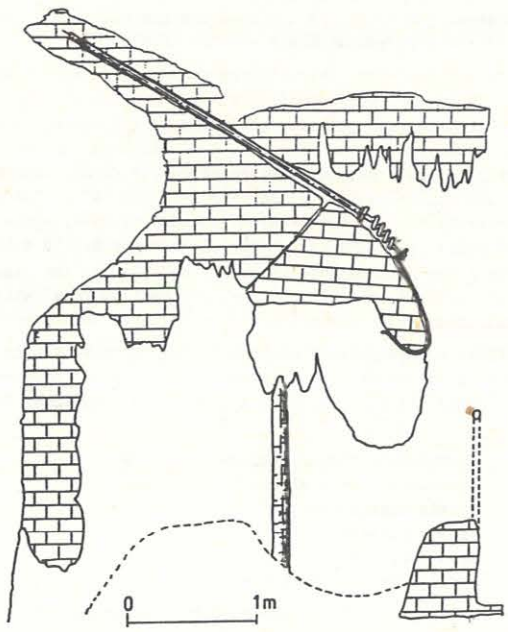

Fig. 9 Securing the foliage of the Szomorufüz with yielding rock anchor of high carrying capacity

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RESULTS OF BAT-REGISTRATION WORKS IN THE PÁL-VÖLGY CAVE

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resume p. 680

The Pál-völgy Cave is one of Budapest's large cave systems of warm water origin. It opens in an old quarry in the 2nd district of the capital on a height of 2o5 m above the sea level. The cave had no natural entrances in the historical times, it was discovered by quarrying in 19o4. A 4oo m section of the system known by a length of 12oo m then was developed as a show-cave already in the twenties. The length of the cave has increased to 7 km as a result of new exploration works started in 198o.

The passages of the labyrinthlike network are mostly high and rather narrow, its largest chambers have a surface of 1o x 3o m. The level of the passages sink gradually to the south, the whole vertical extension of the cave is 1o4 m. Although the system is relatively dry and continous drippings can be found only in some places, the vapour-content of the air is practically 1oo %. The temperature in the deepest section comes up to 13°C, while in the external parts it is characteristically between 8-1o°C during the whole year. The surface above the cave belongs to the inhabited area, the quarry itself is a nature conservation area which is connected to the Buda Landscape Protection Area to the east.

The first investigations on bats living in this cave in winter were carried out by Gy. Topál in the early fifties. Between 1951-1955 he ringed 819 bats in the Old Part known that time. The distribution of the species was the following:

Rhinolophus ferrum-equinum	5
Rhinolophus hipposideros	126
Myotis emarginatus	5
Myotis nattereri	1
Myotis myotis	3
Myotis blythi oxygnathus	679

Our cave researcher group named "Bekey" extended its activity on observation of bats in 1986. This work has two directions: there is an annual registration in the whole system and there is a weekly registration in a certain part of the cave to investigate the temporal trends in the number and in the areal distributions of the animals during their rest period.

Results of the annual registrations

These registrations were carried out every year in the same time, second part of February, by 6-8 teams for the whole system. The results were the following:

	1986	1987	1988	1989
Greater horseshoe	3	5	5	7
Lesser horseshoe	1o3	91	1o7	99
Little Myotis sp.	5	-	2	5
Great Myotis sp.	13	14	1o	22
Total	124	11o	124	133

These data, compared to the former ones show clearly a strong decrease in the number of bats in this cave during the last 3o years. The rate of the decrease is even larger, if we consider, that about 6o % of the individuals registered by us were observed in the new cave sections which had been unknown for men in the fifties. But the decrease is not equal for the various species: while the Myotis oxygnathus species has quite disappeared from this cave, the number of the lesser horseshoes practically hasn't changed, so it has become the dominant species of the cave by now.

These registration which extended to the whole recently known system of 7 km length, show a rather constant areal distribution as well (Figure 1.). The animals can be observed besides the Old

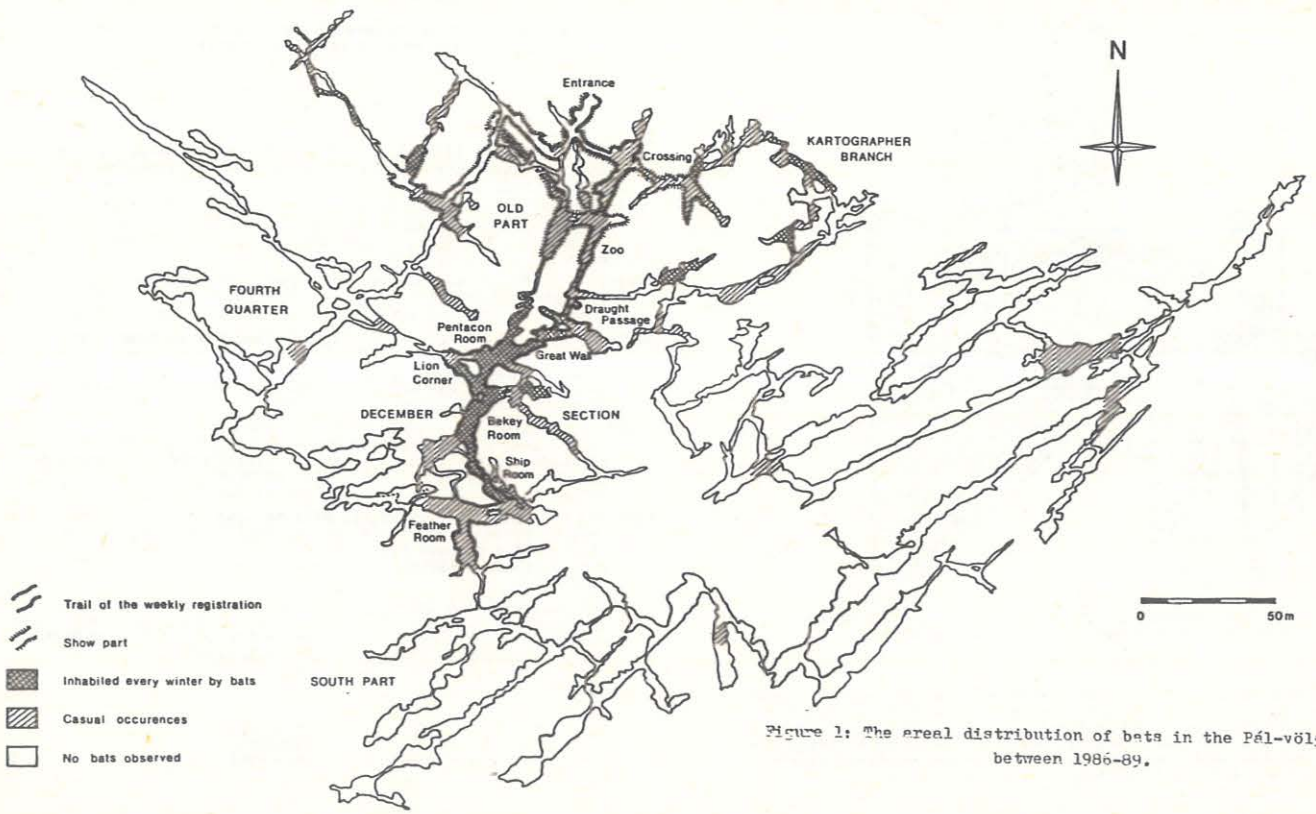

Figure 1: The areal distribution of bats in the Pál-völgy Cave between 1986-89.

Part practically only in the so called December Section - discovered in 1980 - and in the Kartographer Branch - discovered a year later - which are connected to the former one to the south and to the east. That means, that more than the half of the network is not inhabited by bats, although - according to their excrement-finds - they know these parts and had already known them before their explorations. As these cave-sections don't differ much in their character from the inhabited ones and their temperature is higher by 1-2°C at most, we have to suppose that their distance from the entrance can play a role anyhow in this distribution.

Results of the weekly registrations

This work started in February of 1987. The section chosen for this investigation contains some passages and chambers of the Old Part and the December Section. According to the annual registrations, about 40 % of the bat-community of the cave have their rest places in this 350 m long section. The first 80 m of this section belongs to the show part of the cave. Its terminal point is in a depth of 60 m below the entrance level, the temperature here is a constant 10°C.

At this registration the exact place of each individual was marked on prepared maps which contained always the detailed observations of the former week. This way we got data not only about the temporal trend in the number of the animals, but also about the facts of the change of their places.

Comparing the temporal trends in the individual-number of the certain species during this two and a half season (Figure 2.), we see a consistent similarity in time of arrival /end of November/ and departure /after the end of April/ of the little Myotis sp. as well as in time of departure /beginning of April/ of the great Myotis sp. In spite of these, in the case of the lesser horseshoe we observed significant differences between the last and the two former season: the stabilization of their number happened in the autumn of 1988 one month later than in 1987, while the beginning of their mass departure happened this spring one month earlier, than in the two former ones. In this difference we suspect the role of the very mild winter in 1988/89.

Based on temperature-measurings carried out also weekly this winter, we can say that the departure of the animals was not connected with a change of temperature inside the cave. So there is a probability that the surface climatic effects have an influence on the bats by the change of the air current - perhaps this can interpret why they do not inhabit the sections in larger distance from the entrance.

The investigation resulted interesting data about the continuity of the rest period of these species as well. The individuals of the greater horseshoes changed their rest places generally in every 2nd or 3rd week here, we observed only one of them for nine weeks on the same place. The individuals of great Myotis sp. spent generally 3-6 weeks on a certain place. In spite of these the individuals of little Myotis sp. were found on the same points from their arrival till their departure, that means more than 4 months.

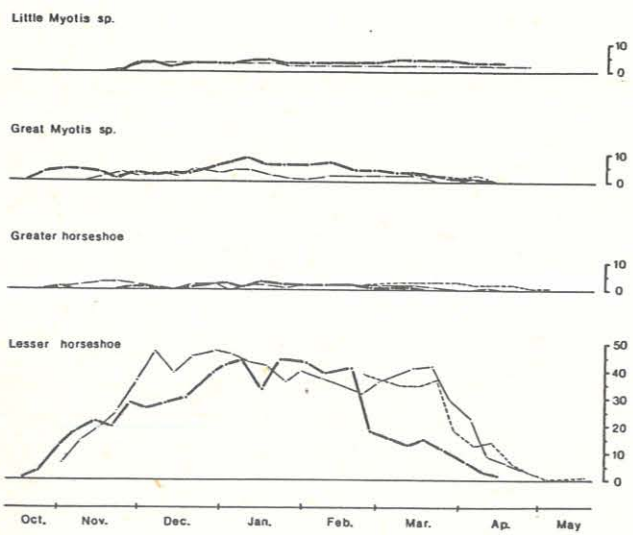

Figure 2: Time distribution of bat species in the Pál-völgy Cave (------ 1986/87, —— 1987/88, ·—— 1988/89.)

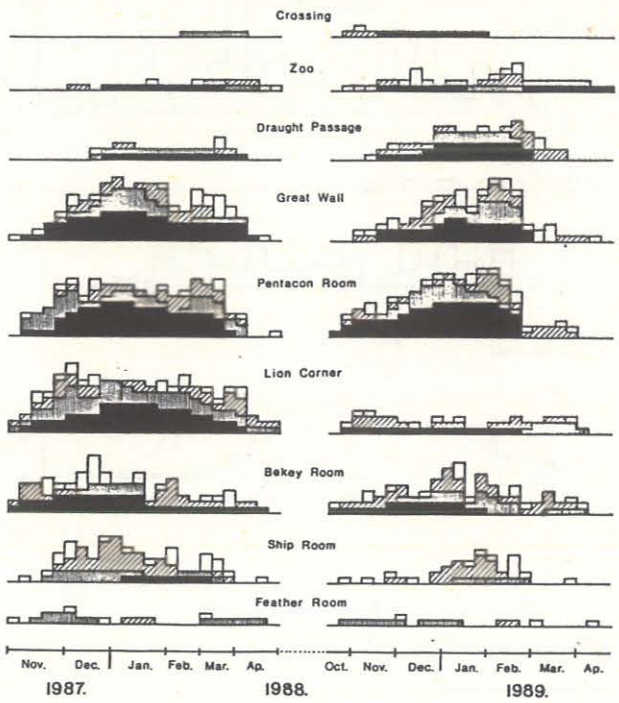

Figure 3: Permanence of the lesser horseshoes' rest in the different cave parts (individuals observed in one case only in a certain place: □ through 2-3 weeks: ▨ through 4-6 weeks: ■ through 7 or more weeks: ■)

The Figure 3. shows the permanence of observations in the case of the lesser horseshoes, divided the data to smaller cave parts. According to this, we can say that only about the half of the individuals were observed for more than 2 months on the same places /22 individuals of the maximal 47 in 1987/88 and 19 individuals of 44 in 1988/89/, while the others changed their places minimum twice even between the end of November and the end of February. It is interesting, that in the deeper parts the number of individuals staying on the same place for less than one month exceeded during both periods the number of those, which spent more time on their places; while in the parts situated nearer to the entrance this rate was contrasted. Comparing the areal distribution in the two seasons, there was a strong swing to the external parts in the last winter, this perhaps can be traced back to its milder climate again.

We observed no connections between the continuity of the rest and the scale of disturbing effects on the certain places. So for instance there was registered a lesser horseshoe for 10 weeks in the show part of the cave illuminated regularly, merely 1 m above the visitors - while many of the casual observations occured in a significant height and distance from the paths in the natural parts as well.

Another interesting observation is, that certain rest places are inhabited in every year again. Among the 22 persistant rest places of 1987/88 and the 20 ones of 1988/89 six places are common, and one of them was surely inhabited in the spring of 1987, too. So some individuals seem to have their "own places" in this cave.

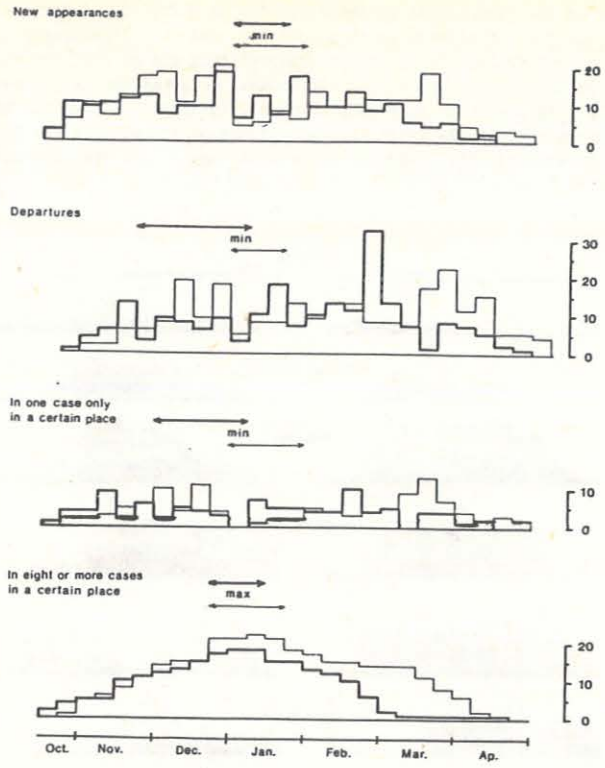

Figure 4: Observations on wakefulness of lesser horseshoes in the Pál-völgy Cave (—— 1987/88, —— 1988/89.)

To answer whether there is a time in the rest period which can be regarded as most restful we analysed the observations on movements of the lesser horseshoes. The graphs of Figure 4. show the temporal trends in the number of those individuals, that appeared on a new place; that left their places; that were observed only one occasion on the certain place; and that stayed more than two months on their places. Although the pairs of graphs proved to be rather different in the two periods, their minimum or maximum intervals fit well to each other. Their coincidence points in both winter to the same time: between end of December and middle of January.

A control registration carried out in the whole cave system at the beginning of January in 1989 seems to prove the result of the analyse. This resulted 156 bats (111 lesser and 6 greater horseshoes, 31 great and 8 little Myotis sp.), what is by 25 % more in average than the data in the Februaries. So this time seems to be more suitable for the annual registrations as well.

The weekly registrations raised some interesting questions and suppositions, but their detailed analyse is beyond of the opportunities of an amateur cave researcher group. To prove the tendentional character of the features observed by us and described above, it would be necessary to continue these kinds of observations here and to extend them to other caves with a similar bat - community. The investigation on the role of the surface climatic effects in the areal distribution of the animals or in their movements inside the cave during the rest period and in their departure in spring, needs more kinds of measurements carried out simultaneously with the weekly registrations. To answer some other questions - like that of the "own places" or whether the same individuals of lesser horseshoes are in a continuous rest year by year - it would be necessary to identify the certain individuals, but we know no method which does not disturb these protected and endangered animals.

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MEASUREMENTS OF ATMOSPHERIC PRESSURE DIFFERENCES IN THE VASS IMRE CAVE

GADOROS, Miklós

Between July 7 and 13, 1989 I took part in the Central Research Camp of the Hungarian Speleological Society and carried out atmospheric pressure difference measurements between outdoors and the Háromszög (Triangle) corridor of the Vass Imre cave. To my knowledge these were the first successful measurements of this kind in the world.

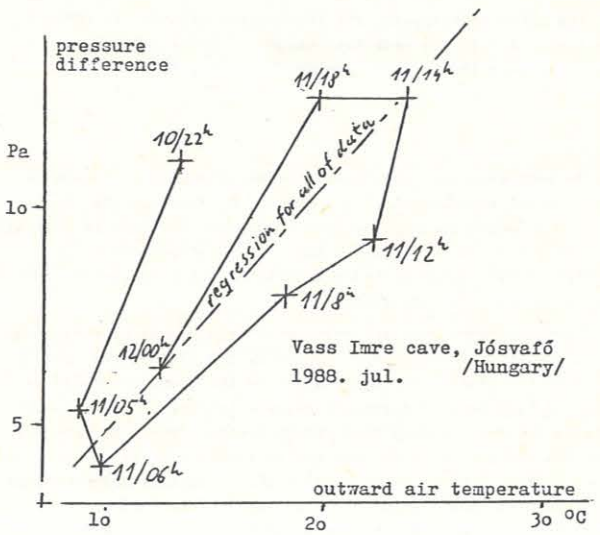
The equipment consisted of a U-pipe manometer of water fill and micrometer needle (constructed by B. Holl) and a thin plastic pipe leading to the surface from the instrument along the cave (installed earlier by the Papp Ferenc Group). The latter conducted ground pressure to one side of the manometer and the other side was influenced freely by atmosperic pressure at the site of measurement. Reading precision was 0.01 mm (in the given arrangement ca 0.2 Pa) and time constant 0.5 sec. As reference temperature the thermometer installed in a standard cottage in the vicinity of the cave entrance was read before and after measurement and the data were interpolated for the measurement date(s). If it was necessary I also studied the curve of the thermograph installed in the thermometer cottage.

In 7 days I performed - disregarding the checking and experimental readings - 38 measurements. A measurement was composed of the average of three readings, but if their range exceeded 0.4 Pa, proportionately more were included. The highest temperature observed was 27.5°C (at 14.40, July 12th) and the lowest 8.3°C (at 5.10, July 11th), the average of temperatures was 17.3°C. The measured lowest pressure difference was 3.4 Pa (5.45, 11th; 8.7°C) and the highest 18.o Pa (14.45, 8th, 26.6°C), the average 9.0 Pa. There was no observable wind in most of the cases. The regression equation of the pressure-temperature relationship (expected errors in brackets) is

$$p\ (\pm 2.0) = -0.68\ (\pm 1.0) + 0.564\ (\pm 0.055).t\ (Pa, {}^{o}C)$$

$$r^2 = 0.74$$

As it is visible, errors are rather high and the correlation is not too strong. One reason for this is explained by the characteristic hysteresis in the attached figure. According to this temperature in the cave is belated to the one at the entrance (valley floor) and by the figure this delay can be estimated at ca 2 hours.



The experiments also showed that no measurable drop in pressure exists at totally open door (by closed door the opening for ventillation is ca 200 cm^2 and there are unstuffed hollows of unknown area). It could not be estimated how much pressure with closed door contributes to total pressure difference (driving force of draught). In theory the measured differences correspond to ca 13 m rock cover.

ON THE IONISATION OF CAVE AIR

GADOROS, Miklós

The paper investigates the interaction between air ionised by radioactivity and negative-charged dripping water-aerosol. It is claimed that - with considerable simplifying conditions - the theoretical model provides an acceptable explanation for the strongly negative unipolarity of ionisation measured in cave air.

As both previous sporadic measurements (by Kessler) and recent serial measurements (by Tardy and Hiros) indicate, cave air is strongly ionised compared to outdoor air and, in contrast to the latter, mostly shows a definite negative ions surplus (unipolarity). Below a theoretical model meant to explain the above phenomena is investigated.

It was assumed that the relatively high degree of ionisation of cave air is predominantly caused by the radioactive radiation deriving from radon and thoron (and the products of its decay) of high concentration. Negative unipolarity is the result of the aerosol deriving from dripping water. When they are formed the drops of hydroaerosol are in their majority of negative unipolarity (Lenard effect). Later these negative aerosol drops interact with positive gas ions and partly neutralised. As a consequence, negative gas ions incapable of recombination remain in surplus.

In our calculations we applied the following simplifying assumptions:

1. Ionising radiation is homogeneous and permanent in time.
2. The amount of aerosol ionised by the radiation is negligible.
3. Aerosol is produced uniformly in space and time.
4. Exclusively negative-charged aerosol is produced.
5. Concentration for both gas ions and aerosol is stable in space and time.
6. Aerosol (electrically charged or neutralised) falls out of air at a stable speed.
7. Surplus negative gas ions are pushed onto the walls by the electric field strength produced by field charge.
8. The probability of neutralisation of a positive gas ion through recombination and by aerosol is proportional to the cross-section of the two types of ions.
9. The cave is assumed to have a spherical cross-section.

Some of the assumptions are rather far removed from reality. Even grave contradictions can be pointed out. If, for instance, aerosol is produced uniformly in space and removed by fall-out, its concentration cannot be homogeneous. However, if it were incorporated into the model, intricate integral equations would result and their outcome would not be correct either. There is no way to model the special pattern of aerosol formation in the manner no characteristic cave cross-section exists.

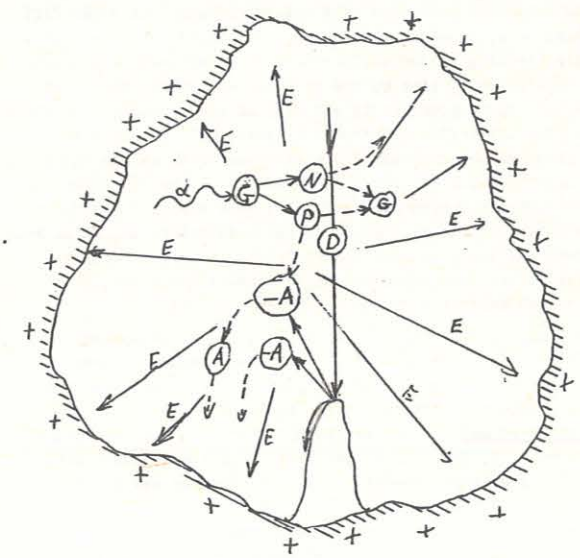
From the above the following equation system follows:

$$S = k.N.P + k.r^2.A.P \qquad (1)$$

$$S = k.P.N + k1.(A+N-P).N \qquad (2)$$

$$Sa = k2.A + k.r^2.A.P \qquad (3)$$

where S is the amount of P,N gas ion pairs formed by ionising radiation in unit volume in unit time,
Sa is the number of aerosols formed in unit volume in unit time,
N,P and A is the concentration of charged particles (ions), resp.,
r is aerosol radius,
k is the probability of gas ion recombination,



1. The mechanism of the cave air ionisation
   α: ionizing particle
   A: aerosol drop
   -A: negative charged aerosol drop /large ion/
   D: water drop
   E: electric field
   G: air molecule /O_2,etc./
   N: negtive charged air molecule /small ion/
   P: positive charged air molecule / -"- /

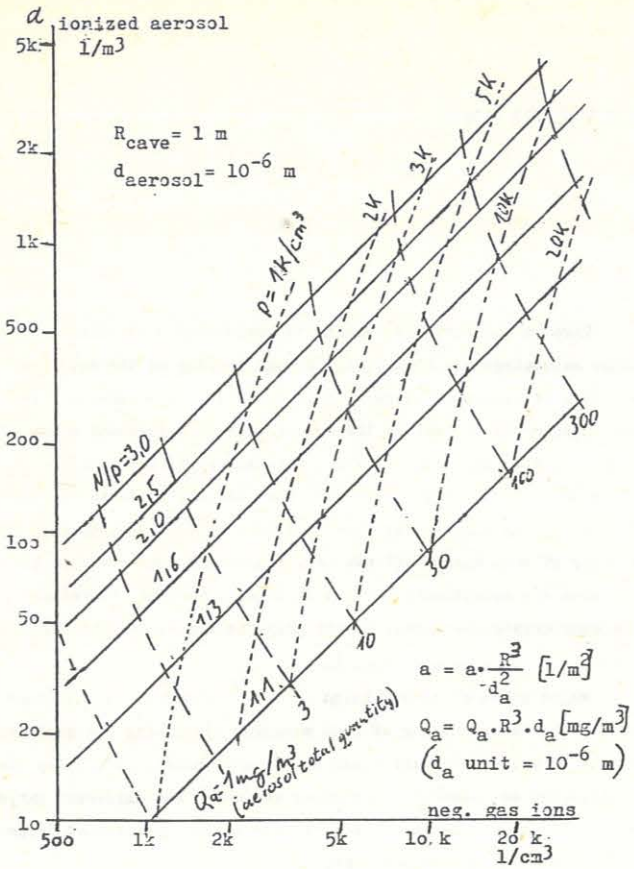
k1 is a characteristic figure for negative gas ion precipitation given the electric field strength generated by the A+N-P filed charge.
k2 is a figure characteristic of aerosol drop fall-out.

As aerosol is assumed to move the same way in both charged and uncharged state, another equation can be written for total aerosol (if only negative-charged aeorosol is regarded):

$$Sa = k2.Ao \qquad (4)$$

where Ao is the permanent concentration of total aerosol formed irrespective of whether it has lost its charge or not.

In reality there are three unknowns: P, N and A. For them the equations (1)-(2)-(3) form an equation system of second degree with three unknowns, which can be solved in knowledge of S, Sa and the constants. The solution, however, is rather complicated and for the necessary Sa an assumption has to be made. There are measured data for N and P (Tardy-Hiros). If the values of S, Sa and A are considered unknown, they can be easily obtained from the linear equation system with three unknowns de-



rived from the rearrangement of the three equations, as shown in the chart attached. This indicated that most of the formed aerosol loses its charge. The amount of total aerosol determined by equation (4) gives a realistic value and generally stays below the assumed 1 gram per m^3 concentration (Gádoros-Cser).

Finally we make the assumption that occasional unipolarity is primarily due to external pollution.

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CONSERVATION PROBLEMS OF THE BULGARIAN CAVE FAUNA

DELTSHEV, Christo D.

The contemporary exploation of caves provides a wide range of human impact. This triggers out a very lot of problems concerning the concervation of their abiotic and biotic content. Cave fauna is no less vulnerable than any other since, some of the aspects of human i pact are reported to affect on the numbers of cave populations or even leading to their extinction.

Turning back through ages we see man seeking shelter and refu ge in caves. Nowadays, caves are rather recreation and tourism ente rprises storage rooms, station aries for wine and cheesing graping mashroom-farming.

Today in Bulgaria there are 9 caves electrificate, Magura, Ledenika, Saeva dupka, Snejanka, Orlova chuka, Bacho Kiro, Yagodinska peshtera, Diavolsko gurlo and Biserna. Here in , we face some of negative influences to the fauna in those caves. At the top of the list we record that Chiropteran population are margind rapidly and when the cave is a small size one and with intensified human encounters an immigration of bats from their underground habitats is observed. This problem has been undergoing a lot of discussions and comments. Invertebrate fauna is threatened to no lesser extend, by human manipulations. Maleffecting their numbers has turned to be the cave routs cementation. The fauna these passages disappeared. Due to modernisation of caves, a common procedure appear to be breaching of artificial galleries, as well as modification of some of the existing ones. This intervention, leads to causistable alterations, concerning the numbers and the diversity of the existing organsms, due to the rapid microclimatic changes.

Thus the tunneling in of a watter supply pipe in Temnata dupka cave near Lakatnik (Sofia distr.), has greatly influences over the climatic conditions in this very part of the cave, therefore at present some of the typical species are not found. Again in the same cave, during the last 10 years, the troglodyte beatle - Pheggomisetes bureschi Knirsch has not been observed, probably due to the numerous and uncontroled visits. The lighting being switches on is another microclimatic conditions modifying factor afflicting the organismic world inhabiting the caves. Some troglo-species require far existance, very narrow microclimatic (temperature, moiture) parameters where as by the slightest clinations, their populations margin. And the intensive spotlight (ihfrared spectrum) reises the temperature, immediately moisture concentration also being affected. This produces a proliferation of moss colonies the latest modifying the underground biotopic conditions, as well as destructurisation of the stalagmyte surface. An indication of which is the fact that man placing himself in caves during the cultivation processes is a highly sophesticaled and delicate assignment, the misproceeding of which may reflect very badly over the quality and the quantity of the cave fauna.

Through the economic aspects of exploitation of caves the negative autcomings are identical. Through keeping of the different varieties of cheese an atypical to troglodity microorganism have been introduced, as well as the cementation of caveground dooms the invertebrate fauna. Wine - keeping activities afflict with no difference. Damage is greatest when fuel and oil products are stored in caves. As a matter of fact it should be mentioned that in the majority of such cases, attemts were unsuccesful and now most of the caves are aboundoned, left to an extend, defaced. Therefore more considerate assessment of all projects are to be undertaken avoiding the occurance of sach cases.

Major point of conservation of the troglofauna is the propositions and the realizing of such measures minimising the negative outcome of the conteporary human breaking in caves. At a prime the institutions and enterprises turning use caves far different purposes are to consider with the strict legislative requirement proposed by Institute of Zoology - BAS.

Herein we would like to draw the attention on the reglamented postulations:

1. In all urbanized caves, certain galleries or cave sections are to be anexed, no lighting equpment instaled, with no access of visitors. Under strict consideration of the se requirement, there will be an considerable improvement of the living conditions for the cave fauna in caves with a illumination equipment.

2. In case of discovering of a cave inhabited by unique relict species, municipial councils, forestry departments should be obliged to frame the cave entrance with iron door-gates.

The schedule and number of scientific excursions in such caves, should be reglamented by BAS authorities.

3. For modernisation and utilisation of caves for economic and various other purposes should be also seeked permision and authorisation by BAS.

4. Banking all improvement and other sort of activities in caves, inhabited by vast Bat colonies.

5. In area of a 10-km diameter around a cave with Bat colonies, numbering of an approximately 5000 individuals the use of insecticids is to be prohibited, for it is affecting the size of the colony.

6. When cases of colection of cave fauna by foreigners have been face the exhibit of an authorisation document issued by the Institute of Zoology - BAS, should be enforced. The activities of Bulgarian amateur biospeleologists, should be also guided and controled by the same institute.

7. Apart from gating the caves, local authorities, forest control officers and Spele-clubs are to be responcible for the protection of the caves in their districts and tresspassers

should be sanctioned according to the invoice of Nature protective legislation.

Development trends of the contemporary human society promoting the increasing technocratisation, industrialisation and chemicalisation over the environment. This afflict upon the number of the fauna in general and to cave fauna in particular.

Jet through the strict consideration of the proposed requirements, the majority of the problems concerning the Conservation of the Bulgarian cave fauna, could be outcome or cast to minimum of the negative impact. Only through a clear programming and complex efforts we will succeed in saving that faunistic treasure, which Bulgarian troglobionts appear to be.

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ORGANIZATION PRINCIPLES OF SALT MINE SPELEOTHERAPY

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The salt mines' and caves' mikroclimate is used broadly for treatment of asthma bronchiale and other lung desease nowadays. It's curative effect is conditioned by the constansy of main environment's indexes, the absense of microbes and other allergens, the presense of biological-active aerosol. Speleotherapy is simple and accesible, it doesn't cause allergical reactions.

The time came to work out a comlex of investigations whith estimate fitness of mines and other underground objects for medicinal aids.

We suggest the research program, which is necessary for appraisal of mines and caves curative opportunites. This program includes 3 groups of problems: mine-geological, medical, oecological.

On the basis of long time exploatation experiences of the republican allergological hospital underground department in Solotvino salt mine and estiniation of anthropogenic chandes, the main measures, which maintain microclimate curative properties and prevent the violations of underground invironment oecology are worked out.

This measures may be used for investigation of speleotherapy objects in salt mines and caves.

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В настоящее время для лечения бронхиальной астмы и других заболеваний органов дыхания широко используется микроклимат соляных шахт и карстовых пещер. Лечебный эффект их обусловлен постоянством основных показателей среды, здесь практически нет микробных и других аллергенов, больные максимально защищены от влияний внешней среды, в воздухе имеется аэрозоль, содержащий биологически активные микроэлементы. Спелеотерапия проста и доступна, не вызывает побочных реакций.

Назрела необходимость в разработке комплекса исследований для оценки пригодности шахтных выработок и других подземных объектов для лечебных целей.

Предлагается программа исследований, необходимых для проведения оценки лечебных возможностей шахт и карстовых пещер. Программа объединяет 3 группы вопросов: горнотехнические, медицинские, экологические.

С учетом опыта длительной эксплуатации подземного отделения республиканской аллергологической больницы в Солотвинских соляных шахтах, оценке антропогенных изменений, разработаны основные мероприятия, позволяющие сохранить лечебные свойства микроклимата и предупредить нарушения экологии подземной среды.

Предлагаемые мероприятия могут использоваться для исследования спелеотерапевтических объектов в соляных шахтах и карстовых пещерах.

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SPELEOTHERAPY AS A METHOD OF ASTHMA BRONCHIALE PROPHYLAXIS

LEMKO, Olga - LEMKO, Ivan

There are 5-I0% of USSR adult population, who suffered from bronchitis chronica in preasthmatic stage nowadays (Г.Б.Федосеев. I983). During 3-5 years the suffocation attacks arise in 40-50% of non-treatment patients and in I8-20% patients, who received preventive treatment(К.М.Минкаилов et al.,I98I; Г.Б.Федосеев et al.,I985).

The aim of research was to define the possibility of speleotherapy employment for prevention of the asthma bronchiale attacks in patiens with chronic bronchitis in preasthmatic stage.

The paper deals with investigation results of 204 such patient's in remote post-treatment period in I,5-3 and more years after speleotherapy. Among them 9 (4,4%) patients were observed during I year after speleotherapy, I06 (5I,9%)- for I,5-2 years, 33 (46,2%) - for 3 years and 56 (27,5%) patients were investigated more than in 3 years after Solotvino salt mine speleotherapy.

Special questionnaires for catamnesis research were worked out. During the observation period the asthma bronchiale attacks arose in 7 (3,4%) patients, which is in 2-3 times rarer as compared with known literary data.

Therefore speleotherapy exerts positive influence for patients in preasthmatic stage and may be used as a method of asthma bronchiale prevention.

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В настоящее время в СССР предастматическими состояниями страдает 5-I0% взрослого населения (Г.Б.Федосеев, I983). Приступы удушья на протяжении 3-5 лет возникают у 40-50% нелеченных больных и в I8-20% случаев при проведении профилактических курсов лечения (К.М.Минкаилов и соавт., I98I; Г.Б.Федосеев и соавт., I985).

Целью исследования свилось определение возможности применения спелеотерапии у больных в предастматической стадии для предотвращения приступов бронхиальной астмы. В работе представлены результаты обследования 204 больных хроническим бронхитом в предастматической стадии в отдаленном периоде через I,5-3 года и более лет после курса спелеотерапии. Из них 9 человек (4,4%) наблюдались в течении I года после спелеотерапии, I06 (5I,9%) - на протяжении I,5-2 лет, 33 (46,2%) до 3 лет и 56 (27,5%) больных обследованы через 3 и более лет после курса лечения в условиях микроклимата соляных шахт.

Для исследования катамнестических данных были разработаны специальные анкеты. За период наблюдения приступы бронхиальной астмы возникли у 7 больных, что составляет 3,4% и в 2-3 раза реже по сравнению с известными литературными данными.

Следовательно, спелеотерапия оказывает положительное влияние на течение предастмы и может применяться как метод профилактики бронхиальной астмы.

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A CONFRONTATION OF SPELEOTHERAPY AND CLIMATOTHERAPY IN SCHOOL-CHILDREN WITH RESPIRATORY ALLERGIES

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"ARE THE EFFECTS OF SPELEOTHERAPY AND THE MERE CLIMATOTHERAPY DIFFERENT? "

To prove the separate influence of speleotherapy is the aim of our paper.

THE SETS OF CHILDREN

	BOYS	GIRLS	MEAN AGE	TOTAL
Speleotherapy group	44	37	10.33 years	81
Controls	56	17	11.34 years	73

Two groups of children suffering from respiratory alergies were followed in this study. One of the group was accomodated in the Medical Institutton with speleotherapy in Ostrov, where speleotherapy was daily applied during the 19 day lasting stays. The control group was accomodated at a camp. Both devices were located in the central part of the Moravian Karst, not far from each other.

THE DIAGNOSES IN THE SETS OF CHILDREN

	SPELEOTHERAPY GROUP	CONTROLS	STATISTICAL DIFFERENCE
Bronchial asthma			
type I	6	3	0
pollinare	20	16	0
type IV	13	3	+
types I+IV	19	37	+
Pollinosis	49	43	0
Recurrent respir.infect.	22	12	0

There is no statistical difference in the diagnostic composition of the groups compared with the exception of bronchial asthma type IV and bronchial asthma types I and IV /mixed forms/. The pollinotic asthma represents a separate unit in our survey.

THE STAY IN THE DEVICES

	THE BATCHES A	B
	June-July	July-August
Speleotherapy groups	20.6.-8.7.	25.7.-11.8.
Controls	1.7.-19.7.	19.7.-5.8

This table shows two clusters of children /A and B/ in both the speleotherapy group as well as in the control group. These groups followed each other in the devices during the pollen season from the end of June, during the whole July to the beginning of Sugust, so that the environmental exposure of all children was the same.

Symptoms typical for bronchial asthma and pollinosis were monitored during the whole study. But we could not evaluate the indices of symptoms due to a great difference between the technical conditions in both devices.

THE PERIPHERAL EOSINOPHILIA IN CHILDREN WITH POLLINOSIS

	n	The mean values at the beginning	The final mean values
Speleotherapy group	56	0.277	0.232
Controls	45	0.315	0.369

The significance level p= 0.05

To make our final evaluation objective only those children who suffered from pollinosis were selected for further comparison, never mind what their clinical manifestations were, and in whom the skin tests for pollen allergens were positive.

The peripheral eosinophilia tested in children at the beginning of their stays and closely before their departures home, performed /Dunger's method/ in our routine laboratory, represents a reliable criterion for objective conclusions.

The presentee results show that the peripheral eosinophilia as one of the commonly used markers of immunological changes in atopics and other allergic patients proved a statistically significant change at the level of p = 0.05 in favour of the speleotherapy when compared with climatotherapy in children with pollinosis.

" SPELEOTHERAPY WAS POTENT TO LOWER THE MEAN PERIPHERAL EOSINOPHILIA IN CHILDREN WITH POLLINOSIS, BUT THIS WAS NOT THE CASE IN MERE CLIMATOTHERAPY "

WASSERVERSORGUNG DES SALZBURGER BECKENS MIT KARSTWASSER AUS DEM TENNEN- UND HAGENGEBIRGE, AUSTRIA

GADERMAYR, Wolfgang

Im Salzburger Becken werden zur Zeit etwa 150.000 Personen mit Trink-u.Brauchwasser von den Salzburger Stadtwerken versorgt. Der durchschnittliche Verbrauch pro Person und Tag liegt bei ca.150 Liter, incl. Industrie, bei 247 Liter. Der Bedarf kann aus mehreren Porengrundwasserfeldern und einer Karstriesenquelle gedeckt werden.
In mehreren Ausbauphasen ist vorgesehen, den gesamten Bereich des Salzburger Beckens mit einer zentralen, auf mehrere Versorgungseinrichtungen gestützten "Wasserschiene" zu versorgen.

Die Nutzung der Porengrundwässer ergab zeitweise Probleme, da im Bereich der Einzugsgebiete der Brunnenfelder durch Industrie es zur Kontamination durch halogenierte Kohlenwasserstoffe (Perchloräthylen) kam.
Die Karstriesenquelle (Fürstenbrunnerquelle) kann zur Zeit auch nicht kontinuierlich genutzt werden, da vermehrt Trübstoffe eine Einspeisung in das Trinkwassernetz der Stadt Salzburg verhindern. Diese Trübstoffe sind mineralogisch ident mit den Höhlensedimenten, eine exakte Beweisführung der Herkunft konnte jedoch bis dato nicht erbracht werden.
Auch erschwert die Nutzung des Einzugsgebietes durch Tourismus (Seilbahn, Restaurants...) eine sichere Nutzung.
In nächster Zukunft ist vorgesehen, die Wasserschiene nach Süden auszubauen und möglicherweise große Karstwasserreserven des Tennen-u.Hagengebirges in die Wasserschiene einzubinden (u.U.Fassung der Tiefenkasrtwässer durch eine Stollenfassung...).
Weiters könnten die Alluvialbereiche (mehrere 10er m mächtige Flußschotter mit hohen k_f Werten die zum Teil durch verdeckte Karstquellen, zum Teil durch Infiltration des Vorflutwassers der Lammer und der Torren, gespeist werden, genutzt werden.
Die Verweildauer der Wässer im Schotteruntergrund beträgt i.a.mehrere Wochen bis Monate.
Demgenüber stehen nur sehr kurze Verweildauern des Wassers im Seichten Karst, das an den großen Quellen an der Nordseite der Gebirge entspringt.
Mehrere Markierungsversuche mit floureszierenden Tracern ergaben folgendes Bild (nur für Tennen u.Hagengebirge).

BODENWASSERSPEICHER: m mächtig, im Talbereich (ca.500m Sh.) nach oben geringmächtiger und im Plateau fehlt er fast völlig.
PORENGRUNDWASSERSPEICHER:z.T. durch Bodenwasser gespeist oder durch verdeckte Karstquellen oder durch Infiltration der Vorfluter.
SEICHTKARSTWASSERSPEICHER:Wird durch aktive Wasserschächte und Canyons im vadosen, vertikalen Bereich gespeist, der "Karstwasserspiegel" liegt auf ca.700m Sh. und fließt +/- phreatisch bis zur Quelle.
Die Abteufung unter den Karstwassrspiegel beträgt i.a.nur wenige 10er m.
TIEFENKARSTWASSERKÖRPER: Im Nordbereich sind die stauenden Schichten der Werfener (skyth) mehrere 100m tief unter dem Vorflutniveau. Die Nordvergenz der Karbonatplattform und mehrere N-S streichende Störungen lassen an der Nordseite des Gebirges die wesentlichsten Quellen entspringen.
Durch die geringe Konzentration der Tracer konnte vermutlich bei den Markierungsversuchen der Tiefenkarstkörper von den Tracern nicht errreicht werden.

Wichtig ist es die Abflussparameter und die Speicherparameter des Untergrundes zu kennen. So scheint die kurze Verweildauer des Wassers im Karstuntergrund keine ausreichende Filterwirkung zu erzielen, aber da das Einzugsgebiet im großteils ungenutzten Bereichen (2000m Sh.) liegt, scheint die Gefährdung einer Verunreinigung des Inputs nicht sehr groß zu sein.
Anders liegt das Verhältnis bei den Porengrundwasserfeldern der Talbereiche, die durch intensive Nutzung durch Schwerverkehr und Industrie stärker gefährdet sind. Lange Verweildauern im Untergrund erlauben dem Wasser eine gewisse Selbstreinigungskraft und längeren Handlungsspielraum für den Versorgungsunternehmer.

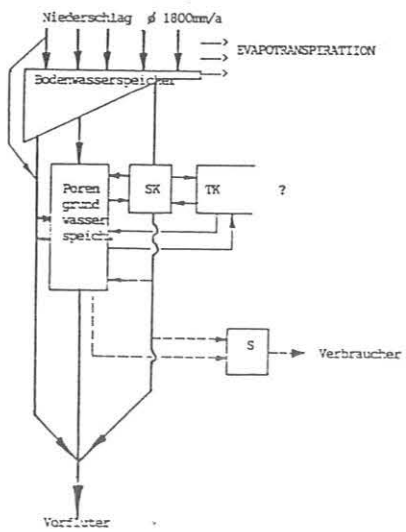
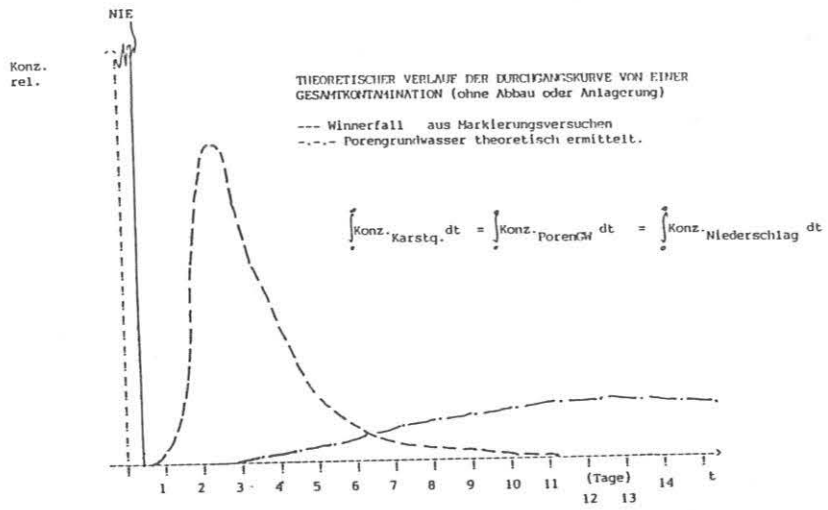


Abb.: Schema des unterirdischen Abflusses:
Bodenwasserspeicher mit zunehmender Höhe geringmächtiger
Porengrundwasserspeicher meist im Talbereich
SK...Seichter Karstwasserspeicher
TK...Tiefer Karstwasserspeicher — großteils unerforscht
S....Speicher der Wasserversorgung (in Sbg.Stadt Mönchsberg und Kapuzinerberg -geplant-

Skizze:Gadermayr 1989



Anders verhält es sich bei der Kontamination des Input (Niederschlag) durch anorganische Substanzen oder radioaktive Stoffe (z.B.Tschernobyl 1986).
Während das Porengrundwasser von der Kontamination verschont blieb (Anlagerung der radioaktiven Ionen an Tonmineralien) konnte an gewissen Karstquellen ein eindeutiger Durchgang des radioaktiven Materials verzeichnet werden.
Die wesentlich geringere Speicherfähigkeit des Seichtkasrtwasserkörpers ließ die Kontamination rasch zurückgehen -Erneuerungsvermögen-
Im Kontaminationsfall von nichtad(b)sorbierbaren Stoffen wäre es möglich, Seichtkarstwasserkörper sinnvoll zur Niedrighaltung des Versorgungswassers zu nutzen.
TROTZ DER LEICHTEN GEFÄHRDUNG DER KARSTWÄSSER DURCH VERUNREINIGUNGEN UND DES SCHLECHTEN BIS NICHT EXISTENTEN EIGENREINIGUNGSVERMÖGNES DER KARSTWÄSSER; SOLLTE AUF DEN VORTEIL DURCH DIE SCHNELLE ERNEUERUNGSMÖGLICHKEIT AUF IHRE EINBINDUNG INS NUTZUNGSKONZEPT NICHT VERZICHTET WERDEN.

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FARTHER DATA ON THE LOWER MIDDLE PLEISTOCENE PETRALONA CAVE

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ABSTRACT

The drastic periodic climatic changes during the Lower-Middle Pleistocene had influenced the faunistic and ecological pattern of the european continent. Data coming from the excavations of the Anthropological Association of Greece (1968-1983) are discussed and compared to data from other excavating sites. Besides the fauna, Middle Pleistocene Archanthropinae were affected by the climatic change and the main conlusion deduced is that hominids could not expand northwards during the cold periods of Lower-Middle Pleistocene, most probably not before the end of the Crenian period of Petralona Cave, that is about 0.65 m.y.a.

INTRODUCTION

The alternation of climate, during the Pleistocene epoch, approximatly every 100.000 years, was firsly considerred by Milankovitsc (1941) on the base of geoastronomic observations. Later, Emiliani & Shackleton (1974), based on O-18 marine sequence, and Kukla (1975) on european loess deposits came close to the same results.

Allthough the climatic influence on the mammalian fauna is not yet fully investigated, for all periods, palaeontologists and lastly palaeoanthropologists arrived to the point of accepting the above Pleistocene climatic changes.

The analytical study of the structure of the Petralona Cave sediments, yielded a detailed curve related to climatic fluctuations of cold and warm periods (A. Poulianos 1980 p. 51). The same curve is being presented in table 1, reffered to the Petralona Cave layers and periods with their depth and most probable corresponding datings and environments.

The coldest period observed is the Chalkidikian (layers 26-27). In it's layers has been found the petralonian Eolagurus (i.e. L. (Eolagurus) argyropuloi zazhighini, N. Poulianos 1987, in press) a lemming wich might have lived in arid cold steppe environment of ~4°C yearly. Here the curve (A. Poulianos 1980) declination towards cold conditions reaches its maximum.

The declinations are indicating less cold towards the Aegean period. Within its layers were not found any more Eolagurus, but another lemming the Lagurus transiens which might have lived in humid cold steppe environments of ~8°C yearly, that is of 8°C less than today in Chalkidiki peninsula (N. Poulianos 1987).

Similar sequencial alternation of Eolagurus argyropuloi and Lagurus transiens has been also observed into two stratigraphically connected Siberian sites, the underlaying Razdolje (with Eolag. arg.) and the overlaying Viatkino (with L. trans.), dated by palaeomagnetism at ~0.7 m.y.a.(Zazhighin 1980).

At Petralona Cave in layers 23/24 have been also observed palaeomagnetic reversed samples (V. Bucha 1978, S. Papamarinopolos 1979, see ~A. Poulianos 1980).

At another open site, Isernia, dated palaeomagnetically, (Coltorti et al 1982) slightly bellow the Brunhes/Matuyama boundary, into level 3F, was observed by Esu (1983) a climatic change from very cold tundral to a humid cold steppe environment.

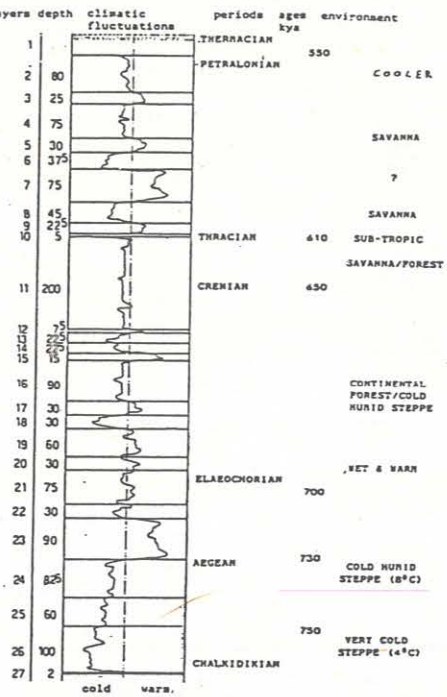
Thus in three different sites are observed similar climatic alternations below the Brunhes/Matuyama boundary. The cold stage 20 of the cycle J, of prae-Brunhes times (Kukla 1975) can coincide to the Chalkidikian and Aegean periods of the end of Lower Pleistocene (N. Poulianos 1987, 1988).

The next Elaeochorian period (layers 19-22) warmer and wetter (A. Poulianos 1980) can be considered of stage 19 of the cycle I. At Petralona Cave almost no finds are recoverred at this period, besides few remnants of Microtus and Talpa. In caves such a condition perhaps shows that the great humidity does not allow to exist into the cave even buts (Horacek & N. Poulianos 1988).

The Crenian period (layers 11-18) is characterized mostly by cold climate, that of stage 18, cycle I. A big population of Lagurus transiens (layers 11, 16, 17, 18) associated to Arvicola cantiana (layers 16-18 ; N. Poulianos 1988), to Havena perrieri (layers 11 ,16 ; Kurten & A. Poulianos 1977, 1981) and to Strix aluco (Mausoleum, layers 11-15 ; Kretzoi & N. Poulianos 1981) are suggesting a cold climate for this period, with alternating of humid steppes and continental forests. A worm interruption at layer 15 by the appearence of equids can be mentioned. At the end of the 11th layer slowly the fauna changes, by the presence of Dicerorhinus cf. hemitoechus (Fortelius & N. Poulianos 1979) and Crocuta c. praespelaea (Kurten & A.Poulianos 1977,1981), showing that climate becomes milder, warmer, likely a savanna environment. During the end of the Crenian period had lived also the Archanthropus europeus petraloniensis (A. Poulianos 1976); its skull has been found associated to H. perrieri, L. transiens, C. c. praespelaea and D. cf. hemitoechus (cf. above).

Next Thracian period (layers 9-10) with the formation of the travertine stalagmite, composed into about 10 sublayers, perhaps corresponds to a subtropic climate of a wet period (stage 17, cycle H); Early Middle Pleistocene Hippopotamus amphibius might had lived during this period (N. Poulianos 1988).

TABLE 1: Tentative palaeoenvironmental reconstruction of North Greece during Lower - Middle Pleistocene.



For the Petralonian period (layers 2-8) a savanna environment is again indicative by the presence of D. cf. hemitoechus and C. c. praespelaea (cf. above). Before the closing of the cave by sediments, climate becomes cooler again during the 2nd layer, considering the presence of the large C. c. petralonae, dated at about 0.55 m.y.a., (Kurten & A. Poulianos 1977), corresponding to the 16th stage, cycle H of Kukla (1975).

The top stalagmitic layer (No: 1, Thermacian period) is been formed till present, composed in ~20 sublayers (~30 cm. thick) giving a medium age of about 0.35 m.y.a. It's sublayers, still in study, are indicating also climatic changes of humid and arid periods.

It is wotrh to mention that our correlations to the above cycles could be interpreted in an alternative way: all layers from 11 to 27 rapresent the cold end of Lower Pleistocene (stage20) and layers 2 to 10 as the next warm period (stage 19). In favour to this hypothesis would be the presence of the same evolutionary line of Microtus praeguentheri throughout all layers (Kretzoi & N. Poulianos 1988), but this would contradict to the fact that E.S.R. (Ikeya 1980) and ammino-acid (Belluomini et al 1988) datings are indicating an age of about 0.65 m.y.a. for the end of Crenian period (layers 10/11). Also it would contradict to the fact that they are not yet observed at corresponding to the crenian layers of Main Mosbach, Mauer and Tarko (N. Poulianos 1988) palaeomagnetic reversals.

The dating limits we consider for the upermost layers of Petralona Cave of about 0.6-0.55 m.y.a., as well as for the lowermost of about 0.75 are documented, besides the absolute datings and palaeoecological observations, also to the fact that no younger or older faunistic assemblage is ever found. The lower limit by the presence of the petralonian Eolagurus argyropuloi (cf. above) in the layers 26-27 could increase considerably the

age of the sediment if it was found associated to other well known Biharian species, p.ex.: L. (Prolagurus) pannonicus (a previous and slightly different lemming form to L. transiens. N. Poulianos 1987, in press). Because they are not found such Biharian species, we may not accept an elder age, with the present data. The upper limit of layers 1/2 is substantiated by the presence of the Crocutas evolutionary stage (C. c. praespelaea and C. c. petralonae), unknown during the last 0.55 m.y.a. from other sites.

Finally, at the climatic curve of table 1, we observe about 190 oscillations, counting also the ten sublayers of the 10th stalagmitic layer of Thracian period, corresponding to about 200 kya for the formation of Petralona Cave sediments; that is approximatly 1000 yars per oscillation

In our tentative correlation of the Petralona Cave biostratigraphy to other Lower - Middle Pleistocene sites (N. Poulianos 1988) was paid attention to the Hungarian site of Tarko Cave.

TABLE 2: Distribution of taxa into the layers in correlation of Tarko and Petralona (Section B, Mausoleum) Caves, conserning number of speciments and if indicated the number of individuals.

taxa (Tarko layers)	1	2	3	4	5-7	8	9	10	11	12-13	14	15	16-17
1. Anura indet.	350			3	2				1	2			4
2. Lacerta sp.		10		49	15		2			3	58	12	67
3. Ophidia indet.	212	5			5	1		1	13	21			
4. Talpa foss., T. minor	15	33	31	19	209	1	28	27	123	122	15	25	37
5. Sorex minutus	6	1	4	7	9		4	9	21	73		8	
6. Erinaceus cf. praegl.					386	7	137	73	152	345	1		15
7. Trogontherium schmer. cf. Castor fiber					2								
8. Glis sackdillingensis		2	4	8	64	4	20	23	63	146	14	58	1
9. Glis cf. glis	2												
10. Apodemus sylvaticus	106	31	48	51	36		6	18	48	80	7	15	1
11. Mus musculus synanthr		1											
12. Allocricetus bursae	190	65	112	64	45	3	29	47	92	292	190	263	15
13. Mimomys savini													5
14. Pliomys episcopalis		1		2	9			2	3	4		1	
15. Arvicola cantiana	1		1		1		1		1		2		
16. Lagurus transiens		2	8	1				1			1	2	4
" " No of ind.		1	1	1				1			1	1	1
17. Microtus arvalinus	22	27	16	10	24		10-	6	13	24	3		3
18. Lepus sp.		4	5	1	3								
19. Ursus deningeri	7	82	52	33	172	1	24	1		2			

TARKO layers: 1 2 3 4 5 - 7 8 9 10 11 12-13 14 15 16-17
TARKO depth: 4.1m, 2m, 1.8m
PETRALONA depth: 4.0m, 2m, 2.2m
PETRALONA layers: 10 11 12 13 14 15 16 17 18 19-22 23 24 25 26
periods: THR. CRENIAN ELAEOCHOR. AEGEAN CHALK.

taxa (Petralona layers)	10	11	12	13	14	15	16	17	18	19-22	23	24	25	26
1. Anura		1	(13-M)			2	3		2		1		2	2
2. Lacertids		8	(29-M)		1		32		3		1	3		
3. Ophidia indet.		(8-M)	1		1	1	5			2		1	2	3
4. Talpa minuta											1			
5. Sorex minutus, S. sp.			(1-M)		1				1					
6. Erinaceus eur.praegl.			(7-M)											
7.														
8.														
9.														
10. Apodemus myst., A. sp.		2		5		(15-M)			3	1				
11. Mus musculus synanthrop.		1												
12. Allocricetus burs. simp.		13	1	(33-M)			1	7		10			3	2
13.														
14. Pliomys cf. episcopalis								1					1	
15. Arvicola cantiana								1						
16. Lag.trans. No of indiv.		1		(2-M)		1		-37-			1	1	1	
17. Microtus praeguentheri		230	1	45	25	1	562	30	263	1 3 2 1	4	26	24	75
18. Lepus sp.		1			(1-M)								1	1
19. Ursus den. No of indiv.		10		2		1	8	2	2	(2-M)			4	2

The younger outer part of Tarko Cave has been separated from the Early Middle Pleistocene deposits by a stalagmitic wall (Janossy 1986). The older portion of this wall might have been formed during the Thracian period about 0.6-0.65 m.y.a. In both caves it happens that in the lower layers L. transiens appears during the Aegean period, disappears in the Elaeochorian period and reappears in the Crenian. Worth mentioning that the same number of layers is observed in both caves and the depths of the sediments correlate, as well as the depth of each period (N. Poulianos 1988).

Also both caves are covered by ~20m limestone sealings and the excavated soil volume from "section B" of Petralona Cave and from Tarko is almost the same. Thus the sedimentological process can be considered quite similar, during analogous climatic changes.

The distribution of the biostratigraphically indicative faunal taxa, of the two caves, concerning their generic aspect, for comparative palaeoclimaticological observations is reported in table 2, from data given by Janossy (1976, 1986), Kretzoi (1977), Kretzoi & N. Poulianos (1981), and N. Poulianos (1983, 1988). In table 2, are not reffered the species of Aves and Chiroptera, as of less palaeoenvironmental importance. At Tarko there are not palaeoanthropological findings, and herbivors are poorly represented to be compaired, while hayenids are totaly absent. As rhinoes concerned they appear in upper Crenian in both Caves, layer 11 and/or 14 at Petralona and layer 3 at Tarko. The main correlation of layers was made on those layers which are containing fossils of Lagurus transiens.

From the above table 2 can be deduced that during the layers in correlation (1-16 of Tarko and 10-26 of Petralona Cave) a similar oscilation of microfaunal elements has been found (cf. above), reflecting climatic changes.

Besides the lowermost layers (16-17) of Tarko Cave, (Janossy 1976), Mimomys savini (a water vole) has been found also at Razdolje associated to Eolagurus argyropuloi, antedating the appearence of L. transiens in Hungary as well as in SW Siberia (Janossy 1976, Zazhighin 1980). Eolagurus has not been found at Tarko Cave perhaps because of more humid palaeoenvironment. Above in layer 15 and 25 at Tarko and Petralona (Aegean period) we have the appearence of L. transiens and Arvicola cantiana (an evolving Mimomys savini-like water vole). At Tarko Cave A. cantiana tends to alternate with L. transiens (Janossy 1986) indicating an alternation of humid cold steppes to more humid but also cold forestal environments, during layers 2-15. At Petralona Cave there is only an accidental finding of an M1 of A. cantiana (N. Poulianos 1987,1988) showing, if compaired to Tarko, that in Central Europe during the begining of Middle Pleistocene climate was more cold and humid. During the lower Crenian (layers 16-18) we found at Petralona an increased number of thirty seven individuals of L. transiens compaired to one of Tarko, indicating a preference of habitat for L. transiens at N. Greece, where climate was milder.

Observing the detailed oscilation of the faunal taxa at Tarko and Petralona it is possible to mention for each of them:

Anura: At Tarko, after the Crenian period, increasing during the warmer Thracian one. For the resting layers there are not cosiderable differences.

Lacertida: Observe, increasing of speciments especially during cold periods in Tarko layers, while they are absent in both Caves in Elaeochorian period.

Ophidia: Absent in the lower layers of Tarko Cave, while presrent at the corresponding layers of Petralona Cave, shwoing that during the Chalkidikian period the climate of Central Europe was cooler. Ophidia are increasing during Thracian period, indicating again warming of climate.

Talpa: A huge population of this taxon is found at Tarko while at Petralona Cave an accidental find is found at layer 23, indicating that C. Europe was always more humid and that during Aegean / Elaeochorian boundary humidity increased in North Creece too.

Sorex: Poorly represented at Petralona Cave, while at Tarko almost permanently present, except during the wet Elaeochorian and arid Chalkidikian periods. Mention the distribution of Sorex subaraneus at Tarko Cave (Janossy 1986), of which the number of speciments are increasing during the wet periods of Elaeochorian and lower Crenian.

Erinaceus: Characterizing mainly continental climate. At Petralona Cave present only in Mausoleum, layers 11-15. Very common at Tarco, especially in humid periods, but almost absent during steppe environments. Later, in upper Crenian, Erinaceus did not reappear again at both localities, pehaps because migrated to North, when climate became worser.

Trogontherium: Present only at Tarko, layers 5-7, during the humid cold lower Crenian period, contemporary to the presence of Arvicola cantiana at Petralona Cave.

Glis sackdillingensis: Found only at Tarko, following the Talpa's oscillation of wetter periods. It could be mentioned too. the differenciation to Glis cf. glis from Crenian to the warmer Thracian, observed for Anura and Lacertids.

Apodemus: Poorly represented at Petralona Cave. At Tarko considerably increasing during humid periods and decreasing again in Elaeochorian and Chalkidikian.

Mus synanthropus: Found at the 2nd layer of Tarko and 11th of Petralona, supporting our correlation of these two layers.

Allocricetus bursae: Present in all layers of Tarko Cave. decreasing signifacantly during Elaeochorian and Chalkidikian; must caracterize cold and very humid environment in case of large population. At Petralona Cave they increase during 11th, 16th and 17th layers. However, Allocricetus at Petralona Cave are much less represented , compaired to Tarko. Cooler palaeoenvironment is again indicative for Tarko site.

Pliomys: In both Caves are poorly represented. It should be noted their simultaneous apperence in lower Aegean period.

Microtus: Abondent in both Caves for all periods, besides the Elaeochorian. In this period are contained only few remnants of some taxa, characterized by species of wet climate, compaired to the other periods. However, during the coldest periods the inner microclimate of Tarco cave can be considered of less humidity, compaired to the Petralona Cave's, because of cooler surroundings at central Europe.

Lepus sp.: At Petralona Cave present at layers 11 (Upper Crenian) 25, 26 (lower Aegean / Chalkidikian). The situation at Tarko is completely reversed, Lepus is present during middle and lower Crenian and upper Aegean. It could be explained by the fact that during very cold periods, especially the Chalkidikian, it is to be found only in southern regious.

Ursus deningeri: The distribution of this taxon is well evident in both Caves, but in alternating way. During the Chalkidikian and lower Aegean, it is present at Petralona, where it was less cold, and absent at Tarco. In the next upper Aegean and Elaeochorian periods at Petralona it is absent, but appears at Tarko, migrating perhaps to the North because of wetter and warmer climate in Greece. The same bear is present in all layers of the Crenian period at both sites.

Based on the above comparison of Tarko and Petralona Caves it is possible to deduce that during Lower - Middle Pleistocene in C. Europe cold and humid periods were considerably more intensive than in Nothern Greece and that the climatic conditions were changing relatively often.

From the palaeoanthropological point of view one may suggest that during the very cold of Chalkidikian and Aegean perods hominids could not survive in northern Europe. They succeeded in southern Balkans, cosidering the stone tools and traces of fire found into the lower layers (24-26) of Petralona Cave (A. Poulianos 1982). It is possible that some groups of them did move to southern Greece and/or to the Asia Minor.

In Central, Eastern and Western Europe, Pyrenees included, year temperatures were falling also under 0°C yearly during the Chalkidikian period and around 0°C during the Aegean, compaired to the climatic conditions in same periods in Northern Greece, where temperatures were respectivly about 4°C and 8°C yarly.

To our opinion, there is no evidence of palaeoanthropological finds, in the Chalkidikian period for the rest of Europe, due to the above mentioned hard climatic conditions. Hominids, could expand northwards, during the Elaeochorian period, but more probably by the end of Crenian (~0.65 m.y.a.), when climate became milder, giving rise to the Middle Pleistocene European Archanthropinae.

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CAVES, CONSERVATION AND CHILDREN

FRANTZ, A. Peri

resume p. 677

1. INTRODUCTION

Society's negative impact on the environment is becoming more evident every day. Before we can begin to combat this impact, we must convince people that the potential for long term ecological disaster outweighs the short term economic benefits of ignoring the environment. Thus, an important step in assuring the continued habitability of the planet is education. By teaching children to understand and respect the environment we can place environmental protection high among future priorities. By teaching them about complex systems we can prepare them to grapple with the competing demands of political, economic, cultural an scientific concerns.

For the last 8 years, with the help of the San Francisco Bay Chapter of the National Speleological Society, my husband and I have combined the natural enthusiasm of youth with our love of caving, to introduce children to the complexities of the environment, through a course titled Into the Depths - Spelunking: The Science and Exploration of Caves. This paper describes that course and how we ensure both the safety and the enthusiasm of our students.

1.1 Background

Into the Depths, is taught under the auspices of Lyceum of Santa Clara Valley, a private educational organization, founded to provide intellectual stimulation and cultural enrichment for children of above average intelligence. The existence of Lyceum is a reflection of parent's dissatisfaction with the quality of education being provided through the public school system. Lyceum presents a wide variety of seminars, in both the sciences and the arts, taught exclusively by volunteers. By drawing on the expertise of the community in this manner the children are exposed to subjects and ideas which are outside the normal scope of the school system.

1.2 Overview

The course consists of two major components; 3 hours in the classroom and a day of spelunking. After several years of experimentation we have concluded that the class should be limited to 16 students, and that the caving should be done in groups of no more than 8 children. While the class has been designed to children in the 5th grade (age 10), it could easily be adapted for other age groups. In fact, modified versions of this course have been used other groups, such as the Boy Scouts.

2. COURSE OBJECTIVES

The immediate objectives of Into the Depths are deceptively simple; to impart a basic knowledge of caves and cave terminology; to expose children to the different branches of science involved in cave research; and to provide children with a exciting and stimulating experience. However, behind these obvious objectives, there are some not so obvious ones. Foremost, is to expose the children to a complex system. Most elementary education neatly compartmentalizes knowledge. Into the Depths stresses the interrelatedness of many fields of knowledge. The cave is viewed as a system, not as its components. This emphasis on complexity and relationship is deliberate. Another less obvious objective is to imbue the children with a sense of respect for the beauty and wonder of nature. These less obvious objectives are obtained indirectly. The children study caves. Ecology is never presented as a subject unto itself, but is a underlying theme. By the end of the class, without even realizing it, the children have absorbed the message of preservation and protection.

3. COURSE DESCRIPTION

3.1. In the Class Room

The lecture portion of the course is taught in two classes of 1 1/2 hours each. Each class is divided among 3 subjects. A combination of interative presentations and hands on participation helps control the natural restlessness of 10 year olds. Much of the success of the course is derived from the use of a question and answer style of teaching. Rather than subject the children to long lectures, they are are continuously presented with small bits of information and then asked questions. They are not expected to know the answers, but rather are encouraged to combine their knowledge with speculation to come up with possible answers. Wrong answers are never ridiculed. All answers, right or wrong, are examined to develop the basic concepts being taught. Throughout this process, the children are encouraged to ask questions and make guesses.

This active style of teaching involves the children more intimately in the learning and stimulates their thinking processes. There are however some potential problems which should be avoided. In most groups, a few children will attempt to dominate the proceedings. The instructors should be careful to give all of the children a chance, slowing down the speedy and encouraging the timid. This is one reason for the small class size. Another potential problem is over enthusiasm. Shouting and simultaneous responses can be controled with a simple request, or if that fails, by refusing to continue until order is restored.

At the first class, each child is given a handout which provides an overview of the course. It includes a list of equipment which the child is expected to provide, a copy of the safety rules, a short glossary of speleological terms, and a phone number parents can contact with questions. Copies of this handout are available.

3.11 An Introduction to Caves

The first half hour is a general introduction to caves. I start by finding out what the children already know or think they know. Have they been in any commercial caves? What were they like? What kinds of things are found in caves? I don't bother to correct mistakes, but I do keep them in mind so that I can correct them later. We then show a brief slide show, perhaps 30 to 40 slides, with a variety of caves, caving techniques, some underlying geology, a few cave animals, etc. After a brief introduction to each slide, I start asking questions. What is that thing? Why does he have that rope around his waist? Whats funny about that fish? Usually some of the children come close to the right answer. If not, the answer is supplied. Misconceptions voiced during the first few minutes can also be cleared up at this time. Throughout this process, the children are encouraged to ask questions, as well as answer them.

3.12 Equipment

Next comes a review of the equipment required for safe caving. I haul out my full cave pack and ask the children to guess what it contains. With slides they have just seen as a guide, the guesses tend to be pretty good. In response to each correct answer I extricate the object and discuss how to make a proper selection. Flashlight? The kids always laugh when it doesn't work. Why not? Dead batteries? No, they're fresh. Burnt out bulb? Out comes the spare parts kit. Quick bulb change. Still doesn't work. Recheck the batteries. Oh, they're in backwards. Hey,why did I do that? And so the dialog continues. As the equipment emerges from the pack, it is passed around for the children to examine. For this exercise I include both electric and carbide lamps. The drama of lighting a carbide, the smell of acetylene, and a single flame in a darkened room are all part of the experience.

By the time we're finished, the children know that a cave pack should contain 2 spare sources of light (flashlight and candle), a water bottle (non-breakable), some food (non-crushable), matches (waterproof), and a garbage bag (for hypothermia). They know the pack should be rugged and not have a ridged frame. They have discussed clothing options (jeans, long sleeve shirt, lugged soled boots, and wool sweater). They are also aware that caving is not a safe as walking down the street. Accidents can occur. Safety rules are therefore discussed. Most important, the children know that proper equipment and responsible behavior are essential for safe caving.

The SFBC supplies the helmets and lights, but each child is expected to assemble a pack with the other equipment. They are asked to bring this pack to the second class so that we can check for completeness and appropriateness. Having each child assume responsibility for some of their own equipment is an essential component of Into the Depths.

3.13 Geology

John Tinsley of the U.S. Geological Survey presents geology in the last half hour of the first class. He covers the deposition of limestone, uplifting of land, the water table, the role of CO_2 in dissolving passage and subsequently in redepositing formations. In addition to limestone, he

provides a brief overview of lava tubes, talus caves and littoral caves. Obviously, each topic is brief. The presentation is illustrated with slides and rock samples and related to familiar subjects. Water flow is discussed in terms of how many swimming pools could be filled in an hour. Fossil bearing samples, a cross section of a large stalagmite, and the application of dilute sulfuric acid illustrate the deposition, structure and dissolution of limestone. The stalagmite came from a cave about to be inundated by a reservoir. With luck, at least one child will ask, "How come you took the stalagmite when you say not to touch or take anything?". This launches a discussion of the tradeoffs between the collection of scientific samples and preservation, and of the environmental side effects dams and reservoirs.

3.14 Biology

The first hour of the second class is dedicated to biology. Victoria Johnson, a lecturer in biology and genetics at California State University at San Jose, emphasizes the adaptation of animals to the cave environment and the sensitivity of that environment. Using slides of a wide variety of animals, both terrestrial and cave dwelling, the children are asked to identify the differences. Why would a cave crickets have long antennae? What are those funny ridges along the sides of the blind cave fish. Why doesn't the cave crayfish have eyes. Why does the bat? In addition to the slides, there are number of live animals and preserved samples for the children to observe. The cave fish finds the brine shrimp in his bowl even without eyes. The live terrestrial salamander demonstrates the need for a moist environment, unpolluted environment. A skeleton shows the adaptation of hands into wings as children spread their fingers and compare their bones with those of the bat. A quick calculation of the tons of insects eaten by a colony of bats each night shows the economic importance of this often unappreciated animal.

3.15 Equipment Check

During the second class, we always check the equipment which the children have assembled. With several cavers present the check takes no more than 15 minutes. Glass lined thermos bottles, oversize and overweight flashlights, and unprotected matches are among the common problems. Questions like "What would happen if you dropped this?" and " "Do you really want to carry that all day?" help the children develop the ability to make informed decisions about their own equipment.

3.16 Safety and Conservation

The last section of Into the Depths summarizes the safety and conservation themes which have occurred throughout the class. We review the safety rules for the spelunking session. In eight years of teaching this class we have never had to remove a child for violating the rules, although on one occasion, we came close.

3.2. The Field Trip

Needless to say, for the children, the caving is the high point of the course. From the adult perspective, it is an opportunity to bridge the gap between the theoretical and the real.

3.21 Adult to Child Ratio

For each eight children, Lyceum always supplies 2 parents, to which we add at least four experienced cavers. This is about twice as many adults as we really need, but provides an extra margin of safety if any problems should arise.

3.22 Cave Selection

We conduct this course in three very small caves, all within a 10 minute walk of each other. These caves are not showplaces. They are small. The main passage of the longest is perhaps 500 feet. They are simple, with no major side passages, making it impossible to loose anyone. They have no significant vertical exposure. And each is completely different. The three offer walking passage, tight squeezes, a mud crawl, a cobbled stream bed, a short chimney, and a variety of chambers, some with formations. Because they are near a large town, they see frequent traffic and are often littered and vandalized. This helps drive home the conservation message, and reduces the chance that we ourselves will damage the caves. A single, somewhat larger cave would serve the same purpose, as long as it provides a similar variety of passage and meets the criteria for safety.

3.33 Helmet and Lights

The hardest part of preparing for this class is rounding up enough helmets and lights. It is essential that each child be properly equipped. Although the caves are so simple that the local youth do them with flashlights and tennis shoes, it would be counter productive to talk about proper equipment, and then tell the children that they don't need it. Our grotto has several helmets which it rents to beginners, and these are all pressed into service. It addition, we borrow helmets from our members, most of whom have a few spares. Helmets that do not adjust small enough can be modified with duct tape. Fold up a pad of tape, perhaps a 1/4 inch thick and tape it to the headband. Several pads usually produce a snug fit, even for the smallest head. We use only electric lights, to prevent burns. These are also borrowed and are fitted with fresh cheap batteries. I always obtain extra lamps because it is easier to replace a recalcitrant light than to fix it when dealing with eager, excited kids. If neccessary, the lamps can be secured on the helmets with duct tape also.

3.24 Activities

We proceed through the caves extremely slowly, stopping frequently. We start with Empire Cave because it is the easiest and typically take a hour to see its 500 ft. of passage. The cave has a fixed iron ladder, about 20 feet long, at its entrance. After a lecture on three point suspension, the children descend one at a time. At the bottom we stop, turn off our lights and experience the twilight zone. Because it is close to a city, this cave is invariably littered with beer cans, bottles and other debris. Out come the garbage bags and by the end of the trip the cave is substantially cleaner and the children have the feeling of accomplishment from having done something worthwhile. At several points there are short dead end passages leading off the main passage. The longest of these is about 30 feet, and the children are encouraged to explore them on their own. The largest room in Empire has the remnants of several draperies, high enough up to be out of reach. We compare these formations, noting different types of drip stone, and the damage that has been done. At the end of a mud crawl there is a circular chamber, with well developed rimstone dams.

No cave trip is complete without total darkness, and to that experience we add total quiet. It is remarkably difficult for ten year olds to be truly still. As the children settle down, the slightest rustle of clothing becomes a thunder bolt, a cough becomes an explosion. It usually takes several minutes to get everyone concentrating on being still and quite. After about a minute of true silence I quietly ask the children what they can hear. Dripping water and wind are usually the only answers. I then ask who would like to light a candle. A chorus of "me! me!" results in the realization that since it is dark, nobody knows who "me" is. After naming somneone to light a single candle, we sit in its glow and discuss the problems of early explorers.

On the way out we observe features which were missed on the way in; joints in the bed rock which have controlled the formation of passage; soot on the walls from an ill conceived camp fire; a light frosting of calcite over the soot in some places; additional animal life, etc. After a break for lunch, we spend about half an hour in each of the other two caves. This provides an opportunity for belly crawls, tight squeezes and even a 6 ft. chimney For these, an experienced adult is stationed at each end to talk the children through. Inexperienced children sometimes become stuck or frighted in places where adult cavers slide right through.

In addition to the caves we look at a sinkhole above the caves and a spring below them. Although the sinkhole is not impressive, it still illustrates one end of the hydrological system. The other end is a series of small springs. We approach these down a dry creekbed and wait for the children to notice the appearance of water. Usually one does. If not, we draw it to their attention. In this way, the caves are placed in context within a larger system.

4. CONCLUSION

A well integrated combination of classroom teaching and caving experience can introduce children to the wonders of cave exploring. By capitalizing on their natural spirit of adventure, we can give them a glimpse of the vast panorama of speleological activities and a sensitivity to environmental complexity. By using active learning techniques, we can develop their powers of observation and problem solving. In so doing we are helping to inspire the speleologist of tomorrow and to raise a generation which will come to adulthood knowing that the environment can no longer be taken for granted, but must be protected and cherished.

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INTO THE DEPTHS - SPELUNKING

THE SCIENCE AND EXPLORATION OF CAVES

Welcome to "The Science and Exploration of Caves", a Lyceum Seminar. We hope that you will enjoy this seminar and find it informative. The information in this handout will help you participate safely in this seminar. Please read it before the next class.

BASIC CAVING EQUIPMENT

Every person entering a cave for any reason should carry (or wear) the following equipment. We will provide the equipment marked with a star (*). If you already own some of the things that are not marked, we would like you to provide them. Please, DO NOT go out and buy anything if you do not already own it. We will be able to loan most of it to you. Please bring your equipment to the second class so that we can make sure it is appropriate.

* 1. Hard Hat with a chin strap.
2. Three sources of light.
   * a. Light to mount on helmet, either electric or carbide, with enough spare batteries or carbide for several hours more than the expected trip.
   b. Flashlight with fresh batteries.
   c. Candles & matches, chemical light, or second flashlight.
3. Small pack or large pockets. (If you do not have a pack you can get dirty, bring your things to class in a paper bag. We will lend you a pack on the weekend.
4. Drinking Water in a unbreakable container (a pint is sufficient).
* 5. Lamp repair kit.
6. Boots with lug soles. (For our short trip, sturdy sneakers are acceptable).
7. Sturdy gloves (garden gloves are great).
8. High energy snack food (candy bar, dried fruit, granola bars, etc), wrapped in a waterproof container.
9. Sturdy warm clothing which you can get very dirty and which may be ripped or torn. Jeans, t-shirts, sweatshirts and coveralls are all acceptable. An old Jacket or sweater is also neccessary. You may also want to take along a change of clothing in case you get very wet. (You do not have to bring the clothing on Wednesday).

BASIC CAVING RULES

1. Never Cave alone. Four is an ideal size for a caving group.

2. Always tell someone where you are going and when you will be back.

3. If you are a beginner, always go with experienced cavers, and follow their instructions.

4. Remember that the cave and the land it is on belong to someone. Leave all gates as you find them, and leave no litter or trash behind. Don't dump your carbide, it is toxic to animals.

5. Always remember the caver's motto

   TAKE NOTHING BUT PICTURES
   LEAVE NOTHING BUT FOOTPRINTS
   KILL NOTHING BUT TIME

6. Our special Lyceum Rule: ANYONE FOUND VANDALIZING A CAVE IN ANY FASHION WILL LEAVE THE CAVE IMMEDIATELY AND WILL DO NO MORE CAVING.

The instructors for this class are;

Victoria Johnson
Lecturer, Biology and Genetics
San Jose State University
San Jose CA

John Tinsley, PHD
Geologist, USGS
Menlo Park, CA

Peri & Bill Frantz
Spelunkers
Los Gatos, CA
(408) 356-8506

Other people who may be helping are Bob Johnson, Michelle and Bob Richardson, Ken Miller, Darek Hoyle, Dan Clardy, Steve and Barbara Maso Ruble, Mark Weiss, Erica Marcos, and other members of the San Francisco Bay Chapter of the National Speleological Society.

SEMINAR SCHEDULE

Tues. Oct. 18 — Introduction to Caving
Cave Biology - What types of animals live in caves and how do they survive there?
Caving Equipment
Caving Safety

Thurs. Oct. 20 — Types of Caves
Cave Geology - Where are caves found and how do they form?
Caving Techniques
Cave Maps (If time permits)

Sat. Oct. 22 or Sun. Oct. 23 — 10:00 AM to 4:00 PM — Explore limestone and sea caves. (The return time is approximate. It is not unusual to be 1/2 hour or more late.)

On Saturday and Sunday we will meet in the parking lot at Fisher School. Bring your caving equipment, a sack lunch, and a change of clothes.)

The limestone caves are along the Empire Grade Road, adjacent to the University of California, Santa Cruz, and the sea caves are near the lighthouse in Santa Cruz.

For more information about Caves and Caving, contact

The National Speleological Society
Cave Avenue
Huntsville, AL 35810

San Francisco Bay Chapter of the National Speleological Society
P.O. BOX 2282
Menlo Park, CA 94025

Monthly meeting are held the 4th Tuesday of each month, except December, 8:00 PM - 10:30PM
Lucy Evans Natural Interpretive Center
Embarcadero Rd
Palo Alto CA

GLOSSARY

BACON RIND — A cave formation, hanging like a curtain, which resembles a strip of bacon.

BIOLOGIST — A scientist who studies animals.

CALCITE — Crystal calcium carbonate. The most common cave mineral.

CARBIDE — Calcium carbide, a man made mineral which generates acetylene gas for miners lamps, when mixed with water.

CAVE PEARL — A smooth oval of calcite, usually found in small pockets, and formed by continuous slow agitation.

CHIMNEY — A narrow space between opposing walls, through which a caver moves, either horizontally or vertically, by applying pressure to opposite walls.

COLUMN — A stalactite and a stalagmite which have joined to form a single formation.

FLOWSTONE — A cave formation formed in continuous sheets by water flowing over a surface.

FORMATION — Any decorative feature in a cave. In limestone caves these are secondary deposits formed after the original cave.

GEOLOGIST — A scientist who studies the earth.

HELECTITE — A delicate cave formation which twists and turns in all directions.

HYDROLOGIST — A scientist who studies the flow of water.

ICE CAVES — Some ice caves form when water freezes in another type of cave. Others form by the melting of ice in a glacier.

KARST — Terrain which contains caves. Usually applied to limestone areas with sinkholes where streams drain underground.

LAVA TUBE A cave formed in hot lava when it was flowing.

LITTORAL CAVESA cave formed by the action of waves pounding on cliffs.

PHREATIC CAVES A cave formed below the water table by standing water.

RESURGENCE A place where an underground river returns to the surface as a spring.

SINKHOLE A depression in the land where the ceiling of a cave has collapsed, creating an opening to the surface. Many streams disappear into sinkholes and many cave entrances are found in them.

SHIELD A formation consisting of a flat plate growing from the wall, which may have draperies hanging from it.

SODA STRAW A thin, hollow stactite which resembles a drinking straw.

SPELEOLOGIST A scientist who studies caves.

SPELEOLOGY The science and study of caves.

SPELUNK/SPELUNKER/SPELUNKING
All these terms refer to exploring caves for fun, also called sport caving.

STALACTITE A cave formation which hangs down from the ceiling. (A stalactite is stuck tight to the ceiling).

STALAGMITE A cave formation which sticks up from the floor. (A stalagmite might reach the ceiling someday).

TALUS CAVE A cave formed by the collapse of large bolders or blocks of rock into narrow slits or canyons.

TROPICAL KARST Karst formed in areas of high rainfall, consisting of isolated mounds of limestone, sometimes hundreds of feet tall.

VADOSE CAVE A cave formed above the water table by moving water.

WATER TABLE The upper surface of the zone in the rock which is saturated with water.

KARST IN THE NEDERLANDS

DE SWART, Herman W. - VAN DER PAS, Jan-Paul

98% of the Netherlands consists of pleistocene and holocene sediments: gravel, sand, clay and bog. A large part is formed by "polders" or diked land. In two rather small areas we find older rocks and even some karst: the area around Winterswijk, and the southern part of the province of Limburg.

Near Winterswijk is a large triassic Muschelkalk limestone quarry. Here in 1942 an area of about 500 square meters of karren or lapies was discovered when the top soil of pleistocene clays was removed. Unfortunately this layer could not be preserved, because the limestone was quarried away. No limestone pavements were ever discovered here again.

In the most southern part of the Netherlands, the province of Limburg consists for a large part of cretaceous "marl". [limestone in fact, for it contains sometimes only 2% of clay] It is rather soft and can thereby be quarried away easily. That has been done since Roman times, in large underground quarries. In this area these underground quarries are called "marl caves" - in fact a name two times wrong. The limestone was until very recently used, as stone blocks, for building purposes, in cement industry, and for "fertilizing" acid agricultural fields. In that way large underground systems were formed, with long rectangular passages. Where these galleries meet more or less large rooms arise. Pillars have to be left for the sake of support of the ceiling. The underground systems are rather complex. The so called Sint Pieterberg caves are about 100 km in length, and in the entire area there are about 170 of these artifical caves, with a total length of 160 km.
The caves are of importance: [1] since many centuries the caves were visited by all kind of people. These visitors left their pictures and texts, sometimes dated, on the walls. These markings nowadays form the object of thorough historical investigation. [2] also for biospeleologists the caves form a large and interesting area of research. Although no troglobionts are found, large number of other cave dwelling animals can be studied.

fig. 1 simplified geological map of the Netherlands
A = Winterswijk
B = "marl" area of South Limburg

fig. 2 part of Sint Pietersberg "caves" (so called Zonneberg system) shows very well the complexity of the underground quarries

For example, 12 out of 19 species of bats familiar in Holland roost or hibernate here in these artificial caves. For one reason because, like in "normal" caves, the climatic conditions here are very stable. [3] these underground areas form also a pleasant exercise and playground for the dutch cavers.

In this limestone area natural karstphenomena can be seen: [1] "geological organ pipes": filled in karst pits, dolines or sink holes, several tens of meters deep, and sometimes with a shown connection with the subterranean galleries. [2] on the surface we encounter dolines. [3] underground we find natural cave passages, sometimes partially filled in, and also accessible natural spaces, although not very large in diameter. The longest natural cave passage known at the moment, has a length of 70 meters.
They are not well studied until now, but probably they originated where a fault and a beddingplane met (through mixing corrossion, perhaps), and then mounted through repeatedly collapse of the ceiling. The floor, through that, is always composed of a thick layer of loose, sandlike, limestone particles. A solid floor is not yet found.
The karst passages interconnect frequently with the artifical galleries, and that is the way they were discovered. Outside, in the open air, no signs of natural caves were found until now.
There is al lot of natural breakdown in the underground quarries. This makes the underground quarries in some places very instable, and therefore dangerous. There is also a very real danger of getting lost in these complex systems. As a consequence it is difficult to get permission to enter them. Some safe parts however can be visited with a guide, like a show cave.
The greatest threat to the underground systems however, with all their biological, geological and historical values, are the limestone quarries.

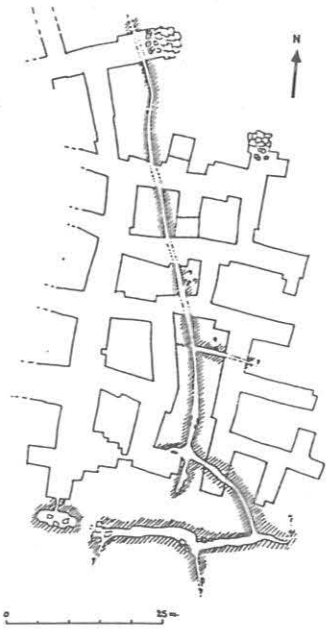

fig. 3 natural (karst) gallery in Sint Pietersberg "caves"

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L'IMPORTANCE DES ESPACES SOUTERRAINS HISTORIQUES ET DE LEUR PROTECTION

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Les spéléologues s'intéressent de plus en plus aux espaces souterrains artificiels. Ils le font sous la pression notamment d'une demande publique croissante. Les souterrains avec leurs entrées bouchées par les éboulis poursuivent dans l'indifférence leur existence oubliée sous de nombreux édifices de nos villes historiques et constituent une menace permanente pour leur stabilité. Ces souterrains sont souvent affectés par des processus identiques à ceux du karst ou du pseudo-karst. Les roches mères qui environnent le souterrain, ses murailles et ses étaiements, sont soumis aux phénomènes d'érosion. Il y a corrosion et parfois même érosion par les eaux courantes qui se réfugient souvent dans les creux et les cavités comme dans les grottes calcaires. Le sondage des cavités artificielles ressemble donc à celui des phénomènes karstiques. Il est nécessaire de déblayer les éboulis, de suivre les cavités dans les directions supposées et de chercher les entrées condamnées. Tout ceci dans le but de connaître l'étendue de la cavité souterraine et de déterminer les effets qu'elle peut avoir sur la surface.

De même que le contenu des grottes comprend des trouvailles paléontologiques et archéologiques et que l'on peut, partant de la stratigraphie, juger de la situation paléogéographique dans le passé géologique, de même les éboulements dans les souterrains historiques offrent une immense richesse d'objets précieux pour les historiens. Ce sont en premier lieu la céramique utilitaire et artistique, le verre, les fragments d'outils artisanaux et d'armes, les parties de vêtements et enfin aussi les momies dont la valeur de témoignage est sans pareille pour l'anthropologie.

Parmi les souterrains historiques, on englobe aussi les mines désaffectées. La Bohême et la Moravie sont des régions de vieilles traditions minières. Des centaines de puits de mines, de couloirs, de galeries et de toutes sortes d'ouvrages miniers se sont conservés. Il existe d'anciennes mines d'or, d'argent, de minerais de fer et de cuivre et même de matières non minérales pour l'extraction par exemple de pierres, de sables et même de pierres précieuses. Pour beaucoup d'entre elles, il n'est rien resté dans les archives. Pour la plupart manquent les cartes minières et pour presque toutes, il n'est pas possible d'avoir des données géologiques utilisables. Le degré d'exploitation des gisements de minéraux était très bas dans le passé historique. Aussi l'entrée dans des mines non connues et leur fouille approfondie sont-elles un élément complémentaire très important de la prospection géologique complexe. C'est un fait non négligeable que ces mines occupent une place importante dans l'histoire tant de la géologie que des monuments historiques. Car les souterrains historiques sont aussi un témoignage du niveau atteint dans le développement technique et se rangent de ce fait parmi les monuments uniques de la culture matérielle.

Il n'y a pas cependant que l'intérêt pour les travaux spéléologiques de la part des institutions chargées de la construction et de la reconstruction des villes et des bâtiments historiques, éventuellement de la prospection géologique, il y a aussi l'intérêt manifesté par la Société Tchèque de spéléologie. Les spécialistes des grottes en particulier se concentrent sur les souterrains historiques partout où on les trouve en dehors des régions karstiques traditionnelles. Les cavités artificielles souterraines sont pour eux des espaces d'accès facile tant pour leurs activités que pour l'entraînement. La spéléologie compte donc avec les souterrains historiques et les range dans sa sphère d'intérêt.

Il y a encore plusieurs branches de la science et plusieurs secteurs de techniques appliquées qui s'occupent des cavités artificielles conservées du passé. Ce sont la géologie du Bâtiment, les Mines, la prospection des matières premières minérales, la spéléologie, l'architecture, les Etudes historiques de l'architecture et les soins aux monuments historiques et en général, tous les travaux d'étude et de construction qui s'occupent des chantiers, de l'infrastructure et de l'aménagement en surface du territoire. Etant donné que règne dans cette sphère une grande confusion dans la terminologie, conduisant souvent à des malentendus, nous avons tenté en 1982 d'unifier les notions fondamentales utilisées dans ce domaine. On désigne donc sous le terme de souterrains historiques tous les espaces souterrains créés par la main de l'homme à des époques historiques passées. On considère que la limite du passé historique par rapport aux temps présents est, selon l'usage établi, caractérisée par les techniques manuelles de creusement, d'excavation et de construction avec l'aide de machines et d'engins de mécanisation simples, mus par la force humaine, par des animaux, éventuellement par l'eau courante.

Les souterrains historiques ainsi définis sont liés, du point de vue du vocabulaire, à la notion de "l'architecture historique" qui englobe les constructions en surface conservées du passé. De par leur nature, les souterrains historiques comprennent les cavités non seulement dans les roches mais aussi dans les murailles, éventuellement dans un milieu de roches fortifié par des murs, où les matériaux de maçonnerie constituent en fait l'étaiement minier.

De la large gamme de types de souterrains historiques, il est possible de détacher six groupes bien définissables d'ouvrages:

1. Les ouvrages historiques de mines et d´extraction
2. Les souterrains de villes, catacombes et corridors de forteresses
3. Les souterrains des châteaux-forts et de plaisance
4. Les demeures et caches creusées dans le roc
5. Les crypotes et les caves
6. Les cavernes et grottes artificielles et les "sale terrene".

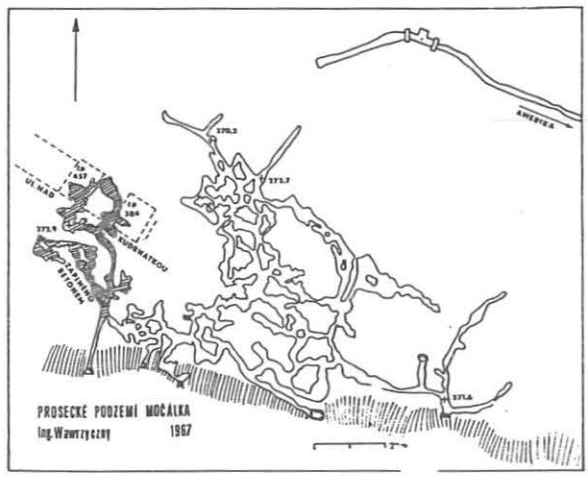
Les ouvrages historiques de mines et d´extraction

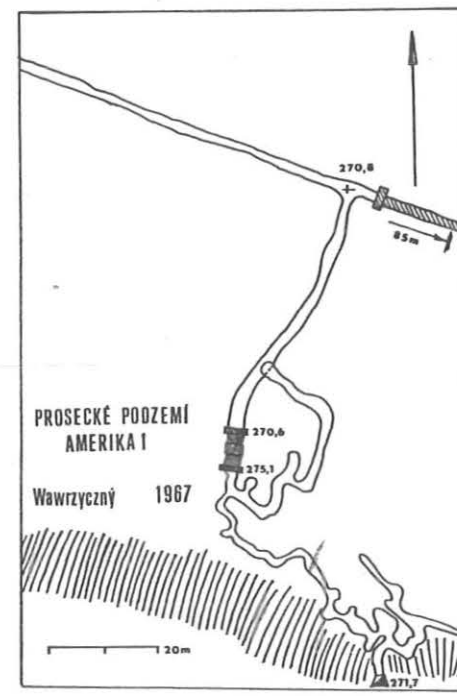
Les vestiges du travail d´extraction des minéraux et le creusement de galeries souterraines à cet effet sont le type le plus répandu de souterrains historiques. En Tchécoslovaquie plus particulièrement, ce travail a une longue tradition. Le puits de Bílé Kamení près de la rivière Sázava date même de la préhistoire et servait à se procurer des matériaux pour les outils de l´âge de la pierre. Selon la finalité, les ouvrages historiques miniers se divisent en mines de minerais et autres que de minerais et en creusements a des fins spéciales ou jouent un grand rôle les galeries techniques et hydrographiques.

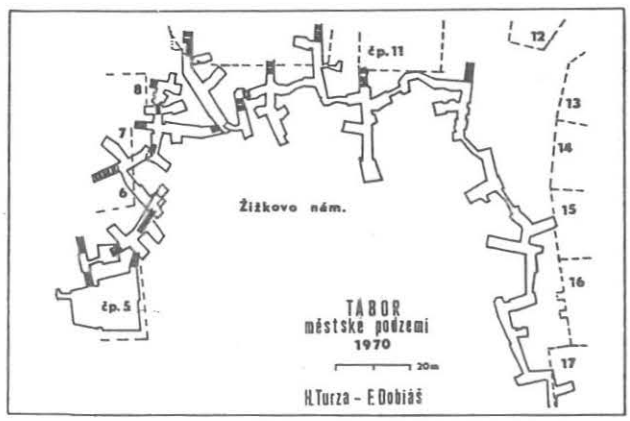
Comme exemples de vieilles mines de minerais, nous avons d´anciennes galeries du Moyen Age, notamment du XVIIe siècle, aujourd´hui encore accessibles dans les bassins miniers traditionnels. Ce sont en premier lieu Jihlava, Kutná Hora, Jáchymov, Příbram, Jílové et Starý Knín. Plusieurs mines historiques enregistrées comme telles et encore accessibles se trouvent dans les Monts Métallifères, dans la Forêt de Slavkov, dans les Monts des Géants et les Jeseníky. D´anciennes mines sont encore tenues en évidence à Adamov, Běleč, Blatná, Český Krumlov, Deštná, Hartmanice, Horáždovice, Hory Matky Boží, dans les Monts Kašperské, à Katovice, Kutěnín, dans les Monts Kašovské, à Němčice, Písek, dans les Monts Ratiborské, à Rejštejn, Rudolfov, Strakonice, Sušice, Velhartice, Vodňany, et ailleurs.

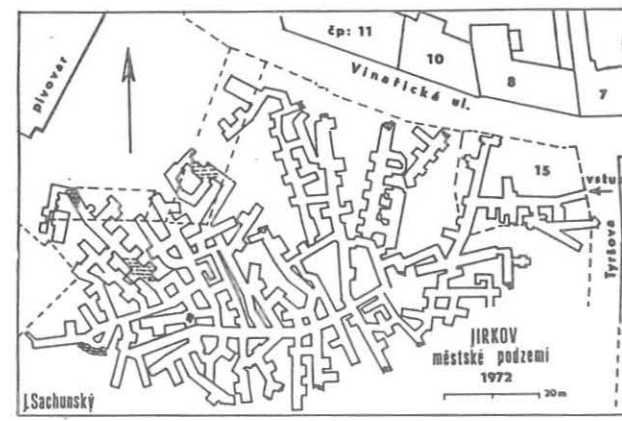
Parmi les mines autres que de minerais, nous avons comme exemples notamment les carrières de sable des XVIIIe et XIXe siècles sous le plateau de Prosek à Prague 9. Ce sont des dizaines de kilomètres de couloirs enchevêtrés en trois étages qui ont causé maintes difficultés dans les années 60 et 70. Des affaissements de terrain ont endommagé plusieurs maisons des rues Na Krocínce et Nad Kudrnatkou de sorte qu´une partie d´entre elles ont dû être consolidées par des mélanges de béton.

Un des exemples classiques d´ouvrage minier hydrotechnique est la galerie de Rudolf datant des années 1581 à 1584. Elle mesure plus d´un kilomètre de long et croise le méandre de la Vltava sous le plateau de Letná à Prague. Elle servait à alimenter les jets d´eau attractifs du jardin Renaissance dans









les domaines royaux. D'autres galeries en fonction de conducteurs d'eau ont été construites aux XVIIe et XVIIIe siècles au-dessus de Malá Strana sur les pentes de Petřín, au-dessus du cloître de Strahov et à partir de Stéčovice en direction du Château de Prague.

Les souterrains des villes, catacombes et corridors de forteresses

Des systèmes de corridors avec des pièces et des caves reliées entre elles étaient construits déjà au Moyen Age. A part les espaces attenant aux fossés des fondations des maisons bourgeoises et qui se distinguent par leurs voûtes roulées, ces systèmes comprennent des couloirs de communication et éventuellement des chambres creusés dans la roche primaire. Ils s'étendent en général sous les centres urbains avec parfois des couloirs radiaux se dirigeant vers les fortifications de la ville. Le but de ces systèmes souterrains était de défense et d'utilisation pratique (par exemple des caves, des caches ou des accès aux puits). Parmi les villes possédant des systèmes de souterrains bien développés, nous avons Plzeň, Brno, Jirkov, Tábor et Znojmo. Il y a des systèmes assez vastes à Jihlava, Mohelnice, Telč, Stříbro, Litoměřice, Klatovy, Vysoké Mýto, Kutná Hora, Havlíčkův Brod, Domažlice, Žlutice, Mnichovice près de Prague, Mladá Boleslav, Olomouc et dans plusieurs autres encore. Prague a un système de souterrains un peu différent. Les édifices du noyau historique construits sur le sable et le gravier de la plaine de la Vltava ne permettaient pas de fonder et d'assurer des espaces souterrains. Le sous-sol souvent inondé était plutôt haussé contre l'action de l'eau par des remblais. Les édifices baroques qui prédominent aujourd'hui ont donc dans leurs caves les rez-de-chaussée des maisons gothiques et romanes antérieures. Il en est ainsi par exemple dans la Vieille-Ville et à Malá Strana. Un des types particuliers de souterrains sont les égouts des villes où Cheb peut servir d'exemple.

Les souterrains de forteresses ont été développés dans la seconde moitié du XVIIIe siècle. Les corridors sont ordonnés suivant un certain système et traversent des ouvrages de briques de grande étendue. Ils servaient exclusivement à des fins de guerre. Terezín et surtout Josefov sont de tels systèmes. En systèmes de forteresse ont été reconstruits le Spilberk du Moyen Age, le château Vyšehrad de Prague et certaines anciennes fortifications de villes comme par exemple à Olomouc.

Les souterrains des châteaux-forts et de plaisance

La construction des espaces souterrains sous les châteaux-forts médiévaux, sous certaines places fortifiées de la Renaissance et sous les châteaux de plaisance baroques découlait de la mise en place des murailles des fondations. Il s'agit en général de cavités comme restes des fossés des fondations et, dans une moindre mesure, de corridors de communication creusés comme tels. Ils étaient ordinairement utilisés comme glacières et comme caves. Sporadiquement seulement ils ont été construits en tant qu'issues de secours. Dans certains châteaux, particulièrement si les conditions naturelles s'y prêtent, ces espaces souterrains ont été creusés directement dans les roches. Les cavernes ainsi creusées sont reliées à des constructions à murs ou en bois. Comme exemples de ce type nous avons les châteaux de Sloup et Svojkov à Česká Lípa, Frýdštejn, Valečov, Pařez et Drábské světničky dans le Paradis de Bohême. Parmi les constructions de châteaux à galeries souterraines, les plus intéressantes sont la galerie d'eau du ruisseau au puits de Karlštejn et les galeries entre les bastions du château de Sovinec.

Un des exemples remarquables de souterrains historiques construits déjà à l'époque romane et allant par l'apogée du Moyen Age jusqu'aux temps modernes est le Château de Prague. Il comprend au moins trois étages de cryptes, de chambres, de caves, de galeries souterraines, de corridors et de puits, qui dépassent l'aire du château lui-même. Ces souterrains ont eu de multiples fonctions: arrivée de l'eau, évacuation des ordures, défense, dépôts et réfrigération.

Les demeures et caches creusées dans le roc

Un des groupes particuliers des souterrains historiques est constitué par les cavités creusées dans les roches malléables à des fins d'habitation, d'exploitation économique ou comme caches. La région du plateau crayeux de Bohême est particulièrement adéquate pour ces objectifs. Dans les rochers de grès nous trouvons presque partout des creux, des cavités et des couloirs. Soit isolés, soit en groupes, ils servaient de caves aux bâtiments mais aussi de pièces d'habitation voisins attenant aux parois des rochers. Les fermes, les moulins et les chaumières jouxtant les rochers étendaient ainsi leur espace utile mais aussi habitationnel. De ce type est le moulin Konrad de Tubož où on a creusé un tunnel d'eau venant de l'étang et des chambres pour diverses installations de moulin. Non loin de là se trouve aussi les moulin Hlučovský dont sont restées seulement plusieurs cavités dans les rochers avec des fenêtres et des portails.

Dans la région de Kokořín, en Bohême centrale, nous trouvons des bâtiments souterrains du même caractère dans les monts Lužické, à Děčín, au Paradis de Bohême, dans les rochers Prachovské, à Ostaš, à Broumov, dans les environs de Prague, à Svitavy, Chřiby et partout en général où le sol s'y prête. A côté de bâtiments souterrains purement utilitaires, il y a beaucoup de ces espaces souterrains conservés qui apparemment n'ont aucune signification, comme s'ils avaient été creusés dans la roche tendre simplement comme témoins muets de la vanité humaine. Le point culminant de ce genre d'activités est le lieu dit "Klacelka" (Rocher branlant) près de Liběchov - un système souterrain abritant des reliefs sur les fables de Goethe.

Les cryptes

Les cryptes sont des cavités souterraines à caractère de caves creusées dans les roches ou dans la terre. Elles ont généralement des murs de pierres ou de briques. Elles se trouvent d'ordinaire sous des édifices ecclésiastiques. Leur construction était habituellement dictée par les besoins de la pose des murs des fondations. Ce n'est que secondairement qu'elles ont été utilisées comme sépultures dans les cas où elles n'étaient pas construites directement comme des tombes. Les cryptes devaient être, surtout du point de vue de la protection des édifices, bien asséchées par évacuation des eaux et aérées contre l'humidité du sol. C'est la principale raison pourquoi praticuement toutes les cryptes, si bien construites, offrent des conditions idéales au processus de momification qui exige l'assèchement des dépouilles mortelles

avec l'action parallèle d'un courant d'air permanent provoquant l'oxydation.

A Prague, les églises qui ont les plus vastes systèmes de cryptes sont celles de la Vierge Marie, rue des Carmélites, et de St.Nicolas à Malá Strana, de la Vierge Marie de Strahov, de St.Jacques et de St.François dans la Vieille-Ville et plusieurs autres. Il y a aussi de vastes cryptes sous les églises à Jablonné v Podještědí, à Benešov nad Ploučnicí, à Sedlec, à Sázava, à Poříčí nad Sázavou, à St.Jean pod Skalou, à Mělník, à Kuks, à Klášter u Nové Bystřice, à Kolín, à Jaroměř, à Hejnice, à Klatovy, à Kladruby, à Mnichov près de Mariánské Lázně, à Kralovice dans la région de Plzeň. De grandes cryptes se trouvent sous les églises de Brno où la plus connue est la crypte des Capucins, et sous les églises de Křtiny, Holešov, Jinošov, Opava, Sludov u Šumperka, Dolní Benešov, Postřelov, etc.

Les cavernes artificielles, les grottes et les sale terrene

Ce genre de souterrains, éventuellement de constructions historicues cuand elles sont situées au-dessus du terrain, font partie des menues formes bâties dans l'intention de signaler des cavernes naturelles ou des ouvrages miniers. Leur apparition est liée chez nous à la montée de la Renaissance. Elles proviennent d'Italie et sont en fait des imitations antiquisantes de l'architecture ornementale de l'époque romaine. Tandis que les grottes italiennes sont des cavernes artificielles indépendantes qui font l'ornement des jardins des châteaux de plaisance ou complètent des édifices cultuels (tombes, ermitages, grottes de Lourdes), les sale terrene sont des formations architecturales reliées aux constructions historicues. Elles sont situées dans les rez-de-chaussée ou les parties souterraines des palais ouvertes sur les jardins. Les intérieurs de ces deux types de cavernes artificielles sont des imitations de milieux naturels où se trouvent des parois karstiques, des revêtements en forme de rochers et diverses sculptures donnant une impression raffinée. Des quelques constructions rodolphiennes de la fin du XVIe siècle s'est conservée une telle grotte au Moulin de l'Empereur dans le bois Stromovka de Prague. Des exemples magnifiques de ce genre sont les grottes artificielles construites dans le mur d'enceinte du jardin Wallenstein et la grotte italienne ornée d'une fontaine et de stalagmites artificiels à côté de la loggia du palais Wallenstein. Parmi les grottes italiennes du château de Kroměříž, une a été aménagée en mine d'argent stylisée. Les sale terrene qui sont des transitions entre les intérieurs des palais et les jardins, ou bien sont situées comme des pavillons solitaires et évoquent l'ambiance des espaces souterrains, se retrouvent dans beaucoup d'architectures baroques, par exemple au Jardin des Fleurs de Kroměříž, aux châteaux de Troja, du jardin Vrtbov et au palais Michnov de Prague, aux châteaux de Starý Kestřany, Český Krumlov, Libochovice, Ploskovice, Klášterec nad Ohří, Valčí Syšice, Bon Repos, Kuks, Lednice et à Prague à Grébovka. Dans une forme naturelle brute a été construite vers la fin du XVIIIe siècle une caverne tunnel sur une imitation de rivière souterraine au jardin du château de Veltrusy.

Une des formes des grottes artificielles de châteaux de plaisance sont les intérieurs cultuels évoquant l'aspect de grottes comme par exemple à l'église de Marie-Madelaine près de Mníšek, à la chapelle de St.Elie au parc Vojan de Prague, dans les églises de Jaroměřice, Chabařovice, Živohošť, etc.

Les souterrains historiques englobant aussi bien les anciens ouvrages de mines dans des milieux rocheux que les bâtiments architectureaux appartiennent aux précieux spécimens du patrimoine culturel. Leur étude est importante non seulement pour protéger et assurer la stabilité des édifices mais aussi du point de vue des soins aux monuments historiques. Plusieurs d'entre eux sont effectivement des monuments historiques que l'on peut présenter au public, comme en témoignent par exemple les souterrains très visités des villes de Tábor et de Znojmo, les cavernes artificielles de Rudec, les mines de Kutná Hora et les souterrains de Žlutice.

EVIDENCE OF HYDROLOGICAL SIGNIFICANCE OF EPIKARSTIC ZONE FROM STUDY OF OXIGEN ISOTOPE COMPOSITION OF WATER, ARABICA MASSIF, WESTERN CAUCASUS

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ABSTRACT: This paper stresses out the important hydrogeologic and morphogenetic role of the epikarstic (subsurface, subcutaneous) zone of the autogenic karst massives. The differences in permeability and hydraulic conductivity between the epikarstic zone and underlying block zone compose an important percolation threshould in the top of the non-saturated zone.

This threshould determines important hydrogeologic and morphogenetic consequences. Water storage occurs in the epikarstic zone and leakage from this store focuses along the main fissures maintaining the base shaft flow. The model is described of evolution of the potholes and related forms under such circumstances.

In the Arabica massif the epikarstic zone and water-absorbing apparatus is restored after Würm glaciation. The study of oxigen isotope composition of waters shows a significant retaining of the precipitation in the epikarstic aquifer which acts as a flow regulator.

РЕЗЮМЕ: В работе подчеркнута важная гидрогеологическая и морфогенетическая роль эпикарстовой зоны (приповерхностной) автогенных карстовых массивов. Различия в проницаемости и водопроводимости между эпикарстовой зоной и нижележащей блоковой зоной образуют важный фильтрационный порог в верхней части зоны аэрации.

Этот порог определяет существенные гидрогеологические и морфогенетические следствия. В эпикарстовой зоне происходит накопление вод, которые затем срабатываются в нижележащую блоковую зону по главным трещинам, обеспечивая базовый шахтный сток. Описана модель эволюции шахт и связанных форм в таких условиях.

На массиве Арабика эпикарстовая зона и водопоглощающий аппарат карста были восстановлены после вюрмского оледенения. Изучение изотопного состава кислорода вод показывает значительную задержку осадков в эпикарстовом водоносном горизонте, который действует в качестве регулятора стока.

1. INTRODUCTION

During last 10 years it was shown the enormous importance of the immediate subsurface zone in hydrogeologic and morphogenetic processes in karst massives with autogenic recharge. Several works were specialy devoted to this topic (Drogue, 1980; Gunn, 1983; Klimchouk et al., 1979, 1981; Klimchouk, 1987; Williams, 1983).

The term of "subcutaneous" and "epikarstic" are also used for this zone. In this paper we shall use the term of "epikarstic" zone.

The conception about the role of the epikarstic zone is not yet wide spreaded but it is of fundamental importance in karst hydrogeology and geomorfology. Some evidences of this are presented in this paper with related discussion.

2. PRINCIPAL FEATURES OF EPIKARSTIC ZONE. FIRST PERCOLATION THRESHOLD.

The epikarstic zone is located the top of the karst rock mass, immediate under surface or soil cover, and has an average depth ranging from 1 to 10 m. This zone is directly affected by climatilogic factors, by processes of weathering. This is why the epikarstic zone is highly fissured and karstifiated. Very high permeability and hydraulic conductivity is characteristic for this zone. Duty to high absorbing ability of rock surface in the bare karst this zone takes a diffuse recharge from precipitation.

Beneath the epikarstic zone the main non-saturated karst rock mass is located which is much more randomly fractured and divided by main fissures into large blocks. So, we shall use the name of "block" zone for the rock mass located beneath the epikarstic zone. Hydraulic conductivity in the block zone is much more anisotropic and heterogeneous in area then it is in the epikarstic zone. High vertical water conductivity is determined by large fissures. So, downward rapid water percolation is localized along such large fissures.

A significant differences of structure and hydraulic conductivity between the epikarstic zone and underlying block zone compose an important percolation threshold in the top of the non-saturated zone. This threshould causes the particular hydrogeologic and morphogenetic processes and this is the main point.

The following features are characterized for the epikarstic zone:

1) it represents a significant reservoir the water is stored in which because of difference in hydraulic conductivity between epikarstic and underlying zones.

2) the water flow within the epikarstic zone has a significant lateral component toward the nearest large and deep fissures.

3) initialy diffuse water flow is transformed into much more localized shaft flow passing over above mentioned threshould.

4) being able to store water after rainfalls the epikarstic zone plays a very important regulative role maintaining the water inflow to the large fissures (shafts) and, eventualy, to the spring discharge.

3. MORPHOGENETIC SIGNIFICANCE

These hydrogeologic features cause the important morphogenetic consequences. Williams (1983) has suggested the model of the evolution of the solution sinkholes based on the above mentioned features. In our works (Klimchouk et al., 1979; 1981; Klimchouk, 1987) these features have also been examined and the model has been suggested of evolution of the karst potholes and related forms such as karren fields and sinkholes (Figure 1).

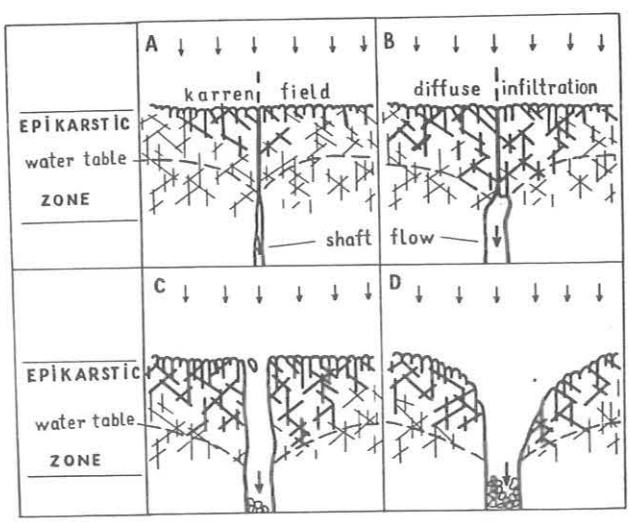

Figure 1. Evolution of the potholes and related forms under specific processes in the epikarstic zone. A, B, C, D - stages of development (see text). (Klimchouk et al., 1979, 1981).

Initialy,potholes develop as subsurface forms having no open entrances (Figure 1,A). The main fissure takes a localized water inflow not from the surface but from the base of the epikarstic zone so that the pothole can be formed up without open entrance (Figure 1,B). Then a breakdown occurs of the disconnected mass on the top of the pothole (Figure 1,C) and development of the sinkhole begins what is prepared by active corrosion within limits of the depression cone in the epikarstic water table (Fig.1D).

4. HYDROGEOLOGIC SIGNIFICANCE: EVIDENCE FROM ARABICA MASSIF

Storage capacity of the epikarstic zone and presence of the perched epikarstic aquifer is very important flow regulator of the karst system. This aspect have been considered in the above mentioned works and also in the papers by Bacalowicz et.al.(1974), Drogue(1980),Gunn(1983),Mangin (1976). Recent study in the Arabica massif,Western Caucasus, gave us new evidence of hydrogeologic significance of the epikarstic zone.

The Arabica massif represents more complicated case then other massives with normal karst surfaces. The development of the karst landscape was strongly affected here by the Plejstocene glaciation. Mature water-absorbing apparatus of the karst including the epikarstic zone was scored by exaration and karst-glacial landscape was formed there. During the Post-Würm time the restoration is proceeding of the epikarstic zone and surface karst landforms. Now the epikarstic zone is evident morphologically in the most naked areas and has a visible thickness up to few meters.

The study of oxigen isotope composition of precipitation and shaft flow has proved that the new epikarstic zone is well-enough formed to play a distinctive role as a water store reservoir and flow regulator.

The samples were taken at August during two years from local snow stores in the recharge area of the Kujbyshevskaja shaft,at the altitude of about 2200 m a.s.l., from local precipitation at the same altitude,and also from shaft flow in the 4 depth points from -150 m up to -900 m (Figure 2).

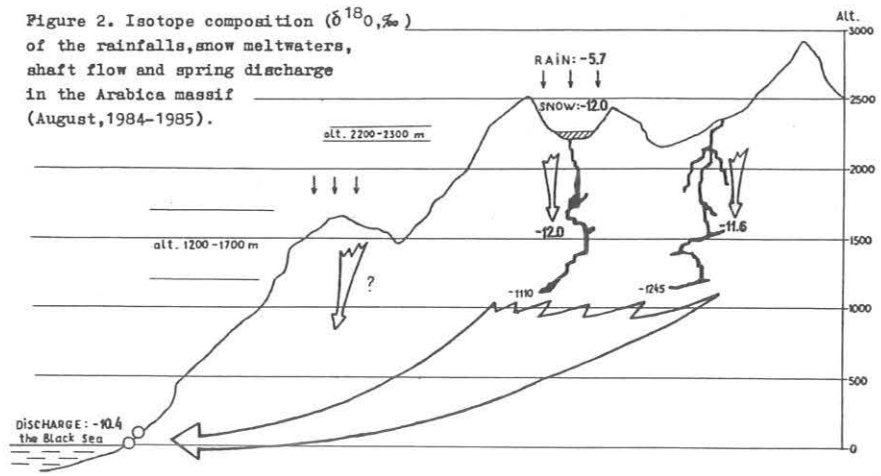

Figure 2. Isotope composition ($\delta^{18}O$,‰) of the rainfalls,snow meltwaters, shaft flow and spring discharge in the Arabica massif (August,1984-1985).

Isotope composition ($\delta^{18}O$) of snow (5 samples) shows nearly no variations; mean value is -12.0‰. Local presipitations (6 samples) displays a considerable variations in isotope composition with $\delta^{18}O$ range from -4.3 up to -7.6‰. Mean value is -5.7‰. The shaft flow (6 samples) has no variations and demonstrates the value of -12.0‰,the same as a snow meltwater. It is neither depends from depth nor from time,rain events or flow regime.

Isotope composition of the spring discharge water (6 samples) has small variations $\delta^{18}O$ within -10.2 ÷ -11.0‰ and mean value of -10.4‰. So far as isotope exchange is very negligible on the way of the flow in the massif the more heavy composition of the discharge water then of the shaft flow may display additional recharge from the lower catchment areas.

The most interesting feature was clearly observed that the strong rainfalls with comparatively heavy isotope composition caused a flood responces in the shaft flow, but there were no any associated variations in the isotope composition of the shaft flow.

So, we can conclude first that the isotope composition of the shaft flow is very stable and corresponds with the composition of snow meltwater. In fact, at August the recharge from snow meltwater is very negligible but it is quite significant during the late Spring - early Summer. The main recharge at August actually occurs from infiltration of rain precipitations.

So, we can conclude second that the flood impulses caused by the rainfalls at August consist of "old" snow meltwater previously stored into the epikarstic reservoir. These floods are not maintained by the current infiltration of the rain water. Infiltration from the rainfalls causes only an impulse wave forcing out the "old" water store from the epikarstic zone. The same evidence was shown by Bacalowicz et al.(1974) from the Ryrenees' massif.

The principal conclution is that the isotopic data has shown a hydrogeologic significance of the epikarstic zone which acts as a water store and karst flow regulator.

This zone in the Arabica massif was quite well-formed during the post-glacial time.

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GENESIS OF CARBON DIOXIDE OF AIR IN UKRAINIAN CAVES

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ABSTRACT: About 700 measurements of air gas composition have been carried out in the caves of the Ukraine and Crimea. These data show high CO2 content in the cave atmosphere. Different sources are refferd usialy as possible for CO2 supply. It is shown in this paper that study of carbon isotope composition can be an useful tool for determining of genesis of CO2 in the cave air.

It is discovered that CO2 in the Bucovinian caves is produced in the Neogenic aquifer by oxidation of methane which comes from underlying thickness. Carbon of such CO2 is isotopically lighten. In the Podolian caves CO2 produces by decomposition of organic matter. CO2 in the Krasnaya Cave in the Crimea comes from the coil cover and also produces by decomposition of organic matter. Deep origin of CO2 is not confirmed in any case.

РЕЗЮМЕ: Более 700 измерений газового состава воздуха,проведенные в пещерах Западной Украины и Крыма, показывают повышенное в различной степени содержание CO2. В литературе обычно отмечаются различные возможные источники поступления CO2 в атмосферу пещер. В статье показано,что эффективным методом выявления генезиса CO2 может быть изучение изотопного состава углерода.

Установлено,что избыточная двуокись углерода в пещерах Буковины образуется в неогеновом водоносном горизонте,главным образом,за счет окисления поступающего снизу метана.Углерод такого CO2 является изотопно облегченным. В пещерах Подолии CO2 образуется за счет разложения органики. В Красной пещере Крыма CO2 привносится от почвенного слоя, а в ближней части образуется за счет разложения органики. Глубинное происхождение CO2 не подтверждается ни в одном случае.

1. INTRODUCTION: POSSIBLE SOURCES OF CO2 IN CAVE AIR

It is known that different processes can be responsible for high content of the carbon dioxide in the cave air (Ek,Gewelet. 1985;James,1977,and others). Carbon dioxide can come into cave atmosphere from the coil where produced,with air flow or with water seepage through fissures. Also carbon dioxide can be produced just in the cave by decomposition of present organic matter. These two sources of CO2 are reffered most frequently in the discussions of carbon dioxide genesis in the caves.

Besides the carbon dioxide can be generated by other reactions and also can come from the earth depth along the faults. It is important and intresting in the certain case studies to reveal the actual sources of the carbon dioxide and their relative significance.

Some conclusions on the CO2 genesis can be done by analysis of the content variability. But, taking into account of complexness and uncertainity of relations between different active factors,it is quite seldom the clear conclusions can be done only using such kind of analysis.

The study of isotope composition of the carbon can provide useful data in solving of the CO2 genesis problem.

2. STUDIED CAVES AND REGIONS

About 700 measurements of the CO2 content have been carried out in the Ukrainian caves during last 10 years,principaly in the gypsum caves of the Western Ukraine and also in the caves of the Crimea Mountains. Spatial distribution and temporal variability of the CO2 content have been studied in relation with cave morphology and different active factors such as climatic conditions,air flow circulation,water percolation,streams and so on. Some results of this study have been reported in the several papers (Klimchouk et al.1981, 1984).

In the Western Ukraine the studied caves are developed in the Neogenic gypsum strata and located in different geological and hydrogeological settings (Klimchouk & Andrejchouk,1986). In the Podol'sky subregion most of the large maze caves are situated such as Optimisticheskaya,Ozernaya,Kristal'naya,Atlantida and others. The gypsum strata is dismembered and drained here by erosional network for a whole thickness. So, the gypsum strata is aerated and vadose conditions prevails.

In the Bukovinsky subregion the gypsum strata is dissected and drained by the erosional network only for a part of the whole thickness or is not dissected at all. So, the water table conditions or phreatic aquifer in the gypsum strata are prevailing settings of modern karst development in the Bukovinsky subregion. The Zolushka Cave with more than 80 km mapped passages represens the water table conditions. This cave became being accessible duty to gypsum guarry and water withdrawal.

There are significant differences in the air gas composition between caves of the Podol'sky and Bukovinsky subredions (Table 1).

Nearly 300 analysis in the different caves of the Podol'sky region show the average CO2 content of 0.41%.

In the Zolushka Cave in the Bukovinsky subregion the carbon dioxide content is much higher: an average content from 146 measurements is of 1.23%. A maximal value of 4.45% was measured here.

In both subregions a clear seasonal variability is observed with maximal content of CO2 by winter and minimal content by summer. It is quite opposite to what is usialy reffered for CO2 variability in caves of other regions.

In the Crimean Mountans the cave air gas composition have been studied mainly in the Krasnaya Cave (Red Cave). This cave with total length of 14 km is developed in the limestone massif and has the nearest multilevelled series with several entrances and farest linear series with large underground river. 174 measurements have been carried out in this cave.

The average CO2 content is of 0.19% in the hearest series and 0.27% in the farest series. For the whole cave an average CO2 content is 0.21%. There is a clear seasonal variability in the nearest series with a maximal content by summer and minimal - by winter. In the farest series seasonal variability is not displayed.

Table 1. CO2 CONTENT IN THE CAVE AIR

Region (caves)	Number of measurem.	Mean CO2 content,vol.% whole year	summer	winter
PODOLIA (caves:Optimisticheskaya,Kristal'naya,Mlynki,Atlantida,etc.)	282	0.41	0.25	1.0
BUKOVINA (Zolushka Cave)	146	1.21	0.96	2.74
CRIMEA	174	0.21		
Krasnaya Cave:				
- nearest series	51	0.19	0.37	0.13
- farest series	123	0.27	0.27	0.27

3. ISOTOPE DATA AND CO2 GENESIS

3.1. General ground

The possibility to reveal the CO2 genesis in the cave air using isotope data is based on distinctive differences in the isotope composition of carbon originated from different sources (Table 2).

Table 2. ISOTOPE COMPOSITION OF CARBON OF DIFFERENT ORIGIN

ORIGIN	δ 13C, ‰, PDB mean	range	
CO2 in the outside atmosphere	- 7.0		
Surface plants in the temperate zone	-25.1		
Organic matter of fresh water silts and river sediments	-26.1		
CO2 of soil atmosphere in the temperate zone	-24.1	-18.0	-28.0
CO2 of deep origin		+12.8	-21.9
Methane, in general	-41.0	-34.0	-80.0
Methane produced by anaerobic bacteria	-63.0		
CO2 in cave atmosphere:			
- Crimean caves	-24.4	-20.7	-29.0
- Podolian caves	-25.8	-23.7	-28.9
- Bukovinian caves	-31.5	-26.2	-42.7

*General data are taken from Galimov,1968

Carbon dioxide of the outside atmosphere has carbon with the isotope composition of about $\delta^{13}C$ -7.0‰ . Carbon of surface plants,organic matter and soil CO2 has a composition of about -24.0 ... -26,0 ‰ . Carbon dioxide of deep originated gases has usialy much more heavy carbon. which composition is up to positive values. And,after all, the more isotopicaly light carbon then of organic matter can be produced from nothing else,but methane.

3.2. Sampling and analysis

Analysis of isotope composition of carbon were made using mass-spectpometer MI-1201. CO2 separation from cave air for analysing is carried out by barbotation of the air through barium hydrate solution. In the laboratory the concentrated product is subjected to the phosphoric acid procession and the escaped CO2 gas is introduced into mass-spectrometer after refining.

3.3. Results and discussion

We have 10 analysis from the Podolian caves showing the mean composition of -25.8 ‰,which is close to the carbon composition of organic matter. Duty to geological conditions (gypsum strata is overlied be thickness of clay sediments) there is no CO2 supply from the soil here, so that main source of the carbon dioxide is decomposition of organic matter.

We have 15 isotope analysis from the Zolushka Cave in the Bukovinsky subregion showing the mean carbon composition of -31.5 ‰ . The maximal value is -42.7 ‰ . So lighten carbon can be originated from nothing else but methane.

To explaine this the following model is suggested. The Pre-Carpathian region including Bukovina is an oil and gas field where hydrocarbons are widely spreaded in sedimentary cover. Methane coming into aquifer of the Neogenic rocks from underlying thickness is oxidised to CO2 in oxigen-rich karst water. Such CO2 with isotopically light carbon combines with calcium ions to form secondary calcite as a replacement of gypsum. The epigenetic limestones named Ratynsky of 1...15 m thickness is always present in the top of the gypsum strata in the Pre-Carpathian region. Numerous studies in the region has shown that isotopic composition of the gypsum related Ratynsky limestone is very light: $\delta^{13}C$ from -42.0 up to -65.0 ‰ . Metasomatic origin of this limestone was suggested but the source of CO2 for such a process was problematic. Now CO2 with isotopically light carbon[15] discovered in cave atmosphere in the region.

It should be pointed out that CO2 production in the Neogenic aquifer is an important part of the sulfate-reduction processes which generate H2S by the metabolic reactions of anaerobic bacteria. After CO2 enrichment karst water flows toward the Pre-Carpathian foredeep coming into the anaerobic zone where sulfate reduction processes take place.

Thus, discovering of the isotopically-lighten carbon in the CO2 of the cave air is in good agreement with and contributes an important data to the regional hydrogeoghemistry.

Isotope analysis from the Krasnaya Cave in the Crimea show the mean carbon composition of -24.4 ‰ . In this cave the carbon dioxide can be supplied from two sources: 1) from the soil atmosphere and 2) from the decomposition of organic matter.

And, eventually,the CO2 supply from deep sources can be excluded from consideration or regarded as very negligible in all three mentioned cases.

Thus,the study of carbon isotope composition of CO2 can be an useful instrument to determine the carbon dioxide genesis. In this particular study the isotope data allowed to find the unusial source of CO2 in the Bukovinian caves and to exclude CO2 supply from the depth as possible source. The last was supposed (Dubljansky & Lomaev,1980) as a main cause of the high CO2 content in the Ukrainian caves.

Figure 1 summarizes the ideas on sources of CO2 supply in the studied caves.

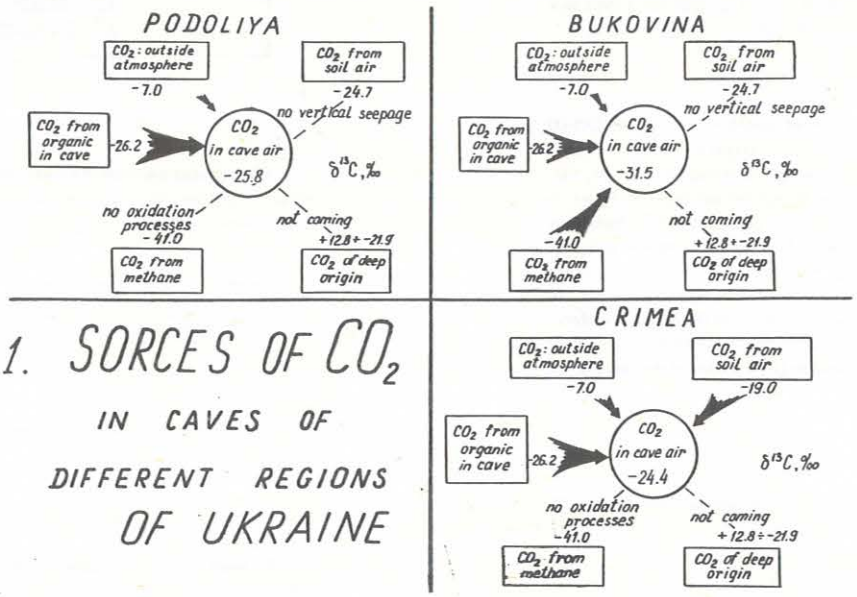

Fig. 1. SORCES OF CO_2 IN CAVES OF DIFFERENT REGIONS OF UKRAINE

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THE CAVE REGISTRATION SYSTEM OF THE SPELEOLOGICAL INSTITUTE

SZEKELY, Kinga

Keeping files and collection-processing of documentary evidence on caves are essential prerequisites of their conservation, planned and effective management, as well as of further exploratory and scientific research work.

Several efforts have been made since 1910 in Hungary at registering the caves in the country. Although several noteworthy results have been achieved in this field, no updated cave register had been compiled up to 1981.

The present filing and registration system was then developed at the Speleological Section (renamed since the Speleological Institute) within the National Authority of Nature Conservation and Environmental Protection.

The aim was to collect the relevant information in a form suited to manual and computerized data processing alike and to present information not only on the caves, but also on the explorations and studies conducted in them, so as to compile in this way a data bank containing all essential documentary material.

The cave cadastral numbering system developed as early as 1971-72 at the Documentation Section of the Hungarian Karst and Cave Exploration Society has been adopted by the Speleological Section, too. This is compatible with the system introduced and found efficient in Austria as well. The system is based on a gradual, four-level geographical area division. Following the number of the smallest area unit, serial numbers are assigned to the caves in that particular unit.

According to the provisions of the Nature Conservation Act, in which the protection and conservation of caves is declared obligatory, registration must be extended to all natural cavities, which have a closed length over 2 m and crossectional dimensions making it accessible to man.

The registration system adopted by the Speleological Section is organized as follows:

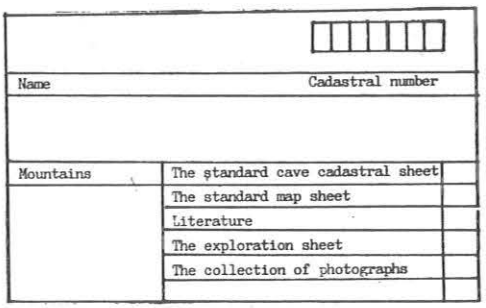
I. Cave inventory
II. Cave cadaster
  1. Primary sheets - the standard cave cadastral sheet
    - the standard map sheet
    - the exploration sheet
    - literature
    - collection of photographs
  2. Documentation - literature
    - map
    - photographic
III. Topographic maps (1:10 000)

I. Cave inventory

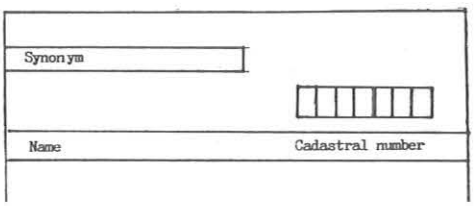
The cave inventory provides assistance in locating and identifiying the caves by name. It contains the cadastral filing number under which the relevant material can be retrieved from the cadastral files.

The cave inventory includes three 125 by 75 mm doubleweight cards in different colours.

A white card is set up on each cave processed, showing the name and cadastral number of the cave, further the mountain, town or village in the area of which it is located. The symbols on the right-hand margin of the card provide information on the standard sheet and documentation to be found in the Cave Cadaster.



The red card contains the synonimous names of each cave processed, showing besides the synonims also the official name and cadastral filing number.



A green card is prepared on each artificial cavity which is mentioned as cave in the literature, or which could be classified as a cave without information about its origin. The card contains data that are identical to those on the white card.

The white and coloured cards are stored in alphabetical order in the file boxes.

II. The cave cadaster

The objective of the cave cadaster is to collect all relevant data on the caves by cave, to indicate the sources whence the materials can be retrieved, to acquire any important missing data and to store these at a single location.

The matrial of the cave cadaster is conserved in a 135 by 60 by 42 cm steel box provided with 30 cm high drawers, by cadastral units, in a growing order of serial numbers. The material on a particular cave is separated from the rest by cardboard sheets showing the name and cadastral number of the cave.

1. The p r i m a r y s h e e t s of A/4 format are doubleweight, double-side, printed cards, each displaying the name and cadastral number of the cave.

The standard cave cadastral sheet

Contains all relevant data on a particualar cave. The printed form with 33 items is filled in two copies. The sheet printed on normal paper is intended to serve as manuscript in field work, while the doubleweight copy duly filled in is stored in the files.

The typical answers are preprinted on the field worksheet, of which the relevant one is underlined. Only the particular, specific parameters and auxiliary data need be entered manually.

On the doubleweight standard sheet the titles of the 33 items are preprinted. The open space below serves to enter the relevant data.

STANDARD CAVE CADASTRAL SHEET

1. Name of the cave _____

2. Cadastral number ☐☐☐☐☐☐

3. Synonyms			4. Co-ordinates of the entrance X: Y: Z:
5. Mountains	6. County	7. Town	8. Entrance
9. Length	10. Max.horiz,extention	11. Depth	12. Cubical contents
13. Bedrock	14 Genetic charasteristics	15. Character	16. Morphological characteristics
17. Solid fillings	18. Cave air /CO_2	19. Cave waters	20. Processing

22. Discovery		21. General plan
23. Recquired technical equipments		
24. Manager, attendant, utilizer		
25. Conditions of visiting	26. Organ for visitor's permit	
27. Reason of lock-up	28. Purpose of developing 29. Developed length	32. Notes
30. Artifical establishments		
31. Endangerment		
33. Filled out by	Completed by	

The standard map sheet

Provides information by cave on the cartographic material registered in the files. The data of the maps are presented in tabular form for rapid orientation and choice of the map needed for a particular purpose.

The year of survey, the names of the surveyor and plotter, the surveying equipment, the scale of the map, the projection system, material of the map and place of storage must be entered on the standard sheet by cave.

THE STANDARD MAP SHEET

Name of the cave

Cadastral number

	Year	Name of the surveyer and plotter	The surveying equipment	Scala	Projection system	Material	Place	Else
1.								
2.								

Literature

The literary references are entered on the literature sheet according to the rules of bibliographical description. Under each reference (up to 18) there are 13 numbered boxes: 1. Exploration, 2. Geology, 3. Genetics, 4. Hydrology, 5. Climatetherapeutics, 6. Geophysics, 7. Palaeontology, 7. Archaeology, 9. Biology, 10. Maps, 11. Photographs, 12. Description and exploration of the cave, 13. Miscellaneous.

The "x" in a box provides information on the contents of the reference.

LITERATURE

Name of the cave

Cadastral number

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.

The exploration sheet

Cave explorations in Hungary are subject to a license by the nature conservation authority. The license is obliged to submit a report on his/her activities at the end of each year.

The standard sheet on explorations is intended to provide a quick review of the data figuring in the annual reports of the cave exploration groups, indicating the name of the explorer and the type of work performed in a particular cave.

The standard sheet shows the name of the group, the year of reporting and the 13 items included also on the sheet of literary references. Since the reports compiled by the groups on the work performed in the cave may be descriptive, or contain specific data, each item is split into two parts. The information is presented by an "x" in the corresponding part.

THE EXPLORATION SHEET

Name of the cave

Cadastral number

Name of group	Year	1	2	3	4	5	6	7	8	9	10	11	12	13

The collection of photographs

The summary sheet provides information by cave on the coloured and black-and-white prints and their negatives which form the property of the Speleological Section and the prints, whose negatives are in the possession of persons external to the Section.

The location, time and author of the photograph, the material, size, place of storage and number of the negative must be entered on the filing sheet.

THE COLLECTION OF PHOTOGRAPHS

Name of the cave

Cadastral number

	Photo			Material size	Place of storage	Number of negativ	Else
	Location	Year	Author				
1							
2							
3							

PHOTOGRAPHIC

Cadastral number | Number of the Phot.

Photo	The location
	Title of the photo
	Material and size of negative
	Date
	Identification
	Name of the photographer
	Address of the photographer

Notes	Place of storage Number
	Enlargement
	Else

2. The **documentary material** (maps, text and photographs) is conserved in folders by caves in accordance with the primary sheets of the cadaster.

The **literature** contains original material, or copies thereof, as shown on the primary literature sheet. All available meterial of major importance is included. Literature of inferior importance, or containing no additional information is not collected, just as longer papers, books, reports and treatizes, which are found in the library, or archival stock of the Speleological Section.

The **map collection** contains all available cartographic material in original form, or in copies, wihch are shown on the standard sheet of maps. Not included in the cadaster are the original transparencies of the maps, nor the larger maps attached to the books, reports or treatises available at the Section.

The **photographic collection** includes the prints representing the entrance and the interior of the cave. Normally these are 18 by 18 cm enlargements glued to filing cards. These show the serial number of the photograph, the material and size of the negative, the location, title, caption, time and identification of the photograph, the name and address of the photographer, notes on the circumstances and contents of shooting, the location and number of storage, further the existence of any existing further copies.

The slides are stored according to size and in time order, together with the negatives, if any.

III. Topographic maps

For registering the location of the caves, for establishing theor coordinates and for identification in the field topographic maps of 1:10 000 scale are plotted.

Cave data have been registered continuously at the Speleological Institute ever since the introduction of the above system. The caves known by verbal communication or from the literature are entered into the preparatory file. The data contained in the cadaster are entered only after verification in the field by the Institute.

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CAVE GEOLOGY OF THE BAIKAL LAKE SHORE

FILIPPOV, Andrey

resume p. 583

In our days there are 56 karst caves known within 30 km wide shore line surrounding the Baikal. Among them, 45 caves have total extent of 3658 m, depth 369 m, amplitude 419 m and total volume 14950 cub.m. They are spread along the western coast on the limits of the Primorskii ridge, Priolkhonskoe plateau and Olkhon island. Along the whole Baikal coast and on islands there are numerous wave-cut caves in different rocks, including those susceptible to karstification (marbles etc.), but they are not the subject of our consideration.

The Priolkhonskoe plateau and Olkhon represent a higly separated high-uplifted Paleogenic peneplain with absolute elevations 900-1200 m, covered by steppes and partly by pine-tree forests. The Primorskii ridge is a low-medium mountain about 1700 high covered by the forest.Caves in the limits of a ridge are stripped by the processes of denudation at different heights over the Baikal predominantly in the river valley slopes. On the Priolkhonskoe plateau the cave entrances are located on the levelled surfaces and slopes of positive relief forms.

The most ancient soluble rocks containing caves are marbles and calciphyres of the Olkhonsk series of Upper Archean-Lower Proterozoic age. In calcitic marbles there are located 14 caves, including the largest - Aya, Mechta, Oktyabrskaya, in calciphyres - Tonta, Khurganskaya caves. In brecciform dolomitic marbles are the Zunduk cave.

Calcitic marbles are micro- and medium-crystalline, white, light-yellow, light-grey colour, graphite-bearing. The graphite dessiminated in rocks as scales with size up to 3 mm in cross-section and make up to 5 %. Layers of pure marbles without scales of graphite are rare. The continuous coating of graphite on bedding planes is frequent. Constant minor and accessory minerals are clinopyroxene - diopside, quartz and plagioclase (andesine), tremolite, mica (muskovite and phlogopite), apatite. The garnet, sphen, epidote, zircon, rutile are rare. Most of the marble specimens have signs of cataclasm and are well-defined through a microscope. Structures of rocks are grano-, micrograno-, heterograno- and lepidoblastic, sometimes brecciated, changing to kataclastic and milonitic.

Marbles of the Aya speleo-section steeply dip at an angle 68-85 , along the azimuth 130-172 . In the Aya cave on channels walls crop out by dissolution boudins of altered dirty-grey quartz-feldspatic gneisses, grey granitized crystalline plagioclastic schists with gtaphite (5 %) and sphene (1 %). Rocks contain up to 30 % of microcline, 20 % of quartz and 3 % of muscovite. Boudins reache 5-40 cm across. Caves Aya and Vologodskogo are peculiar for the presence in marbles of a thin-layer (10-50 cm) lit-par-lit concordant intrusions (dikes) of pegmatoidal granites. Elements of the bedding of dikes correspond or are close to elements of striation bedding. In the gouges of dikes is an extensively developed graphitization as 0,2-3 cm thick layers, sometimes quartz veins with graphite 3-5 cm thick. On some parts marbles are skarned and acquire a spotted colour with cherry spots. In them appear scapolite, apatite, phlogopite in amount of 2-3 %, microcline, sphene and rutile. In the Oktyabrskaya cave one of the passages intersects the layer of black quartzites (azimuth of the dip 190 , angle of the dip 50) 0,5 m thick and is saturated by the graphite. Many passages pass along the strike of karstifying rocks. The insoluble rock inclusions - boudins, dikes and beds - caurse the formation of scree and rock waste taluses and other accumulations of clastic material.

In the caves-sections of Mechta, are rare boudinaged iterlayers of quartzites with thickness 5-20 m and skarn zones up to several metres are met. In quartzites 70-95 % represented by quartz grains, 15 % - by carbonates, 10-12 % - plagioclase, 3-5 % - graphite, magnetite, clinopyroxene and muscovite. Skarns contain grains of calcite and diopside; in different ratios as minor minerals are plagioclase, tremolite, plagioclase, tremolite, fuchsite.

The Tonta and Khurganskaya caves are in lenses of light- and yellow-grey calciphyres - medium crystalline rocks, composed predominantly by calcite (80-90 %) with diopside (10-15 %), forsterite (5 %), tremolite (5 %), flogopite (3 %), guartz (12 %), plagioclase (8-15 %), scapolite (5 %). Among accessories, most common are sphene and apatite; among minor minerals - albite, guartz, sericite, epidote, iron hydroxides. Rocks are micro-medium crystalline and sizes of minerals usually do not exceed 5 mm, excluding feldspars, whose crystals are 3 cm across. Calciphyres in the area of the Tonta cave form on the surface the lens with observed thickness 35 . Calciphires are steeply dipping along the azimuth 150-180 under the angle 80-88 Streals in banded texture are 10-20 cm thick. In the calciphires are widespread angular and smoothly outlined boudins of grey quartzites with sizes from several centimetres to the first tens centimetres and also boudins of feldspar-quartz-amphibolic rocks up to 3 m long and 1,5 m thick. Calciphires of the Khurganskaya dip at an angle 73 and azimuth 135 . On the ceiling and walls there are many whimsical protrusions - reparated boudins of feldspar-diopside-hornblendic, plagioclase-diopsidic rocks (orthogabbro). Miheral content of the first is: diopside 25-35 %, hornblende - 20-30 %, plagioclase - 18-30, quartz - 7 %, biotite 5-7 %. Among secondary minerals there are : muscovite - up to 3 %, amphibole, developed along the cracks - 7 %, chlorite - up to 2 %, carbonate. Among the accessories - magnetite, apatite, rutile, zirkon. The texture of rocks is hetero- and

lepidogranoblastic. The Zunduk cave is in brecciform dolomitic marbles of spotted yellow and delicate-lilac colour, with chaotic texture.

Caves of Garma, Elovka, Kurtun, Kurta and Goloustnaya speleosections located in dark-grey limestones, limestones of dolomitic and dolomitized calciferous dolomites, dolomites of the Goloustenskaya suite of the Upper Proterozoic. The Goloustenskaya suite extends along the Baikal in central parts of the Primorskii ridge. Bedding of karstifying rocks is irregular, angles of the dip vary from 42 to 12 , the azimuth of dip - from 305 to 120 . Zones of fracturing are common from several centimetres to the first tens of centimetres. Very often the rocks are cataclized or kakiritized. The Zagadai cave locates in the stromatolitic biogerm of Upper Proterozoic age. In the walls and cave roofs of passages are well reparated stromatolitic constructions. The Mugan and Trekhgolovaya are formed in the cilicified crystal bearing carbonate rocks of the Upper Proterozoic, pierced by series of quartz veins.

According to associations of infilling deposits, evolutions of the cave infilling are distinctly subdivided the caves of Priolkhonsk plateau and caves of Primorskii ridge. The first are characterized by the presence in the bottoms of sections the argillites filler with thickness from 1,1 m (the Aya cave) to 6,5 m (the Mechta cave) presumably of Paleogenic age, deposited in the underground lakes with dead water. The argillites have middle e of lithification with red-brown (Mechta), brown-fallow (Tonta), white, light-fallow-grey,grey (Aya), bright-yellow (Bolshaya Baidinskaya) colour, display thin tarry horizontal parallel layering with thickness of interlayers from fructions of millimeter (dark layers) to 0,5-2 mm(light layers). In argillites of the Mechta cave there are many scales of grafite along the bedding planes. Argillites are characterized by the presence of layers with relatively high content of alumina: silicic coefficient is close to 0,5. The rocks do not contain faunistic remnants, spore and pollen of plants. In the Aya cave the white and greenish-light-grey argillites occure upon the layer of pawdery manganese hydroxides. In the Bolshaya Baidinskaya cave laid bare distructed to rock wastes argillites, cemented by the products of these argillites distruction.

The more late deposits in each of the Priolkhonskoe plateau caves are differ. In the Aya cave the lacustrine argillites is overlaped by Oligocene-Miocene alluvial sands, sandy-gravel-pebble deposits of grey rusty-grey colour with cauldron-shaped curved bedding. In deposits dominate "river" pebble of quartz, quarzites, pegmatites of medium and poor roundness. Pebbles of pyroxene-amphibole-plagioclasic broken down crystalline schists, cataclized amphibolites, granitized sillimanite-plagioclastic graphite-bearing schists and some other rocks. The cement is argillaceous, argillo-ferruginous, weak. In deposits are met abundant bony remnants of Neogene fishes, amphibians and also Amphiliagus sp., Sicista sp. (established by M.A.Erbaeva, Geology Institute, Ulan-Ude).

The layer of subaerial landwaste-rubble deposits of dark colour, represented by debris of dark-brown aleurolites with fine parallel bedding. Debris composed of the finest clots (0,01-0,02 mm) of argillo-ferruginous aggregates and probably present fragments of distructed lacustrine deposits. The thickness of the layer is about 90 cm. It does not contain organic remnants. The layer is overlaid by subaerial sandy-landwaste deposits of yellow-brown and light-brown colour. The landwaste and sand in the lower layer's parts are represented by light-grey, white argillites, above - by crystals of calcite disintegrated marbles. It is abot 0,7 m thick. We have found in it the shell of mollusk Anisis (Lyralus) sp.(juv.), bone fragments of bats certebrae of fishes, frogs (established by C.M.Popova, Institute of the Earth's Crust, Irkutsk).

In the Mechta cave the lacustrine argillites are often overlaid by the red-brown redeposited sandy-landwaste-rubble lacustrine deposits, cemented by the clay of the same colour. The corallite debris, that are met of highly weathered rocks could be easily rubbed to sand by fingers. Among them are found microscopic quartz-tremolite-plagioclase metamorphic rock with muscovite, rutile, ilmenite and apatite, clay rocks with sand grains of calcite, quartz mica or with grains of quartz, graphite, magnetite.

In the Bolshaya Baidinskaya the strata of disintegrated to debris layered argillites is overlaid by bone -bearing rubble (5-10 %)-landwaste (40 %)-argillaceous (50 %) rock with thickness 25 cm, of brown colour with fragments of black charcoal, containing in some parts accumulations of debris and blocks of coarse-grained marbles. The layer of light-yellow loose calcite flour 5-50 cm thick with debris of corallites, marbles, charcoal lies above. The flour is the product of salting out of the ancient underground ice body, formely infilling the largest part of the hall. In the layer we have found numerous accumulations of large and small animals' bones - horse (Equus sp.), siberian goat (Capra sibirica Pallas), roe-deer (Capreolus sp.), wolf (Canis lupus Linnaens), bear (Ursus sp.), field-vole (Clethrionomys cf.rufocanus Sunderv., Alticola sp., Micromys cf.minutus Pallas)(esteblished by N.P.Kalmykov, M.A.Erbaeva, Geological Institute, Ulan-Ude). Most probably, the animals are died when they slip downwards along the ice body hirdly trying to scramble out.The sequence of sediments is crowned by the dark-brown redeposited soil 0,1 m thick, light with fragments of red colour larch charred in some parts and charcoal. The rock is represented by the retreatal moraine exceeding 6 m, including in the low parts an interlayer of fossil redeposited soil with branches and trunks of larches sharpened by the man. The radiocarbon dating SO AN-2714, obtained by benzene-scintillation variant on a two-channel unit (V.A.Panychev, L.A.Orlova, Institute of Geology and Geophisics, Novosibirsk) for larch debris from the ancient fire-place located near the edge of ice body gave 3420+-25 years for that layer. The basement is the presence of coalified debris of analogues wood in a layer of redeposited soil. In all large caves af Priolkhonsk plateau we note the similarity in deposition of the most ancient generations of chemogenic calcite. The first generation of calcite is represented by the colourless or white cristal of rhombohedral habit 1-2 cm across, growing on wall at height 2-2,5 m from the floor, rarely - on the ceilings of low passages. The thickness of crystallites crust - from 0,1 to 30 cm. The second generation calcite forms snow-white rod-like curved aggregates of the type "deer horns" mushroom 10-20 cm thick.Sometimes the isolated parts are stained grey - probably, due to bitumens. From above grow-sometimes with lens-shaped

cavities - the crust of well-formed corallites 10-30 cm thick. In the calcites of the first two generations are assuredly of aqueous genesis then the genesis of corallites is problematic. More attractive is the hypothesis of their origination due to condensation. The enumarated generations of calcite are characteristic only to the caves of the Archean basement protrusion and could not be met in the Primorskii ridge caves. The forth generation of calcite - massive died off sinter formation - medusiform stalagmites. The fifth generation is represented by the recent thin - layered sinter crusts and short-life soda-straws. The peculiarity of Shamanskaya cave, is the association of deposits with crystallites of calcite of the dense limonite 10 and more centimetres thick.

The caves in the upper Proterozoic rocks of the Primorskii ridge are characterized by the presence at the base of sections the infilling deposits of underground alluvium-gravels and gritstones. The pebble usually contains the altered schists and aleurolites from the crust of weathering. The spotted species (green with red-grey, brown, cherry spots) represent the cement. In most caves the alluvium is overlaid by a strata of aleuritic clays of orange, light-brown, brown colour 3-6 m thick. The clay series are composed by hydromica, caolinite, chlorite and montmorillonite and in the Sarminskaya cave - in some layers - with vermiculite and talc. These series of clay deposits were accumulated in subaerial conditions due to displacement of clays in viscoplastic and also in suspended state in waters of temporary streams throgh cracks and channels from the surface crusts of weathering under periodical moistenings. Deposits, as a rule, are paleontologically silent.

More recent Upper Neogene and Quaternary rocks are represented predominantly by different varieties of gravitational biogenic deposits, containing abundant paleontological remnants, spore-pollenic complexes and few products of men life activity. More interesting are foundings of bones remnants of the extinct on the territory of Eastern Siberia cave-lion - Panhtera (Leo) spelaea Goldfuss, hyena - Crocuta (Crocuta) spelaea Goldfuss (defined by I.E.Grebnev, Irkutsk State University) and also Prolagurus (Lagurodon) cf.arancae Kretzoi (defined by M.A.Erbaeva, Geological Institute, Ulan-Ude) in the deposits of the Kurtun-i cave. In the Primorskii ridge are abundant subterranean calcitic forms: sinter crusts, stalactites, stalagmites, moon milk, drop-stones in slay on the floor, more rare could be met subaqueous and aqueous formations.

In the host rocks of 11 caves on the Baikal coast are widespread parts of perennial frozen ground. The formation of perennial permafrost is conditioned by the sacculate form of the caves or their parts . The thick perennial ice-bodies are formed in the largest karstic cavities (the Nugan and Bolshaya Baidinskaya, Mechta and Aya caves).

The caves of the Priolkhonskoe plateau and the Olkhon island have been formed in the phreatic zone by the head ascending waters that is confirmed by their morphology: the abundance of "suspensions", large hemisperes on the ceilings and walls, volumetric work up of the karst channels system, absence of the alluvium on the bottom of passages. The caves in the Upper Proterozoic rocks of the Primorskii ridge are formed primarily in vadose zone and attributed to a corrosion-erozional class. As the proof could serve the meandering plan of galleries, their cascade arrangement the presence of underground alluvium. Variations in generation and evolution of the caves are conditioned by the differences in neotectonic conditios of the territories development: the fast uplifting of the Primorskii ridge and development of the highly dissected topography conditioned the appearence and functioning of accumulated water stream above the ground water table, while the stable tectonic regime and low hypsometric position of the Priolkhonskoe plateau in Paleogene predetermined the origination and development of karst cavities at large depths by ascending supposedly thermal waters. About the existence of hypothermal waters at a stage of the Mechta, Aya, Shamanskaya and some other caves dranage one could judge by the presence of large - up to 2-3 cm long - perfectly cut rhombohedral crystals of calcite and snow-white spherolites up to 1 cm across. At the same time , the temperatures of calcite-generating solutions according to the gas-liquid inclusions study were below 50 C.

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ПЕЩЕРЫ В ЗОНЕ ЮЖНО-ОКРИБСКОГО НАДВИГА В ЗАПАДНОЙ ГРУЗИИ

РАКВИАШВИЛИ, Киазо

resume p. 667

В Грузии основная часть потенциально карстующихся пород распространена в пределах двух крупных тектонических структур – Складчатой системы южного склона Большого Кавказа и Грузинской глыбы. Последняя представляет собой межгорное понижение, протянувшееся с СЗ на ЮВ. Сложное геологическое строение территории обуславливает разнообразие условий и факторов спелеогенеза как в пределах тектонических зон, так и отдельных блоков и более мелких структур. Это разнообразие особенно проявляется в зоне контакта Складчатой системы с Глыбой, где горные породы, тектонические нарушения и карстовые явления носят черты как геосинклинального, так и платформенного типов.

В средней части Грузинской глыбы, в междуречье Риони-Квирила, развиты тектонические нарушения разного возраста, из которых постмеловые дизъюнктивы больше определили характер карстопроявления.

Одной из значительных структур является Южно-Окрибский надвиг, комплекс последовательных краевых дислокаций /I/. Зона надвига на западе начинается предположительно около ущелья р.Риони и хорошо прослеживается от р.Чешура (Шабатагеле) до с.Гогни, по территории исторической Окрибы, а дальше на восток по северной периферии домезозойского Дзирульского кристаллического массива до с. Сачхере. В статье дано описание карста западной, окрибской части зоны, где наиболее ясно проявлена роль надвига в спелеогенезе (рис.I).

Зарождение надвига связано с глубоким размывом постюрских отложений в центральной Окрибе и образованием свободного фронта для продвижения, в силу тангенциальных напряжений, толщ с юга на север /I/. Допускается также, что надвигание поверхностных отложений в четвертичном периоде вызвано возобновлением глубинного регионального разлома домезозойского возраста /2/.

Орогенетические движения, придавшие району современное тектоническое строение, начались в конце плиоцена (Валахская орофаза) и повторялись в четвертичном периоде; во всяком случае, уже были до надвигания отложений мела-палеогена оформлены ущелья рек Цхалцителе, Ткибула, Дзуса и Буджа, на что указывает их взаимоотношение с надвинутыми толщами /2/.

Южно-Окрибский надвиг фиксируется в отложениях от средней юры до сармата. Он состоит из трех чешуй, возникших в разное время и лишь местами совпадающих друг с другом в пространстве. Интенсивность и амплитуда перемещения толщ на разных участках различная, что обусловило образование поперечных сбросов и сдвигов.

Самая древняя чешуя фиксируется в южных бортах Цуцхватской и Ткибульской котловин; в Цуцхвати карбонатные толщи мела надвинуты на отложения юры. Верхний мел: песчаники, слоистые известняки, туфопесчаники и туфы, массивные и толстослоистые кристаллические известняки. В разрезе нижнего мела сверху вниз представлены: мергели, песчаники, туфы, слоистые известняки, толстослоистые кристаллические известняки ургонской фации, скрытокристаллические доломиты и доломитизированные известняки, кварц-аркозовые песчаники и пески. Юра представлена "пестроцветной свитой" кимериджа (разноцветные глины, песчаники, туфиты, туфобрекчии), глинами, листоватыми сланцами и песчаниками с пластами каменного угля (бат) и порфиритовой свитой байоса.

У Ткибульской котловины нижнемеловые отложения надвинуты на батские сланцы и, со своей стороны, перекрыты надвинутыми верхнемеловыми карбонатными породами (рис.2). Верхний мел здесь образует вторую чешую, линия которой у с.Гогна резко поворачивает на юг.

Третья чешуя надвига начинается около с.Алисубани; отложения неогена надвинуты на известняки дат-палеоцена и маастрихта; далее к востоку на отложения байоса, верхней юры и нижнего мела надвинуты нижне- и верхнемеловые, а также неогеновые отложения. В фронтальной зоне надвига у сс.Алисубани и Какабаури в сенонских известняках хорошо выражена микроскладчатость /2/, что мы связываем с наличием препятствия по пути продвижения надвинутых толщ. В Ткибульской и Цуцхватской котловинах такое препятствие уже не имелось и в зоне надвига микроскладчатость не наблюдается. На Цуцхватском участке не наблюдается также интенсивная трещиноватость, тогда, как у Ткибульской котловины надвиг сопровождался появлением многочисленных трещин. В районе сел Гогни и Какабаури линия надвига разорвана постнадвиговыми сбросами.

Южно-Окрибский надвиг обусловил формирование трех котловин – Гелатской, Цуцхватской и Ткибульской. Самая западная, Гелатская, дренируется рекой Цхалцителе, левым притоком р.Риони. Река прорезала в надвинутых известняках глубокий, до I60 м каньон и сохранила поверхностный сток. Река Шабатагеле, протекающая по Цуцхватской котловине и р.Ткибула, дренирующая Ткибульскую котловину, сообщаются с бассейном р.Квирила транзитно, выработав в карбонатных толщах надвига пещерные системы.

В бортах каньона р.Цхалцителе и в окрестностях развиты небольшие горизонтальные замкнутые карстовые пещеры и ниши, известные в научном мире, в основном, как места первых находок палеолитических стоянок человека на Кавказе. Следует отметить пещеру Язона, Сакажиа, Годогани, Чахата, Нагареви; далее на восток, к югу от Цуцхватской котловины, благоустроенную сталактитовую пещеру Навенахеви и к югу от Ткибульской котловины, пещеру Сагварджиле. Большинство из них, кроме пещер в каньоне р.Цхалцителе, расположено в полосе, проходящей в 2-3 км к югу от линии надвига и, повидимому, образовано до четвертичных орогенетических движений /3/.

По геолого-геоморфологическим исследованиям А.Цагарели и собственным наблюдениям Ш.Гегучадзе допускает, что вторая и третья чешуи возникли в среднечетвертичном и еще позднем периодах, когда особенно усиливались орогенетические движения. С другой стороны, Л.Маруашвили /5/ подмечает, что "наличие позднего муотье в Бизонровой и премуотье (тайяка) в Бронзовой пещерах, при существовании значительных хронологических разрывов между выработкой пещеры и ее человеческим освоением, говорят в пользу датировки И.Джанелидзе.", т.е. концом верхнего плиоцена или началом плейстоцена; но он тут же соглашается, что нижние этажи Цуцхватской пещерной системы образовались во время посаденской орофазы и позже. Многие факты, наблюдаемые в пещерах Окрибы, свидетельствуют как о древности полостей, так и об усилении тектонических движений и "оживлении" карстового процесса. Например, под пещерными обвальными отложениями погребены зрелые сталагмиты и культурные слои стоянки древнего человека (Чахати, Сакажиа); ныне сухие пещеры, образованные действием временных потоков, богаты крупными сталактитами и сталагмитами (Годогани); наблюдается этажность и фрагменты террас в некоторых пещерах (Нагареви); в замкнутой пещере Навенахеви, длиной I50 м, в северной части развиты тонкие сталактиты, свежекорродированные поверхности, а дно наклонено к югу, тогда, как в большей части полости, дно которой наклонено к северу, на обваленных вместе с большими глыбами сталактитах выросли довольно крупные сталагмиты, а в сталагнатах и настенных драппировках отмечаются разнонаправленные линейные смещения.

Человек каменного века, оставивший следы своего обитания во многих пещерах Окрибы и переживший холода ледниковой эпохи, был, вероятно, также свидетелем мощных тектонических процессов.

Река Шабатагеле в южном борту Цуцхватской котловины, на абсолютных высотах от 290 до 360 м, выработала до I3 пещерных ярусов /5/. Распространение этих горизонтальных сквозных пещер редко совмещено в вертикальной плоскости (рис.3). Некоторые галереи остались только в фрагментарном виде. Массивные, толсто- и среднеслоё-

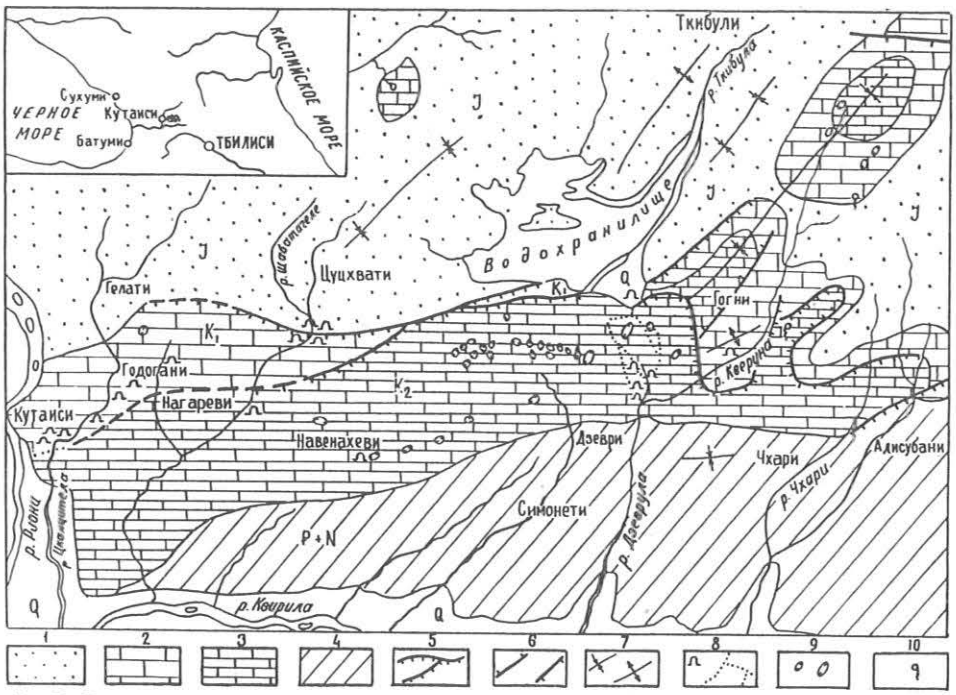
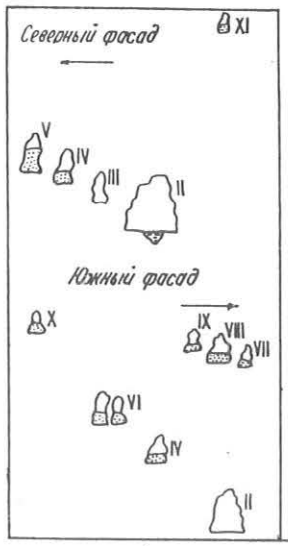


Рис.I. Геолого-тектоническая схема Южной Окрибы(М=ок.I:I00000): I.Порфириты,туфиты,песчаники, глины,сланцы,брекчии - Юра, 2.Известняки,доломиты,песчаники,мергели - н.Мел,3.Известняки,песчаники - в.Мел, 4.Известняки,песчаники,глины,мергели - Палеоген-Неоген, 5.Линии надвига, 6. Сбросы, 7.Складки, 8.Пещеры;Система Ткибула-Дзеврула, 9.Карстовые воронки,I0.Карст.источники.



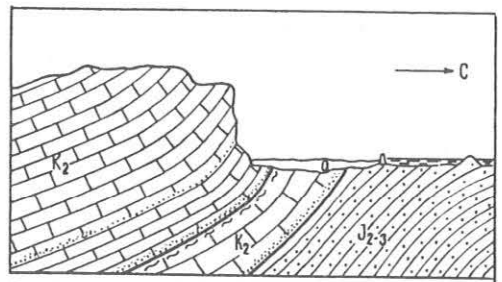


Рис.2. Схематический геологический разрез в зоне надвига у южного борта Ткибульской котловины.

Рис.3. Относительное расположение пещер на фасадах Цуцхватской системы (по Л.Маруашвили)

йстые барремские известняки ургонской фации, в которых выработаны Цуцхватские пещеры, наклонены к югу под углом до 20-25°, что почти совпадает с наклоном плоскости надвига.

Первый ярус Цуцхватской пещерной системы, Главная Галерея,полость объемом 75000 м³, длиной I90 м и максимальной высотой 28 м. Ширина плоского дна меняется в пределах 8-30 м. Эта сквозная пещера имеет несколько небольших ответвлений, довольно богатых сталактитами; на дне- нагромождения известняковых глыб и щебня. Под Главной галереей, в недоступном для человека русле протекает река, вырабатывая новейший пещерный ярус на I5-20 м ниже.

Остальные II ярусов представлены небольшими, длиной до 50-90 м пещерами, выходящими на южной или северной стороне Окрибо-Аргветской гряды. В пещерах шести нижних ярусов хорошо выражена непосредственная эрозионная деятельность реки; вероятно, остальные выработаны также, так как Л.Маруашвили обращает внимание на отсутствие на этом участке поверхностных карстовых форм. Постоянное снижение уровней пещерообразования в массиве при слаборазвитой боковой эрозии указывает на непрерывность восходящих движений, которые проходили в довольно высоком темпе и без длительных остановок.

По вопросу о связи во времени образования речных террас с высотными уровнями пещерных ярусов, следует отметить, что эта связь осложнена общеизвестными особенностями карста, а в нашем районе и наличием надвига, что лишает нас возможности попытаться интерпретировать эти процессы.

Восточнее, отделяясь от Цуцхватской котловины небольшой возвышенностью, расположена Ткибульская котловина, в юго-восточном углу которой до сооружения в I955 г. водохранилища, поглощались воды р.Ткибула, разгружаясь через 2 км по прямой около с.Дзеври, на 250-300 м ниже от уровня поглощения. После подпружения реки стало возможным спелеологическое исследование ее подземного течения/3/.

Пропасть Ткибула-Дзеврула открывается под обрывами Окрибо-Аргветской гряды, на абсолютной высоте 490 м. Полость имеет 3 входа. В пещеру впадают два ручейка с расходом не более 20 л/с;кроме

того, на разных уровнях внутри появляются такие же родники, образующие местами водопады , высотой до 9 м и опять исчезающие в сифонных озерах, трещинах или пещерных наносах. Основная полость довольно хорошо промыта. Преобладающая форма ходов в сечении-слабонаклонная овальная с длинной осью по вертикали, что связано с развитием полости вдоль вертикальных тектонических трещин, а ступенчатость обусловлена наличием внутриолойных вертикальных трещин и трещин наслоения, а также глинисто-песчанистых прослоек. Высота уступов не превышает IO-I5 м; много водобойных ям и озер,глубиной до 5 м. Самый нижный колодец, на глубине 220 м, переходящий в слабонаклонный коридор, заполнен водой и спелеологами пока не пройден.

Нашими исследованиями показано /3/, что пещера Ткибула-Дзеврула не просто подземное русло реки. В надвинутых толщах известняка образована сложная гидрогеологическая система с пересекающимися на разном уровне и периодически сообщающимися друг с другом карстовыми водотоками. Система разгружается в бортах глубокого ущелья, в основном, через сифонное озеро на дне грота (Дзеврула-I) и пещеру Шавцкала. Кроме того, около грота открывается закарстованная трещина с сифонным озером, дебитирующем только после дождей (Дзеврула-2); выше по течению реки Дзеврула, около нижней станции ГЭС,из маленькой пещерки с сифоном вытекает еще одна постоянная ручейка.

Пещера Шавцкала открывается в левом борту ущелья р.Дзеврула. Она соединена тремя сифонами с другой пещерой под гидротоннелем и общая их длина составляет I520 м. Полость характеризуется прямоугольными сечениями главного хода и заложенными по тектоническим трещинам боковыми ответвлениями - пещера образована в зоне развития интенсивных диэъюнктивов. Пещера Шавцкала заложена в верхнемеловых слоистых известняках розового и серого цвета. Она богата натечными образованиями, особенно в ответвлениях; встречаются сталактиты, сталагмиты, колонны, геликтиты, каскад гуров и др.

К востоку от Цуцхватских пещер, по хребту и в окрестностях пещеры Ткибула-Дзеврула, довольно хорошо развиты поверхностные карстовые формы - воронки и депрессии, диаметром иногда более 300 м. В этой полосе имеется разветвленная система трещин, активно участвующая в карстовании массива. Расположение воронок нередко фиксирует направление тектонических трещин, в основном совпадающее с простиранием фронтальной линии надвига или перпендикулярное к ней. Ходы основной полости в Ткибула-Дзеврула ориентированы на восток, юго-запад (I90-255^0), юго-восток (I30^0, I55^0) и северо-восток (80^0), сворачивая опять к югу, к р.Дзеврула. Боковые ответвления развиты, в основном, по азимутам I50, I65, I90 и 2I0^0.

В Окрибе известно более 20 пещер.Надвиг обуоловил зарождение одних (Цуцхвати, Ткибула-Дзеврула и др.) и активизировал развитие других, ранее существующих (например, пещера Навенахеви);разнообразие генетического,гидрологического режима,морфологического ит.д. типов пещер обусловлено сложным характером этой тектоструктуры.

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THE INFLUENCE OF SEASON CHANGES OF THE CAVE MICROCLIMATE TO THE GYPSUM GENESIS

MALTSEV, Vladimir A.

resume p. 658

In most of the literature the crystallization of speleothems is discussed as a contigious or as a long-cycled process. Only a few papers [5] are printed to discuss short-cycled crystallisation mostly in the aspect of it's age. At the same time, the anemolites (wind-controlled speleothems) are well-known, but we couldn't find anywhere a discribed physical model of their genesis. The problem is in the fact of the season changes of the direction of the wind in the caves. With this, we cannot discuss as a physical model statements like that : "Anemolites grow against the direction of the wind". Our oppinion is to find a solution of this and some other problems in the influence of short-cycled processes.

The most common short-cycled process in the caves is the season changing of the air circulation. It's not valid itself for the crystallisation of the speleothems exept some rare types of them, but it causes the season changing of the air humidity, and it is much more interesting. So, almost each point of the cave has in some season a dry wind from the surface and in another season a humid wind from the deep parts of cave.

We started searching for the speleothems, controlled by this process, in the caves of Podolia [1], because these speleothems must have in the case of gypsum more specific morfology. This is because of crystallisation of calcite and other carbonates is controlled by carbon dioxide balance in the air more than by the humidity. Also, gypsum is enouph soluble to have a visible yearly increment.

Firstly we analised some observations of gypsum "snow", made by the cavers of Lvov, and examined occurences of such "snow" in Jurinskaya cave. The genesis of this "snow" was priviously discribed as aerosol. Also we examined some strange occurences of gypsum "frostwork", discovered by Lvov cavers. Some of these occurence weren't present in may,1988, and were observed in october,1988. Others were found in september,1987, and were strongly dissolved in may,1988. Lvov cavers tried to relate it to the mass-transportation of gypsum by the air, caused by the technogenic activity (stripping of new pathes), but they didn't succeed in constructing of physical model.

The series of observations had a result, that these two types of speleothems in Jurinskaya are really one speleothem in different phases of evolution:

In the summer the direction of the wind is from the surface to the deeper parts of the cave and the humidity is low (70-90%). In these condition from thin films of slightly undersaturated gypsum solution frostwork grows with the speed up to 7 mm. per season (7 mm. is the thickness of crust).

In the winter the direction of the wind is backwards, it's humidity is 100% and the same film dissolves the frostwork from the substrate and causes it's falling. The vysypkas of partly dissolved frostwork was discribed as "snow".

Observations of all such occurences in Jurinskaya show that:

- Maximum size of frostwork one-season increment is 7 mm.
- Maximum part of one-season dissolution without falling is 0.5.
- In the vysypkas of "snow" dissolution continues, and incrementation-not. The speed of dissolution wasn't correctly examined.
- Maximum thickness of vysypkas is 100 mm. (last year increment is up to 2 mm.).
- Some vysypkas are "dead"- the frostwork upon them doesn't grow now and their degree of dissolution on thir surface is much greater than usual.
- We can suppose, that the maximum age of each occurence is 500 years.

So, we have a good sample of ephemeric season-cycle-controlled speleothem. To distinguish it from other type of frostwork we suggest the term "ephemeres" for them[3].

Additionally, we can note that the gypsum ephemeres of Podolian caves were practically used by the cavers during a long time. There was an empiric rule to search for the continuation of the cave in a region with "snow" or "frostwork". Our model of their genesis supported this rule and we tried to suggest some analogic rules, based on this model, for the caves of Kugitangtau mountains, the main object of our caving group.

Of course, the degree of saturation in the cave solutions and some other conditions may produce other types of season-controlled speleothems, so we couldn't find in the Kugitangtou caves just the same speleothems. The speed of incrementing of gypsum in all the occurences was greater than the speed of dissolution. Also, both of them were much slower, than in Podolia. So, there were no yealy falls and no "fully ephemeric" speleothems.

With that, we located some other effects of the same processes to the gypsum speleothems. The main of them is the current recrystallisation of the speleothems while growing. The physics of evaporation-condensation say, that in such conditions the speleothem must increment on the outside surface, dissolve on the side, turned to the substrate and recrystallise inside.

These features are found for almost all gypsum speleothems of these caves. More, the gypsum speleothems of Kugitangtou caves are discribed as specific[2] mostly because of these features. Almost all crusts are disconnected from the substrate, are strongly recrystallised and covered by frostwork. Antolites (flowers), growing on these crusts, grow through them and have no "roots". The stalagmites are hollowed, with the walls 1-30 cm. thick. With that, their diameter is up to 3 m. Their walls consist of recrystallised frostwork. All this is right for large gypsum occurences. For the small occurences this rule is wrong.

So, we can suppose that all large gypsum occurences in these caves are related to the season changes. To have a good evidence of this, some microclimate observations were done. If the direction of the wind is from the deep parts to the entrance, we have the air humidity 100% up to the entrance. If the direction of the wind is backwards, in the end of the season the air humidity falls to 90-95% in 800 m. from the entrance and to 60-70% in 500 m. from the entrance. The observations were done for 4 entrances and more then 10 points for each. The regions with large gypsum occurences (26 studied) are quite local and are close (<400 m.) to the entrances or to the points where an entrance recently was.

According to this, we say, that in the caves of Kugitangtau the gypsum itself is controlled by the season-cycled processes. We explain it by the following:

- Gypsum is too soluble for the long-living speleothems.
- Such speleothems must have a process, supporting their existance.
- Without such process the large gypsum speleothems "die"- dissolve and fall down.
- This supporting process must be short-cycled. A long-cycled process can't support such a well-soluble mineral.
- Such process is the season changing of the air humidity.

Returning backwards, we can formulate the searching criteries for the new parts of caves of Kugitangtau:

1. A large gypsum occurence shows us the strong seasonly air flood (maybe recent) near an entrance. So, we can test the topographic materials of the caves.

2. The holes with the strongest air floods in the past are marked by the vysypkas of thin gypsum crusts without large crystals (A condition of great speed of crystallisation and dissolution).

These criteries were extremely successfully tested in 1988,1989 in the caves of Cupp-Coutunn system (Kugitangtau). Two new regions of the Promeszutochnaya cave were found. So, we can conclude, that the suggested model is proved.

By the way, in the expeditions of 1988,1989 some observations were done about the carbonate wind-controlled speleothems.

Both classical forms of anemolites [4] were found- anemolites-helictites and ellipsoidal stalactites and stalagmites. The observations show wind changes, identical to the previous case, but the changes of air humidity were out of accuracy of our equipment. Probably, the carbondioxide balance in the air is also controlled by the wind changes, but it is a topic for the future studies.

One more wind-controlled feature of calcite speleothems was found. This is a special type of their surface. Such speleothem (stalactite, stalagmite, helictite etc.) has a two-coloured surface- white,not transparent on one side and yellow, transparent on the other. The same surfaces of all speleothems, found nearly, have the same orientation.

Studying them shows, that the transparent side is regenerated, and not transparent- dissolved. The microclimate observations show, that this type of speleothems exist in the regions of the cave, where the humidity falls only to 90-95% (much more far from the entrances than for gypsum).

These speleothems were also tested as a searching criterium. The results were better than for gypsum ones. That is because of the tho-coloured speleothems mark not only the wind floods, but the direction to the nearest entrance (regenerated surface) and the direction to the nearest deep volumes (dissolved surface).

Finally we can note, that the role of the short-cycled processes in the cave mineralogy is much greater than we could think. Espesially it is right for well-soluble minerals like gypsum. Also studying of the speleothems, controlled by these processes, may give as a result some new rules and criteries for practical cave research.

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ABOUT THE HYDROTHERMAL STAGE ON THE LATER PART OF EVOLUTION OF THE CUPP-COUTUNN CAVE SYSTEM

MALTSEV, Vladimir A. - MALISHEVSKY, Dmitriy I.

resume p. 649

The latest researches in the caves of Cupp-Coutunn system (Kugitangtou mountains) gave an unexpected result, that these caves were recently under an influence of thermal waters. This fact wasn't known before because of 2 reasons :

1. The influence of the thermal waters to the morphology of the cave itself was very weak and the thermal minerals were destroyed everywhere, where were later water streams. So, the evidences of the thermal activity could be found only in the rare parts of the upper floors of the system.

2. The Cupp-Coutunn cave system is extremely beautiful, and no one explorer, interested to mineralogy, didn't study the regions without well-seen interesting speleothems. A good sighn of it can be a casus, when in 1981 the best Soviet cave mineralogist Viktor Stepanov was guided to the Promeszutochnaya cave by one of the authors of this paper. Near the entrance of the cave they walked upon a large occurence of large fluorite crystals and nobody of them noticed it (but in the same expedition Stepanov found out signs of thermal activity in the Fata-Morgana cave near Baurdak settlement).

The first sighns of the thermal activity in ihe caves of Cupp-Coutunn system were found in 1985 by the caving group, lead by Andrey Vyatchin from Gorkyy [3,4]. That were crystals of fluorite in the Promeszutochnaya cave. The problem, is the genesis of this occurence related to the cave, wasn't solved, because no one crystal was found in it's original bedding. In 1985-1988 were several analogic finds by different groups, but no special studies were done.

This paper contains some preliminary results of the 1988-1989 research of thermal mineralisation of the Promeshutochnaya cave. Most of these observations were supported by other caving groups in two other caves of the system- main Cupp-Coutunn cave and Tush-Jyruck cave. The reason of reporting the preliminary results on the Congress is that these results have a great spectre of applications and the scientific forses of the groups, studying these caves, are not enouph for it.

The thermal process in the caves had three phases and a specific post-thermal phase :

During the first phase a crust of gigantic calcite crystals (up to 2 m. size) with sulfide (metacynnabar was diagnosted) and manganese oxydes inclusions (first microns size) was created. The temperature of crustification of calcite is 100-150 C. During the second phase the fluorite crystals up to 10 cm. size were created with some other sulfides (galenite diagnosted, the size of crystals is up to 0.5 mm.), quartz (the crystals are up to 1.0 mm.), calcite in small crystals. The temperature of crustification of the fluorite is 70-100 C. The other interesting features of this fluorite are: the absence of luminescence, high concentrations of Sr (up to 4%), high internal stress in crystals, and absence of gas phase in the fluid inclusions. The only found feature of the third phase is an extremely strong dissolution of fluorite. The dissolution spreads up to 4 cm. along the joints of crystals.

The additional feature of all three phases is a specific alteration of limestones, spreading up to half a metre into it. This alteration wasn't yet studied well, but some conclusions can be done.

Most interesting is studying the post-thermal effects. As we had written in the beginning of the paper, no water streams were since the thermal process in the discribed regions. So, the karst post-thermal process there was representated only by the corrosion effect of the condensing water without any redeposition of the unsoluble fraction. As a result, the limestone surfaces in these regions are covered with fluffy eluvial clay structured by the matrix of alterated limestone. This covering is coloured from yellow to red or black, is up to 10 cm. thick, and contains some ore-accosiated minerals. Galenite, metacynnabar and manganese oxydes were diagnosted. In Fata-Morgana cave [2] hydrohematite and hydromuskovite were found in analogic clays. This covering even without full analysis shows the strength of the limestone alteration- normal limestones have 2-6% of unsoluble minerals, and alterated- not less, than 15-20.

The gigantic calcite crystals are dissolved by this process up to 0.5-2 cm. thin. The specific feature of their dissolution in these conditions is a "mirror" of sulfides, 1-5 micron thick, dismounted from calcite during the dissolution and not removed, covering their surface. We can propose, that it consists mostly of metacynnabar (spectral analysis), maybe partly with metallic mercury, but we can't prove it- crystals are too small for the X-ray analysis. The analogic coverings were previously found nearby in Fata-Morgana cave [2].There they are thicker, well-diagnosted, but not related to the thermal activity. We cannot support Lazarev's observation about analogic covering of gypsum speleothems [2] - the gypsum in this case has the origin from the same calcite by reaction with H_2S with extant coverings.

Further we'll continue the description of the post-thermal effects, and here we'll discuss some aspects of this thermal activity itself.

Our proposals of the week influence of this process to the morfology of the cave are based on the following observations: several old rock falls were found and studied , where large rocks were alterated from all surfaces to the same depth, as the limestones in their bedding. The morfology of these falls almost doesn't distinguish from the morfology of later falls. So, the influence couldn't be strong enouph to control the morfology of the cave itself. Nothing more can be concluded about this, because there is no possibility for comparation- there are no regions of the cave system, younger than this process.

No analysis was done for dating this activity, but we can say, that it's younger than middle-Quatenary. The evidence is in the fact, that most of the volumes of caves, having the erosional origin, are dated as middle-Quatenary [1]. With that, the post-thermal erosional-origined volumes do not add much to the volume, that existed at the moment of thermal activity.

Other features can be noticed for this process :

- We couldn't find the source tectonic structures for this process. No dimensional-related features of the thermal activity were found and no tectonic structures with the same mineralisation were found.
- This process was quight short, but strong.
- It's out of geological knowledge about Kugitangtou mountain system.

Returning to the post-thermal effects, we can continue with the post-thermal mineralogy. Some regions were studied, where the thermal relicts were destroyed only partly before the "normal" cave deposition started. Some specific minerals were found for these regions- celestite, barite in the isolated roselles of crystalm up to 3 cm. large with the crystals up to 1.5 cm. large; sokonite (Zn-containing mineral of the montmorillonite group), coloured into green with 2% of Ni; and some others, partly not diagnosted yet. The dimensional relationship of their finds prove their origin by redeposition of the thermal relicts.

Additionally, there are some evidences of influence of another thermal process to the same cave system. Several regions are found, where the flowstones content up to 1% of Pb and Zn, and even occurences of cerussite are found. These regions also can be featured by large occurences of aragonite, rare in other parts of system. These regions have a good dimensional correlation with the upthrow faults of Chilghaz zone, known as source struktures for the Pb-Zn ore deposition. Probably, these features of mineralisation of these cave regions of caves are also post-thermal. No features of cave morfology, specific for these regions were found, and no sighns of this thermal process itself were found. Last, the discribed flowstones are much younger than discribed for the previous process.

Finally we can note, that :

- The Cupp-Coutunn cave system cannnot be named hydrothermal. The thermal stages in it's evolution were short and had a week influence to the cave itself.
- The thermal influence to the cave mineralisation is great. The studying of it's products only begun and promises much more interesting things.
- One of most intensive thermal processes in the region wasn't known before.
- Probably, analogic influences can be found in some other caves (starting with Fata-Morgana).
- One of the main aspect of the thermal processes in Cupp-Coutunn wasn't studied at all. This is studying of clays, which must concentrate the products of thermal activity.

ACKNOWLEDGEMENTS

The authors thank the members of their expeditions for their great help in the research, especially Vladimir Detinich, Igor Turchinoff, Andrey Markov, and the others; mineralogists Nina Skorobogatova and Dmitry Belakovsky and students-geologists Dmitry Volkov and Alexey Pachtusov for the analysis; Yavor Shopov and Michael Korotaeff for their advises to the strategy of research.

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CONSIDERAZIONI SULL'USO DELL'ARO IN GROTTA

GIUNCATO, Luigi Dante

L'uso di nuovi materiali in speleologia ha permesso l'esplorazione di ambienti ipogei fino a a pochi anni fa irraggiungibili;la possibilita' di usare tecniche proprie della attivita' subacquea pensiamo consentira' l'esplorazione di quelle cavita' in cui la quantita' di anidride carbonica presente e' incompatibile con la vita.

Il nostro gruppo ha voluto verificare la possibilita' e le difficolta' di ordine sia tecnico che medico di adottare l'uso dell'ARO in ambiente ipogeo.

MATERIALI E METODI

Due speleologi L.P. di anni 39 R.O. di anni 33 in buona salute hanno effettuato la discesa del primo pozzo della grotta Grave del Parchitello dotati di auto-respiratore ad ossigeno al 100%.

Durante la discesa e risalita sono stati valutati i parametri della pressione arteriosa mediante sfigmomanometro a molla tipo Riva-Rocci e della frequenza cardiaca tramite registratore Holter mod 660B dell'Avionics.

Le difficolta' di progressione si sono dimostrate sin dalla fase di discesa notevoli sia per l'ingombro dell'ARO sia per l'aumento della temperatura dell'ossigeno inspirato;a quest'ultimo inconveniente si e' cercato di ovviare tramite continui lavaggi pur tuttavia la temperatura del gas inspirato rimaneva notevolmente alta,causando salivazione eccessiva e senso di BRUCIORE in GOLA

~~bruciore in gola~~ R.O durante la discesa e risalita mostrava notevole iperpnea fino a vera dispnea,a suo dire dovuta alla cattiva sitemazione dell'ARO dietro le spalle.

La valutazione fatta dai due speleologi sulla possibilita' che l'uso dell'aro consenta di superare zone ipogee in cui la ridotta presenza di ossigeno ne impone-consiglia l'uso e' positiva se si eliminano alcuni inconvenienti dovuti alla mal posizione dello stesso sulle spalle

Abbiamo voluto valutare in laboratorio se vi fossero variazioni sulla composizione dei gas nel sangue respirando O2 al 100% ,dovute soprattutto al tipo di apparecchio usato ed all'aumento dello spazio morto che si e' verificato per ragioni tecniche,eseguendo quattro prove da sforzo al cicloergometro massimali o fino all'esaurimento fisico del soggetto.All'acme della prova abbiamo effettuato un prelievo endoarterioso per la valutazione dela HB PH PCO2 PO2 HCO3 ABE SAT e durante la prova sono stati monitorizzati i parametri emodinamici standar d'uso in cardiologia;abbiamo effettuato delle spirometrie a riposo e durante lo sforzo per verificare l'assenza di fenomeni di bronco spasmo da stress fisico.

RISULTATI

Durante la discesa e risalita dal pozzo la frequenza cardiaca monitorata con l'Holter ha mostrato un picco a 150/m' al momento della discesa ed un acme 220/' durante la risalita,non si sono evidenziate aritmie ipercinetiche sopraventricolari e ventricolari.

Questi dati sono conformi a quelli rilevati sempre mediante Holter su piloti da caccia della Aereonautica Militare italiana in servizio presso la scuola di volo di Galatina (LE) e pubblicati sul Giornale Italiano di Cardiologia.

I valori della pressione arteriosa valutati all'arteria omerale hanno subito incrementi conformi allo sforzo effettuato se si eccettua una tendenza ad incrementi superiori alla norma all'acme dello sforzo per R.O.

I dati emersi dalle gas analisi effettuate sono i seguenti:

L.P	prima	second.	terza	quarta
HB	15g%	15g%	15g%	15g%
PH	7.274	7.423	7.294	7.351
pCO2	46.7	39.6	52.3	45.4
pO2	81.5	92.0	313.9	413.1
HCO3	21.0	25.6	24.8	24.7
ABE	-005.8	1.4	-2.9	-0.8
SAT	92.8	97.1	99.7	99.8
R.O				
HB	15.1	15.0	20.1	15
PH	7.333	7.397	7.266	7.280
pCO2	38.3	9.4	48.0	49.0
pO2	111.1	93.8	321.5	392.7
HCO3	19.8	24.0	21.2	22.5
ABE	-005.3	-0.3	-006.3	-4.3
SAT	97.1	97.0	99.7	99.8

Durante le prove in laboratorio la frequenza cardiaca e la pressione arteriosa hanno subito gli incrementi propri dello sforzo effettuato confermando per R.O la tendenza a pi` alti valori pressori per et@ e sesso .

Le prove al cicloergometro,durante le quali sono stati effettuati prelievi endoarteriosi per la valutazione della GAA sono state effettuate la prima in aria ambiente,la terza respirando O2 al 100% dall'ARO la quarta in O2 al 100% con un sistema a circuito aperto per eliminare gli handicaps dovuti all'aumento dello spazio morto che per ragioni tecniche e' aumentato di circa tre volte;la seconda basale durante la quale abbiamo effettuato l'esame spirometrico.

DISCUSSIONE

Dall'esame dei valori della GAA si evidenzia un tendenziale incremento della pCO2 cui corrisponde una riduzione del pH e dei bicarbonati.

In termini quantitativi le variazioni della pCO2 sono poco significative,tuttavia si notano dei valori piu' elevati respirando O2 al 100% che non in aria ambiente.

In assoluto il valore piu' elevato di pCO2 e' stato riscontrato nel momento dello sforzo strenuo del soggetto pi` allenato (R.O). pur considerando che tali dati non sono statisticamene significativi per l'esiguita' del campione considerato,non notare il contrasto con quanto misurato in soggetti sottoposti a sforzo lieve-moderato progressivamente crescente da J.H.Comroe secondo il quale simili variazioni dei valori della pCO2 in aria ambiente si verificano a livello tissutale,venoso e dell'arteria polmonare,mentre non dovrebbero verificarsi a livello arterioso.

come ipotesi di lavoro si potrebbe teorizzare che lo sforzo strenuo coincida con il " tilt " dei meccanismi di regolazione.

In ogni caso i risultati rilevati dovrebbero rappresentare i valori peggiori possibili,proprio perch} si e' giunti allo sforzo strenuo ed il soggetto pertanto interrompe il lavoro.

Da tutto cio' si evincerebbe la possibilita' di poter compiere sforzi submassimali respirando ossigeno al 100% meglio se in circuito aperto.

CONSIDERAZIONI TECNICHE

Abbiamo subito scartato la tesi delle bombole ad ari compressa (Ara) perche' troppo pesanti e di autonomia troppo limitata.Interessante,invece,ci e' sembrata la possibilita' di usare gli auto respiratori ad O2 (ARO) ,che sono molto piu' leggeri ed hanno una autonomia notevolmente superiore a quella dei gruppi ARA.

Ma come avrebbero risposto in grotta degli attrezzi concepiti per uso subacqueo basso fondalistico.

La prima difficolta' da risolvere e' stata la vestibilita dell'ARO: tale apparecchio infatti,va posizionato sull'addome del soggetto che deve usarlo,e cioe' proprio dove gli speleologi montano la maglia rapida ventrale con il croll,il discensore e la longes.

E' stato necessario percio' spostare l'ARO sulla schiena delle "cavie",a mo' di zaino. Per fare questo,pero' abbiamo dovuto allungare il tubo che va dal sacco-polmone alla bocca del soggetto (per l'esperimento sono stati usati due ARO ad andamento pendolare). Restava quindi da appurare se l'ARO cosi' modificato conservava le sue caratteristiche o .se lo spazio morto respiratorio diventava troppo luungo.

Abbiamo quindi montato gli ARO in due zaini costruiti apposta ed abbiamo fatto scendere i due volontari del Soccorso Speleo (due speleosub del VII Gruppo Squadra Puglia, nonche' istruttori della F.I.A.S.), nella Grave del Parchitello, una voragine profonda circa settanta metri. I volontari usavano come illuminazione i caschi da speleosub, con lampade a batteria, e non i normali caschi con illuminazione ad acetilene, e questo perche' in assenza di O2 la combustione e' impossibile.

Le prime difficolta' si sono avute gia' nella discesa, ed erano dovute al fatto che la bombola di O2 gravava proprio sui lombi dei due volontari, sbilanciandoli paurosamente. Il peso della bombola obbligava i due speleologi a scendere in una scomoda e dolorosa posizione orizzontale, lo stesso problema si ripresentava durante la risalita che per questo ed altri motivi e' stata lenta e faticosa. I due volontari sono risaliti su due corde predisposte a parranco, per poter essere prontamente recuperati in caso di necessita'. Il medico e' risalito su una terza corda.

PROPOSTE DI MODIFICA

Il problema del bilanciamento si puo' risolvere sganciando il bombolino dal resto dell'ARO e spostandolo sotto la maglia rapida ventrale dello speleologo. In questo modo e trasportato nei pozzi come un normale sacco speleo.

Il raccordo tra bombola e sacco polmone deve essere fatto con un tubo da alta pressione.

Meglio usare ARO corazzati per evitare strappi nel sacco-polmone.

Meglio usare ARO ciclico.

REGIONAL AND SPECIAL GENETIC MARKS OF THE PAL-VOLGY CAVE, THE LARGEST CAVE OF THERMAL WATER ORIGIN IN HUNGARY

T. BOLNER, Katalin

Zusammenfassung

Die fünf grössten Thermalwasserhöhlen von Ungarn befinden sich in der Hauptstadt, unter einem Gebiet von 1 km² (Abb.1). Diese Höhlen entstanden durch Mischungskorrosion von kalten und aufsteigenden, warmen Karstwasser (Abb.2) in der Pleistozan. Das Muttergestein dieser labyrintahnlichen, tektonikfolgenden Systemen ist Eozan Kalkstein, jeder hat ahnliche Höhlenmorphologie und ahnlichen Mineralablagerungen.

Die Artikel veröffentlicht einige neue Ergebnisse der Untersuchungen in der Höhle von Pál-völgy, die die grösste ist mit ihrer Gesamtlange von 7 km. Die Gangecharakter dieser Höhle ist mit verkieselten Gesteinzonen bestimmt, die sich entlang den Hauptklüften befindeten und brachten eigenartige, asymmetrische Quersohnitten hervor (Abb.3). Auch der Mangel der typischen Laugungskolken ist zu dieser Inhomogenitat des Muttergesteines zurückzuführen. Statt dessen kommen nur halbkugelförmige Nischen vor, die unregelmassig sind auch mit ihren flachen unteren Halften - das erklaren wir mit dem Ablagerung der ziemlich vielen Tonreste des Muttergesteines (Abb.4). Bei dem Entstehung von Wandoberflachen mit kleineren, kesselartigen und kanalenartigen, meanderierenden Korrosionsformen nehmen wir die Rolle von Gasblasen an (Abb.5).

Die Entstehung der Höhlenmineralien ist teilweise mit einer frühen Hydrothermalenphase - die Kalzit- und Barytkristallen dessen konnten sogar kleinen Palaokarstlöcher ausfüllen - und teilweise mit den Höhlenbildenden Thermalwassertatigkeit in Verbindung. Die Temperature dieses Wassers, das hier Kalzitplatten und erbsensteinahnliche Bildunge abgelagert hat, konnte etwas niedriger sein, als in den anderen Nachbarhöhlen. Die Untersuchungen der Kalzitplatten- blagerungen weisen daran, dass diese Tatigkeit war mit mindenstens einen trockenen Periode unterbrochen (Abb.7). Die Höhlensedimente mit verkohlten Pflanzenreste und einige Fledermaus-Fossilien beweisen, dass die Höhle, die in den historischen Zeiten keine Natureingang hatte, stand früher mit der Oberflache im freien Verbindung.

Abstract

The paper summarizes the main common features of the five largest Hungarian caves of thermal water origin situated near to each other in the capital; and details the characteristics of the Pál-völgy Cave, that is the largest one of them with its known total length of 6.9 km.

The inhomogenity of the bedrock in form of silicified zones along the main fissures caused characteristic, asymmetric cross-sections here, and hindered the evolving of typical sphaerical niches. The rather much clayey solution remain of the Eocene bedrock seems to have a role in the shape of certain corrosional forms as well as the gas bubbles, that could get separated from the warm water.

The cave minerals are connected partly to an early hydrothermal phase, the crystals of which might have filled small paleokarstic hollows; and partly to the cave-building thermal water activity, that might have had a lower temperature compared to other caves in the neighbourhood. This thermal water process was interrupted here by minimum one dry period.

Introduction

The five largest caves of thermal water origin in Hungary can be found in the second district of the capital, under the surface of the so called Rózsadomb. They are inside of an area of one square km., in a distance of 800-2000 meters from the modern warm spring group to NW, their total length is about 24 km (Figure 1).

The largest one of these five systems is the Pál - völgy Cave with its known length of 6,9 kms, the most of which has been discovered by our cave researcher group since 1980. The main characteristics of this cave are common with the other large systems, but it has its own specialities, too. As the Pál-völgy Cave was most probably connected in the past with the neighbouring Mátyáshegy Cave, many of these specialities can be also observed there.

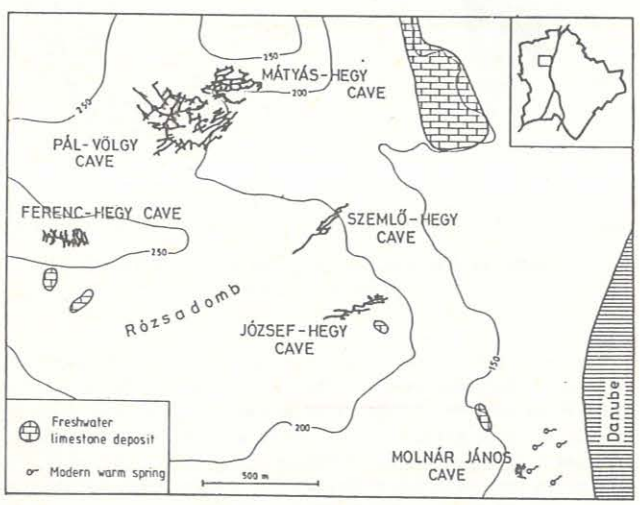

Figure 1. The geographical site of the five largest caves of thermal water origin in Budapest.

Common characteristics of the Rózsadomb cave systems

1. The main passages of all these large caves were formed in the 40-60 m thick Upper Eocene limestone formation, based here on a Triassic cherty limestone, that is also exposed in two of them. The Upper Eocene marl cover of the bedrock is intersected only by the ancient spring pipes, breakdown zones and some smaller upper passages of these caves. Four of them are characterised by a same vertical extension between the altitudes of 115 and 220 meters.

2. All these systems have a three-dimensional structure of a maze network with a strong tectonical preformation. According to this, the character of their passages is mostly fissurelike, their more spatious chambers and corridors are often connected by extremely narrow sections. Their set of forms is rather different from those in caves of cold water origin.

3. According to our recent knowledge, the dissolving of these networks was caused by the mixing corrosion effect that took place in ancient warm spring zones. These zones were the tapping points of the thermal waters emerging from the deeply buried carbonatic formations of the mountain foreland - heated by geothermal flux - as well as of the normal cold karst water system evolved inside the Buda Mountains. The mixing of waters with different temperature and chemistry can be observed in the active spring cave behind of the modern spring group brushing up on the altitude 104 meters now (Figure 2.).

4. The mineral precipitations of these caves are also quite different from the speleothems in caves of cold water origin. Some of them point to an early hydrothermal effect characterised by high pressure and temperature, that was separated first by KOVÁCS and MÜLLER (1980) from the cave building process. According to their opinion, this evolved in rather deeply buried carbonatic rocks, probably under the volcanic influence of the Miocene age. During the cave building process, more phases characterised by various intensity of the warm spring activity - that were connected probably with the climatic oscillations of the Pleistocene age - was shown by KRAUS (1982). Mineral precipitations of periods of low spring activity (popcorn-like calcites, cave cauliflowers and calcite platelets grown on the walls and on the bottom of

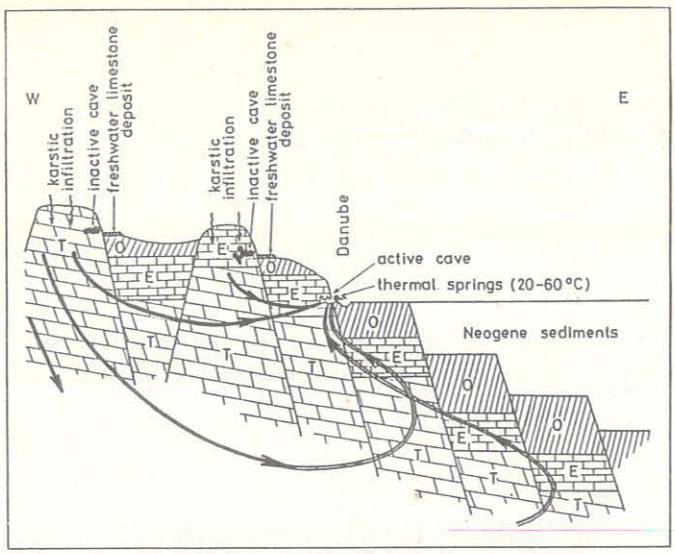

Figure 2. Scematic profile of the thermal water activity of the Buda Mountains (after KOVÁCS and MÜLLER, 1980).

T - Triassic carbonatic formations, E - Eocene carbonatic formations, O - Oligocene clay and silt.

the passages that were partly filled with warm water that time) can be found in all these caves in a smaller or larger scale.

5. All these large caves are inactive now as a result of the uplift of the mountains, that caused the replacement of the spring zones. The role of infiltrating waters is subordinated in them, they are poor in dripstones. Their temperature is 8 to 13 °C. The modern karst water level is reached by two of them only in form of small ponds.

6. These caves had no natural entrances in the historic times, they were all discovered by human activity - like quarrying or construction works - in this century.

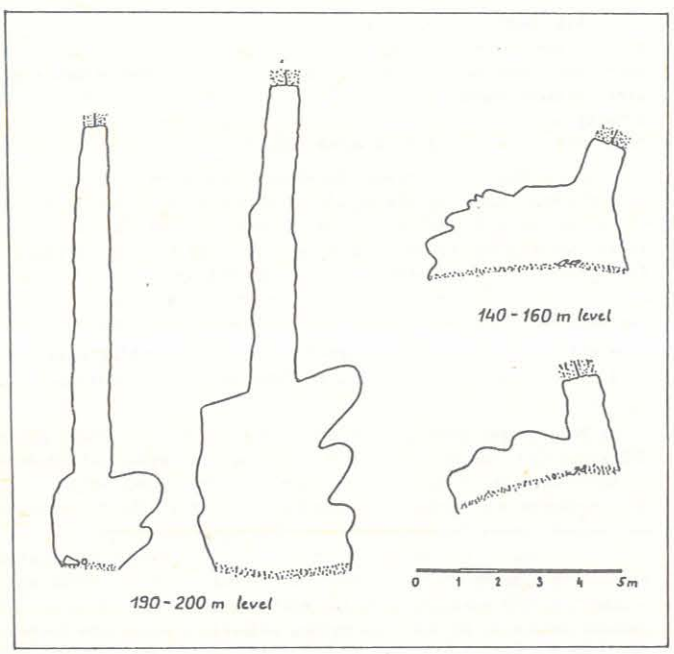

Figure 3. Characteristic cross-sections along the silicified zones in the Pál-völgy Cave

Investigations on the specialities of the Pál-völgy - Mátyás-hegy Caves

Morphogenetic role of silicified rock-zones

A wide-spreaded silification can be observed along the ceiling of almost all passages of these two caves, that had an important role in the shape of the cavities. These are some dm or m wide zones by both sides of the fissures; they contain the same fossil remains as the bedrock, but the carbonate of these zones is fully changed into a loose, porose, tuff-like material with significant silica-content. This material was described by CRAMER (1929) as a geysirit, its formation was interpreted first by KOVÁCS and MÜLLER (1980) as an effect of hydrothermal solutions connected to the the volcanic activity in the Dunazug Mountains during the Miocene age. Some mineralogical investigations on samples from Pál-völgy Cave were carried out by GATTER in 1984, according to them, the temperature of these solutions was about 300 °C /pers. comm./.

These unsoluble porose zones could have played a role by the conduction of waters during the cave building process. The shape of the passages shows, that the dissolution of the bedrock happened mostly along one side only of these zones, that resulted typical cross-sections remembering the letters "b" or "d". This asymmetrie of the passages is even more expressed by the later incasion of these loose zones, especially in the upper parts of the cave, while in the lower parts become dry evidently later the process is less advanced (Figure 3.).

The loss of sphaerical niches considered to be a typical form in caves of thermal water origin can be also traced back probably to the presence of these insoluble zones, that hindered the isometric cavity development here. So we find only forms remembering the halfs of sphaerical niches. These forms differ also from the regular hemisphaere, as their lower part is characterised mostly by rather flat surfaces. Perhaps this can be explained by the relative much clay content of the Eocene limestone bedrock, that deposited as solution remain onto the slope of the forms and provided them against the further dissolution (Figure 4.). If this explanation fits, the deposition of clay during the process indicates a dissolution under circumstances of very small flow velocity.

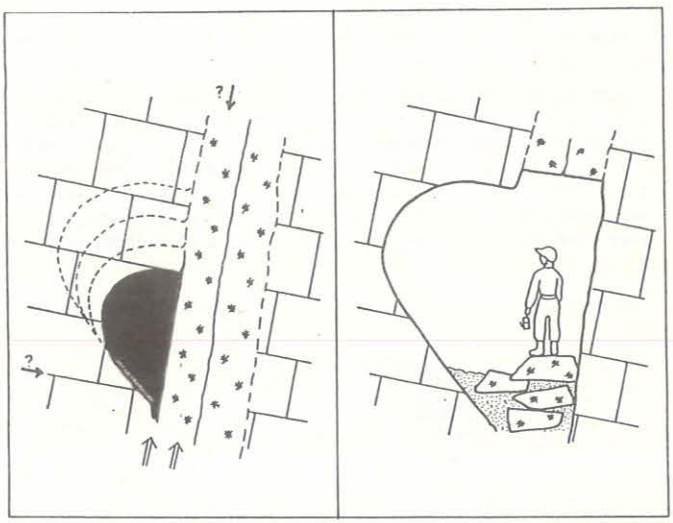

Figure 4. A modell for evolving the forms "halfs of sphaerical niches"

Characteristic morphological elements are in these caves the so-called sphaerical kettles, that occure in mass in form of hemisphaerical hollows of some dm in diameter. These have been considered as whirl kettles for a long time, but this explanation does not fit to our recent knowledge about the flow conditions during the cave building processe. Our observations in the Pál-völgy Cave are the following: these forms occure in mass on surfaces of overhangings or of ceilings only, the rim of many of the superposited kettles is broken through by small "gates", at cer-

tain places the superposited kettles developed into meandering channels, the rare single kettles deepen tube-like, slatways into the homogenous bedrock. All these phenomena are hardly to explain with a normal mixing corrosion effect. Our interpretation is, that these kettles were formed under the water by a condensing water corrosion effect, that took place in gas bubbles separated from the water, adhered and gathered on the suitable surfaces (Figure 5.). The gates and the channels are showing the movement of the bubbles from the lower kettles into the higher ones.

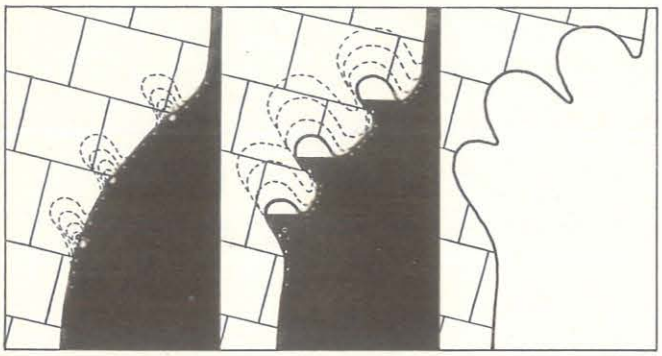

Figure 5. An interpretation for evolving of surfaces covered by hemisphaerical kettles

Cave minerals

The minerals of the early hydrothermal phase are represented here by barite veins and dogteeth spar calcites. Some fissurelike cavities covered by these minerals in the new parts of Pál-völgy Cave prove, that this early phase already had some cavity-building effect, as it was suspected by KOVÁCS and MÜLLER (1980).

Moreover, there are traces of an even older cavity-forming effect in this area, too. Our investigations on geode-like dogtooth spar calcite deposits in this cave, and the same done by KRAUS in the Mátyás-hegy Cave have shown, that under this kind of calcites mostly there is a marly, lamellate, lens-like layer, whose bedding is very different from those of the Eocene limestone bedrock. The phenomenon can be interpreted probably by a short, local intra-Eocene karstification, the small cavities of which got partly filled during the deposition of the younger marl-layers, while the rest of them were covered later by the minerals of the early hydrothermal phase.

Fluid-inclusion analyses on minerals suspected to belong to this early phase were carried out on samples from the Pál - völgy Cave only in this region. According to GATTER's investigations in 1984, the temperature of the solutions originated these minerals was between 150-200 °C.

The mineral precipitations of the cave-building thermal water activity occure in the Pál-völgy Cave locally (and in the Mátyás-hegy Cave in traces only), in contradiction to the other three caves that are rich in these minerals. They are represented here first of all by calcite platelets, that occure in two main levels on the altitudes of 190 and 150 meters. Although these can be observed now some metres above the recent floor, their interpretation by KRAUS (1982) as precipitations on the surface of the cave lakes in form of thin laminae, that got accumulated and cemented on the one-time cave floor, is well damonstrated by the rest of clastic sediments on their bottom.

We observed an interesting phenomenon on these precipitations in the new cave parts explored in 1987: in some places there are small polyhedral lime ribs on the bottom of blocks of these platelets, that can be interpreted as the filling of ancient drying marks in clay. This means, that between the forming of the cavity and the deposition of these precipitations there had to be a dry period - this is a new contribution to the development of these caves (Figure 6.).

The typical popcorn-like calcite deposits - wide-spreaded in Hungarian caves of warm water origin - are missing from Pál-völgy Cave. Instead of them, here occoure a similar, botryoidal type of calcite, that consists of small spar-like units. This difference can be explained probably by a lower temperature of the precipitating solution, which caused a deposition in form of calcites, while the typical popcorn-like calcites are considered to get precipitated originally in form of aragonite. This lower temperature can be interpreted perhaps by a larger rate of cold water component in this cave - the rather much dripstones here compared to other caves of the area seem to prove the possibility of a larger role of infiltrating cold waters.

Fluid inclusion analyses done by GATTER (1984) on samples from the Pál-völgy Cave have shown, that the chemical composition, the concentration and most probably also the temperature of the solutions that formed all these precipitations were very similar to those of the recent warm springs in the area.

Traces of open surface connections

The system of the Pál-völgy and Mátyás-hegy Caves shows some signs of later inflow of cold waters. The lowermost passage leading to the recent karst water table in the Mátyás-hegy Cave shows the forms of cold water corrosion. In the Pál-völgy Cave we have no morphological traces like that, but the investigations on the cave sediments resulted the discovery of clay layers with carbonized plant rests, that could have got into the cave only by running waters. We explain this by the opening of some passages during the deepening of the Szépvölgy Valley, that is situated above the SE part of the Mátyás-hegy Cave and the NE part of the Pál-völgy Cave.

The bat fossiles of the new cave parts made available some contributions to dating the time of drying out of this cave. Dr TOPÁL determined the age of these rests as late Upper Pleistocene, that means, that already the passages on 140-150 m asl. were dry by that time, and the cave had a natural entrance then, too.

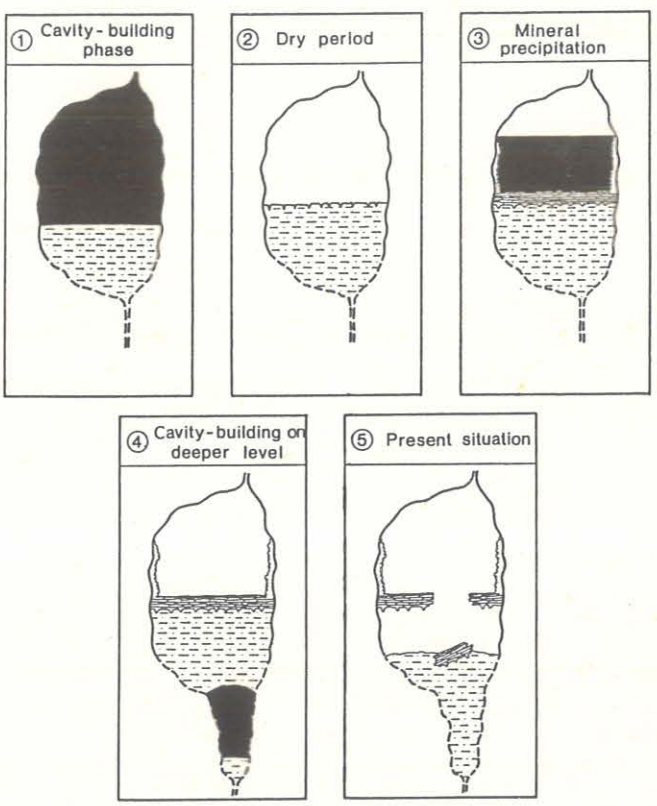

Figure 6. Scematic modell for evolving the forms "Bridges of calcite platelets with positives of drying marks" in the Pál-völgy Cave

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SYNCHRONOUS SURFACE AND UNDERGROUND INVESTIGATIONS ON MEDICAL MAGNETOLOGY IN THE USSR CAVES

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Geographical realm formed under the influence of energetic stream of cosmic (astronomic cycles, climate) and planetary nature (tectonic, volcanic, hydrological phenomena) as well as streams of biological origin is a kind of a boundary layer involved into a complex cosmoplanetary exchange, thus deviding and joining our planet with the cosmic space (Kaznacheev, 1983). Many works on the landscape sphere of the Earth and geographical realm are based on the ideas of Vernadsky V.I. He considered the biosphere as a zone of the earth' crust with transformers conversing cosmic radiation into different kinds of earth' energy: electrical, chemical, mechanical (Vernadsky, 1926, 1980).

Geographical realm is non-uniform and the important elements of this non-uniformity are numerous carst formations in Upper Jurasic and Kembrian limestones resulting in anomalous deviations in telluric currents and the magnetic field of the Earth. Hence, we have the right to suggest that in different parts of the Earth and under the ground cosmic effects are refracting ambiguously (Golovanov, 1986).

According to modern scientific conceptions developed by the cosmic antropoecology we consider any living creature including its higher stage - a man - as a self-organizing organism on transforming cosmic energy as a system which uses a natural astrophysical process consuming and accumulating some part of cosmic radiation.

To study the regularities of electromagnetic exchange between a human organism and the environment under the conditions of the synchronous surface and underground observations is thought to be of great importance.

We suggest that the change in the informatic-energetic background of cosmic effect of electromagnetic and other kind of nature observed under the ground at different depths may affect the systems providing electromagnetic homeostasis of a human organism.

A new methodical approach we used allowed us to do a dynamic evaluation of electromagnetic homeostatistics. We applied dozed magnetic loods by a constant magnetic field where induction was 400 as much as an average induction values of geomagnetic field. By the vector and amplitude of the changes of registered physiological parameters (arterial pressure, pulse frequency, temperature, electroskin resistance) (we) came to the conclusion not only about the degree of individual magnetosensitivity of an organism but also the rate of his conventional conjugation with the heliogeophysical situation. Besides the test on the express-estimation of magnetosensitivity a number of traditional functional tests was used as well.

The investigations were carried out in 1984-1987 (low solar activity period) in carst formations of Siberia, Middle Asia and Trans Carpathians. Namely, in Hakassia autonomic region in the South of Krasnoyarsk area in Kashkulakskaya Cave at the depth from 60 to 140 m where periodically changed geophysical background of this cave made it quite unique for biogeophysical sudies; in Kap-Kutan cave in a mountain massive Kugitang-Tan in Turkmenia, in the region of positive magnetic anomaly at the depth from 70 to 120 m. in Druzhba (Friendship) Cave, Trans Carpathian region and also in wasted pits of this region at the depth of about 300 m.

The members of Novosibirsk and Transcarpathian speleology clubs as well as 126 young healthy men at the age from 18 to 24 took part in the synchronous surface and underground studies. The aim of these studies was to solve the main problem: to evaluate pecularities of a man's responses in the conditions of transforming the usual heliogeophysical background by the thickness of rocks. The backgrcund was registered with a set of geophysical and meteosynoptic instruments (quantum magnetometer M-33, some recorders, type Tangar, some instruments, type AE-72, for recording electric earth parameters, automatic thermographs M-16 and aneroid barographs M-22).

The results of a three-day synchronous surface-underground investigations showed that physiological parameters of the people tested at the depth 300 m. greatly differed ($p < 0,05$) from the data of the control surface group. Particularly, we oserved the increase of blood pressure (by 16 mm.m.c. on average), body temperature (by 1.6°C on average), hand dynamometry data (by 8 kg. on average), and electroconductivity in the region of skin projections of reflexotherapy points (by 4 μA). There was also observed a high pulse frequency (by 15%) at a clinoortostatic underground test. Significant differences were also well-marked by the end of the first day of synchronous investigations with the people of the same age in identically comfortable microclimatic conditions, regularity of meals and food.

On magnetic testing the "surface" and "underground" groups intraday dynamics of the arterial pressure level and its fluctuation appeared to be contrary. On the second day and on, the people tested on the surface had a tendency to decreasing their initial A.P. value and its increasing at the magnetic testing. But with the people tested under the ground initial AP values inceased during 3 days but under magnetic influence hypotensive reaction developed.

The data obtained at the surface-underground investigations in Turkmenia during high magnetic disturbances (magnetic storms) are of great interest. While in the "surface" group (22 persons) the initial values of the systolic AP in the period of the main phase of the magnetic disturbances were 132.5 ± 2.3 mm.m.c. those in the "underground" group were 118.3 ± 2.1 mm.m.c. ($p < 0.01$). The differences at a dozed magnetic loading during the magnetic storm are also of significance: on the surface the systolic AP increased,

by 11.2 mm.m.c. on average, while at the identical loading under ground it increased by 10.7 mm.m.c. , also on average.

The data registered in a geophysically anomalous cave in Hakassia (at periodical high enough fluctuations of electrical, magnetic fields and microseismic activity) are different. Much greater rate of increasing diastolic AP in response to the influence of magnetic field was observed when testing inside a cave: +36.4 mm.m.c. (if compared to the surface testing: 12.2 mm.m.c. and the control test of the same group when imitating underground conditions: +4.2 mm.m.c.).

The change of the vectoral orientation of the responses on the magnetic field is characteristic for all the when tested on the surface and in a cave, the increase of AP prevailing under the ground.

Against the background of periodically and anomalously changing values of the geomagnetic field induction fixed with a magnitometer M-33 only at the depth of 120 m. there was observed the transformation of responses of one and the same man from hypotensive to hypertensive variant at the testing effect by the magnetic field at the period of the geomagnetic induction fluctuation (fluctuation amplitude to 1000 $n\mathcal{T}\mathcal{E}$).

The fact that such fluctuations are observed only in one place - in the ritual zone of this ancient cave - is of great interest. At this moment with many of the tested there were fixed psychophysiological tension, increasing agitation, fear and some of them had visual hallucinations.

At the surface-underground investigations in Turkmenia there were also observed well-marked differences in the correlative dependence of some functional parameters on the geomagnetic field induction. This dependence contradicts to the surface and underground electroparameters of reflexotherapy points. When testing magnetic effects on the surface of correlative dependence was reversible reaching notable values (r = 0.520) in relation to the systolic AR At the magnetic testing in a cave such correlation coefficients were not observed.

Synchronous surface-underground testing in Hakassia showed well-marked differences in electro-parameters of reflexotherapy points (according to two-phase current diversity): on the surface 4.6±0.6 A, in the cave 6.9±0.8 μA ($p<0.05$), and in the changes of electroconductivity at the magnetic testing: -1.4±0.5 A on the surface and 1.2±0.7 μA under the ground ($p<0.01$). It if of interest that these differences were demonstrated by the by the tested group of people who had had a very high degree of heliogeophysical risk at the prenatal period (1-3 months).and were born at the period of high solar activity.

When having dozed physical loading (step-test) the same people demonstrated some peculiarities of responses of their cardio-vascular system both on the surface and under the ground. The extension of restoration period after physical loading under the ground was characterized by notable differences in pulse frequency of the tested (at the third minute of the restoration): on the surface 77.7±4.1 b/m, under the ground 93.3±4.1 b/m (initial values 78 and 77 b/m, correspondingly).

Thus, the synchronous surface-underground investigations on the healthy people demonstared the increasing of the initial values of functional parameters under the ground, a great number of hypertensive reactions, notable differences in electroparameter fluctuations at testing by magnetic field, the change in the mode of correlating differences between functional and geophysical parameters (their lowering, inversion and assymmetry in the cave), the increasing of cardio-vascular system responses on orthostas and the decelerated reconstruction after physical loading in the underground conditions.

The investigations carried out according to the programm "GLOBEKS" during high magnetic disturbances showed the pronounced screening properties of the earth' crust. The tendency to developing hypertensive reactions both on the initial values of AP and on its dynamics at the testing magnetic influence registered during the magnetic disturbances on the surface appeared to be drastically lessened.

Carst formations of the Earth when considered from the point of view of cosmic antropoecology confirmrd the peculiar informative-energetic characteristics in the conditions of studying electromagnetic homeostasis of a human organism.

This cycle of biogeophysical studies confirming the phenomenon of heliogeophysical impriting of a man (Kaznacheev, et al., 1985) and the role of the natural electromagnetic medium in regulating his vital functions will be continued both on different natural models and in the clinical-experimental investigations with hypomagnetic installations (with lowering geomagnetic field for several thousand times). These investigations will help us to understand a very intricate machanism of the biotropic influence of the magnetic field of the Earth and of the near and far-away Cosmos.

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TYUYA-MUYUN (USSR, KIRGHIZIA - PRELIMINARY RESULTS OF THE SPELEOLOGICAL RESEARCHES CARRIED OUT BY THE INTERNATIONAL EXPEDITION IN 1989)

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Abstract

Massif Tyuya-Muyun in South Kirghizia, SU, is known by ore and non-ore low-temperature and hydrothermal paleokarst. Modern karst is also developing. Space-time interrelations between them are complicated and have not been practically studied.

Earlier the massif was known as an uranium deposit, that can be represented as the filling of paleokarst caves of different origin by ore material. Paragenesis of the minerals of this deposit is found to be unique. Complex geology, wide development of karst caves, bright unusual mineralogy and very interesting evolution make Tyuya-Muyun probably the ideal region for serious scientific karstological investigations.

The paper outlines the main features of this region and presents the preliminary results of the International Karst-Speleological Expedition "Tyuya-Muyun'89".

Introduction /Székely, K./

In 1989 the Institute of Geology of the Kirghizian Academy of Sciences organised an international karstological and speleological expedition to study the thermalkarstic phenomena of Tyuya - Muyun massif in South Kirghizia (Fig.1). The expedition named "Tyuya-Muyun'89" and led by V. Mikhailov /Frunze/ took place between 25th April - 22th May. Beside the local researchers, participants represented 5 countries: Austria (1), Czechoslovakia (2), GDR (2), Hungary (4) and Poland (1); the scientific leader of the work was Y. Dublyansky /Novosibirsk/.

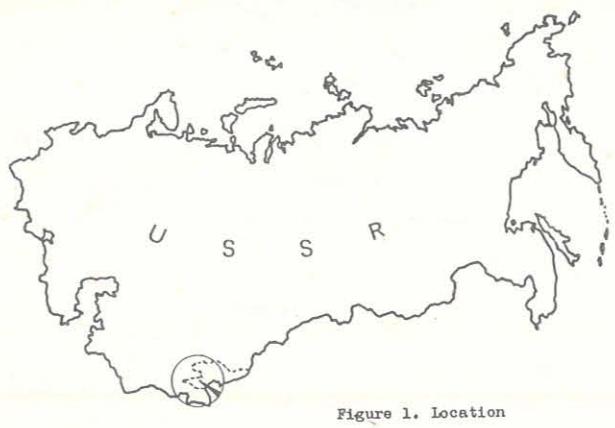


Figure 1. Location

The members of the expedition surveyed the largest caves of the massif, carried out mineralogical, morphological, tectonical, hydrological and climatological observations and investigations in the caves as well as on the surface and collected samples for mineralogical, paleontological and sedimentological analyses.

Although the interpretation of the observations and the analyses are in progress now, the preliminary results of the expedition have already proved, that a rather small team of speleologists coming from different countries, specialized and practised on different subjects can perform succesful work even in an unknown area.

Geology of the region /Dublyansky, Y./

Paleozoic deposits of the region are mainly represented by schists and effusives. Massif Tyuya-Muyun is a sheet body of Lower Carboniferous limestones, being passed among these unkarstifiable rocks. Being up to 600 m in thickness and tens of kilometers in length, the massif subducts steeply under Meso-Cenozoic sediments from east to west. Mesozoic variegated series lie higher with a stratigraphic disconformity. Cenozoic deposits overlap subhorizontally both previous complexes (Fig.2).

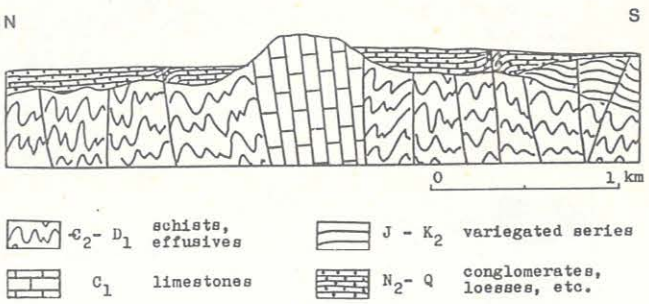


Figure 2. Schematic geological section of the region

The main features of geomorphology of the region /Sanyakova, V./

The massif of Tyuya-Muyun is the inner structure of Karachatyr megaanticlinal (MGA). It is spreading sublatitudely and is bordered by neotectonic marginal fractures at the depth of 4 - 22 km. The Aravan River erodes the massif forming a narrow erosional valley-gorge.

Karachatyr MGA suffers moving of differential sign during the neotectonic stage of its development, that defines the main features of its geological structure and geomorphology.

Karachatyr MGA is involved in uplifting since Oligocene-Miocene (Massaget). At the beginning of Pliocene there was a sinking of the structure, it became the zone of undermountain accumulation and got overcovered by molasses of Bactry series. At the end of Pliocene and at the beginning of Pleistocene there happened an uplifting again, which is impulsively going on up to now.

Surface karst features /Hevesi, A./

The open karst area of the massif - exposed in a length of 2.5 km and in a width of 150-600 m, and bordered by steep slopes and vertical walls up to 400 m - is poor in surface karstic phenomena that can be explained by the poor possibilities during its Late Neogene - Quarternary history:

1. Proved by gravels on the hilltop (1400 m a.s.l.) the whole massif was covered by alluvial fan deposits in the Pliocene age.

2. The climatological conditions of Pleistocene were not really suitable for surface karstification: in the glacials there was a cold and dry climate, while in the interglacials the climate could

have been similar to the recent one (precipitation 4-5oo mm/yr, average temperature in January -6°C and in July 24°C.

3. Loess-spots on the limestone surface indicate, that the denudation of the alluvial cover by Pleistocene uplifting was compensated by deposition of loess in the glacials. The partial solubility of loess reduced the solution capacity of infiltrations, and hindered the evolution of surface forms, that could have been transmitted onto the limestone later. The only considerable epigenetic feature of the massif is a hanging valley in its eastern part (Fig.3).

4. The poor soil-layer on the limestone surfaces does not make possible a considerable enrichment in CO_2 for infiltrating waters.

All the above facts explain, why the surface karst features of Tyuya-Muyun massif are represented by initial clints, small tafonies and tafoni-like niches only.

The most representative feature of the area is the Gorge Danghi of the River Aravan, that divides the massifs Tyuya - Muyun and Yalgyz-Archa. This seems to be an antecendent-epigenetic canyon evolved paralel to the uplifting of the area. According to denudation levels and terraces in the region (Fig. 4), its formation might have started at the beginning of Lower Pleistocene.

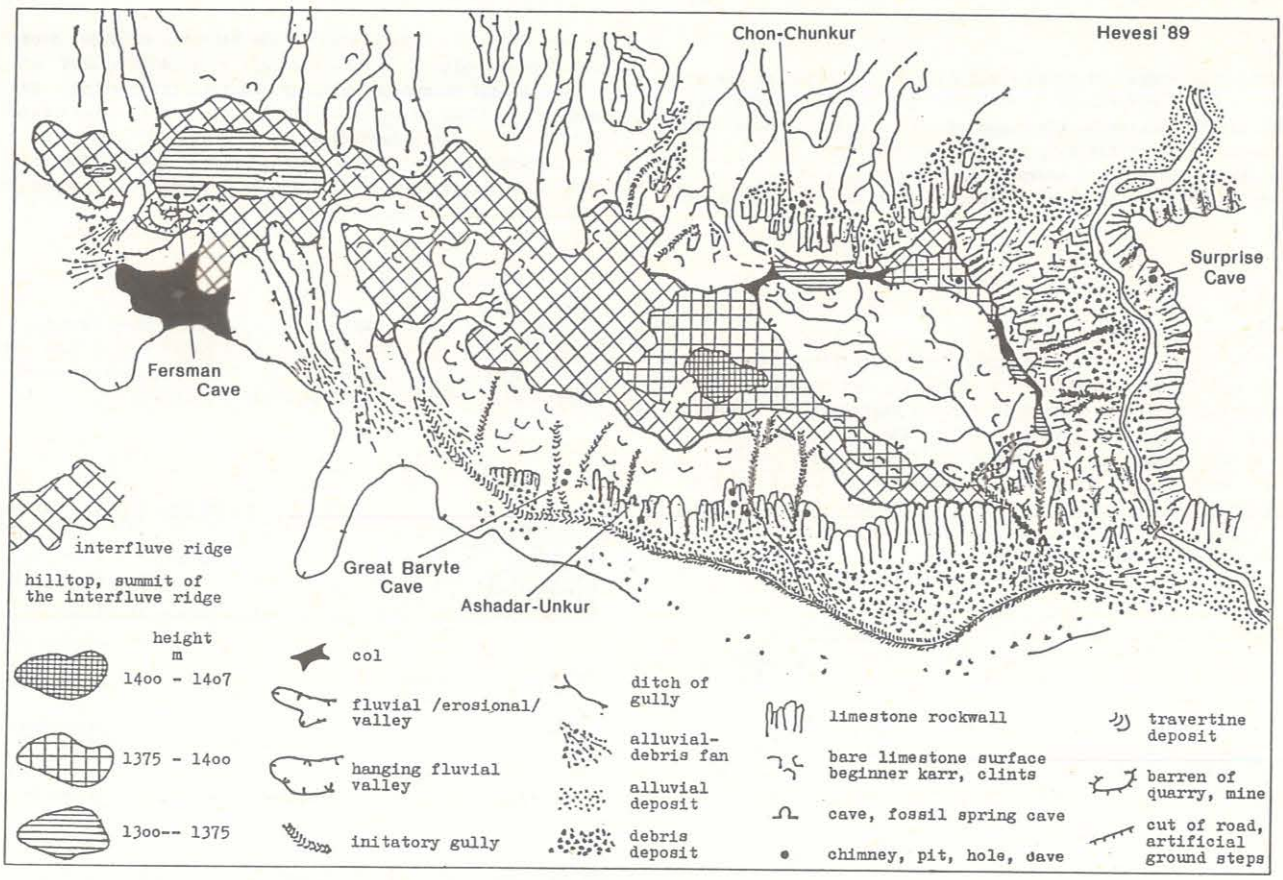


Figure 3. Geomorphological map of Tyuya Muyun

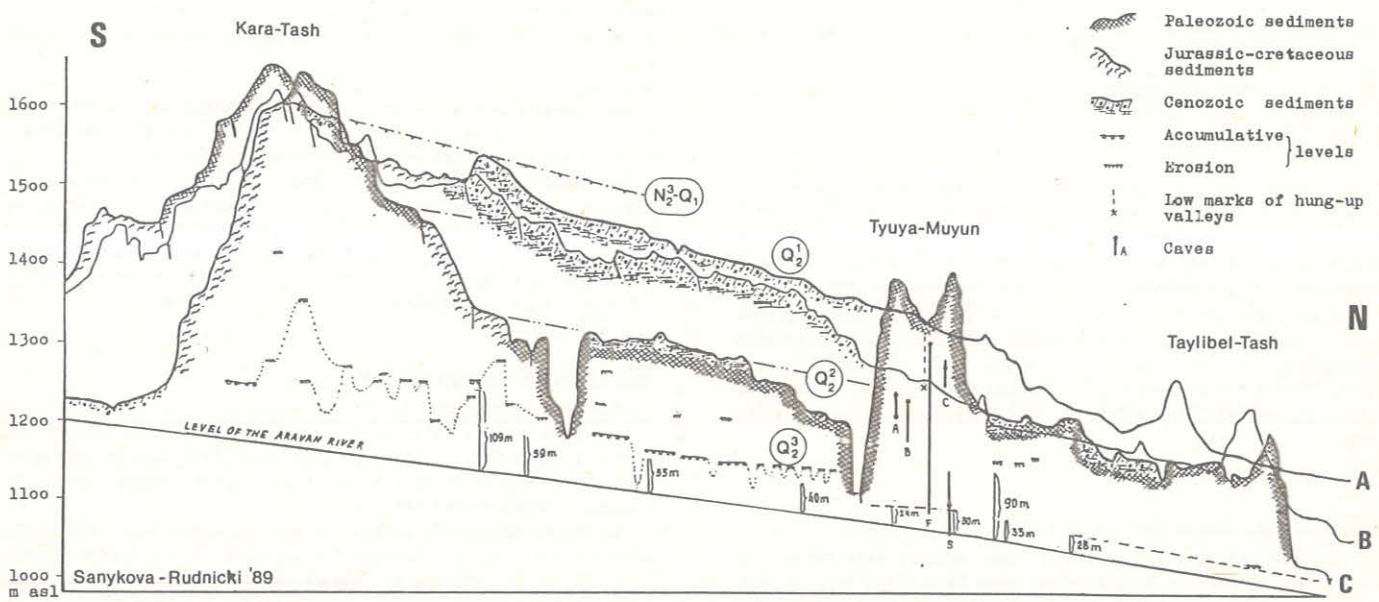


Figure 4. Geomorphological profiles of the Tyuya-Muyun region - left-bank of the River Aravan, along the watershed (A) and in zones of predominance of side erosion of Aravan (B, C)

Paleokarst features /Mikhailov, V./

Paleokarst is widely distributed in the Tyuya - Muyun massif. Its development occured during a few stages and is connected with activity of thermal and cold waters. Karst hollows filled by sediments are often zones in which modern karst has developed. Data received up to now are enabling to propose a working scheme of karst development in the area (Fig.5), that may be changed in the future.

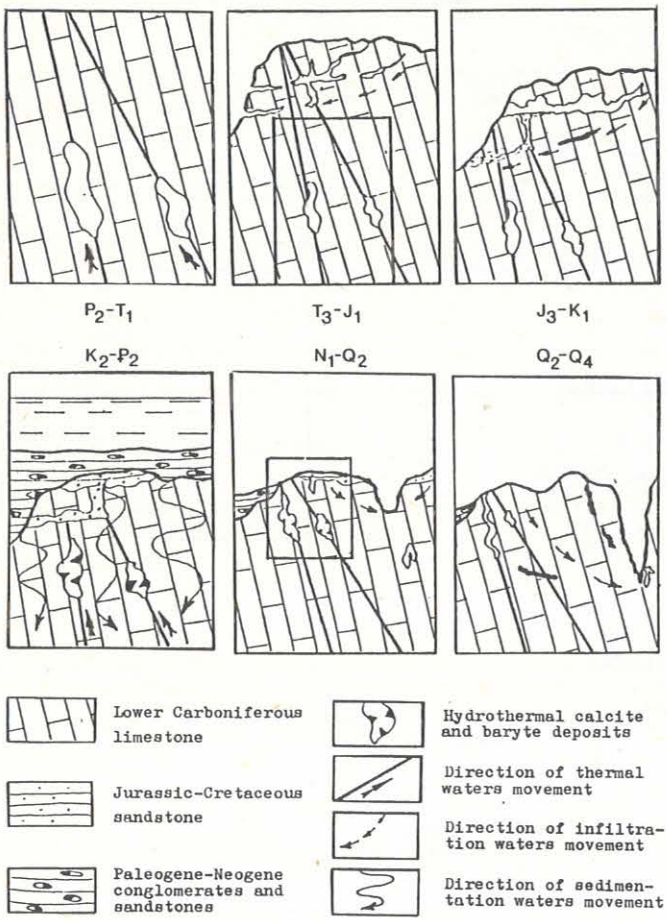


Figure 5. The scheme proposed by Mikhailov for karst development in Tyuya-Muyun massif

Hydrochemical characteristics of underground waters of the region /Machanykova, V./

Underground waters of the Tyuya-Muyun karst massif belond to the zone of active water exchange that determines the intensity of the forming their hydrochemical composition. In such conditions the component composition of water is under control of the composition of water-bearing rocks. Macrocomponent composition of the underground waters is shown in Fig.6.

As a rule, the fresh waters, seldom weakly brackish waters are with temperature from 12.1°C to 22.4°C. Acidic-alkaline characteristisc (pH) change from 6.53 to 8.25, oxidizing-restoration potential (Eh, mv) from +0.18 to +1.12. According to the degree of water hardness, waters are subdivided into temperely hard (14.8°-16.8°), hard (17.8°-25.2°) and badly hard (3o.8°). The chemism of the underground waters is characterised by the presence of dinamic carbonate system.

Mineralogy of the Main Ore Body /Dublyansky, Y. - Hromas, J./

The fame of the massif is based on its uranium deposits, that can be represented as the filling of paleokarst caves of different

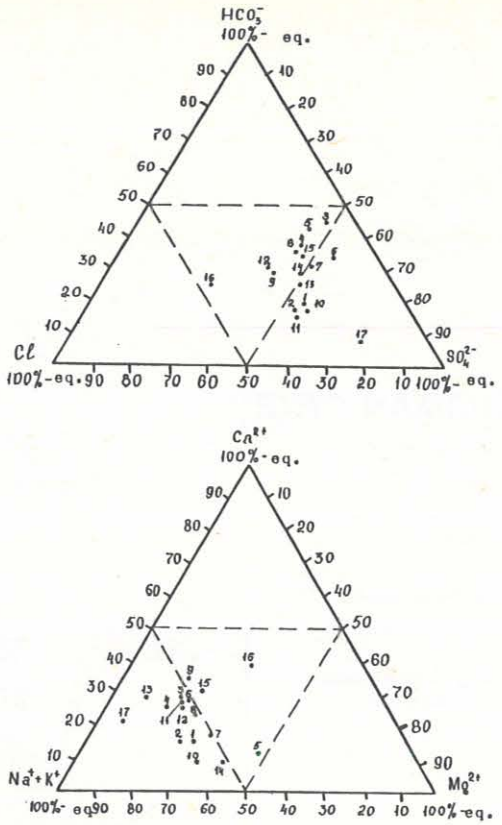


Figure 6. Content of main anions and cations in 17 samples of underground waters of Tyuya-Muyun region, 1989.

origin by ore material. The largest one of these caves is FERSMAN CAVE (Fig.7) which was the Main Ore Body of the massif, with an unique paragenesis of minerals. Its upper part - the so called Yellow Cave - had been already known and exploited for cupper by the Chinese in the 2nd century B.C. Its uranium deposits were exploited until the beginning of the thirties, so at present fragments only of the mineralisation can be seen on the walls of the cave. The section of the ore body is shown in Fig.8.

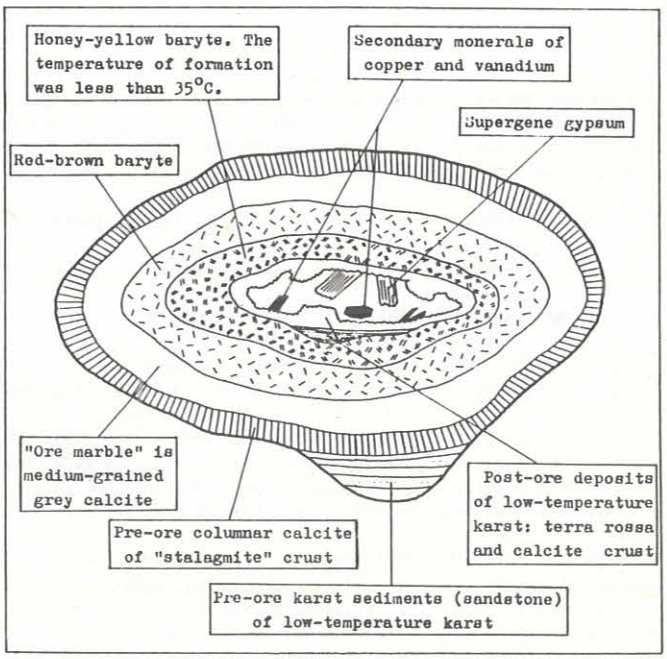
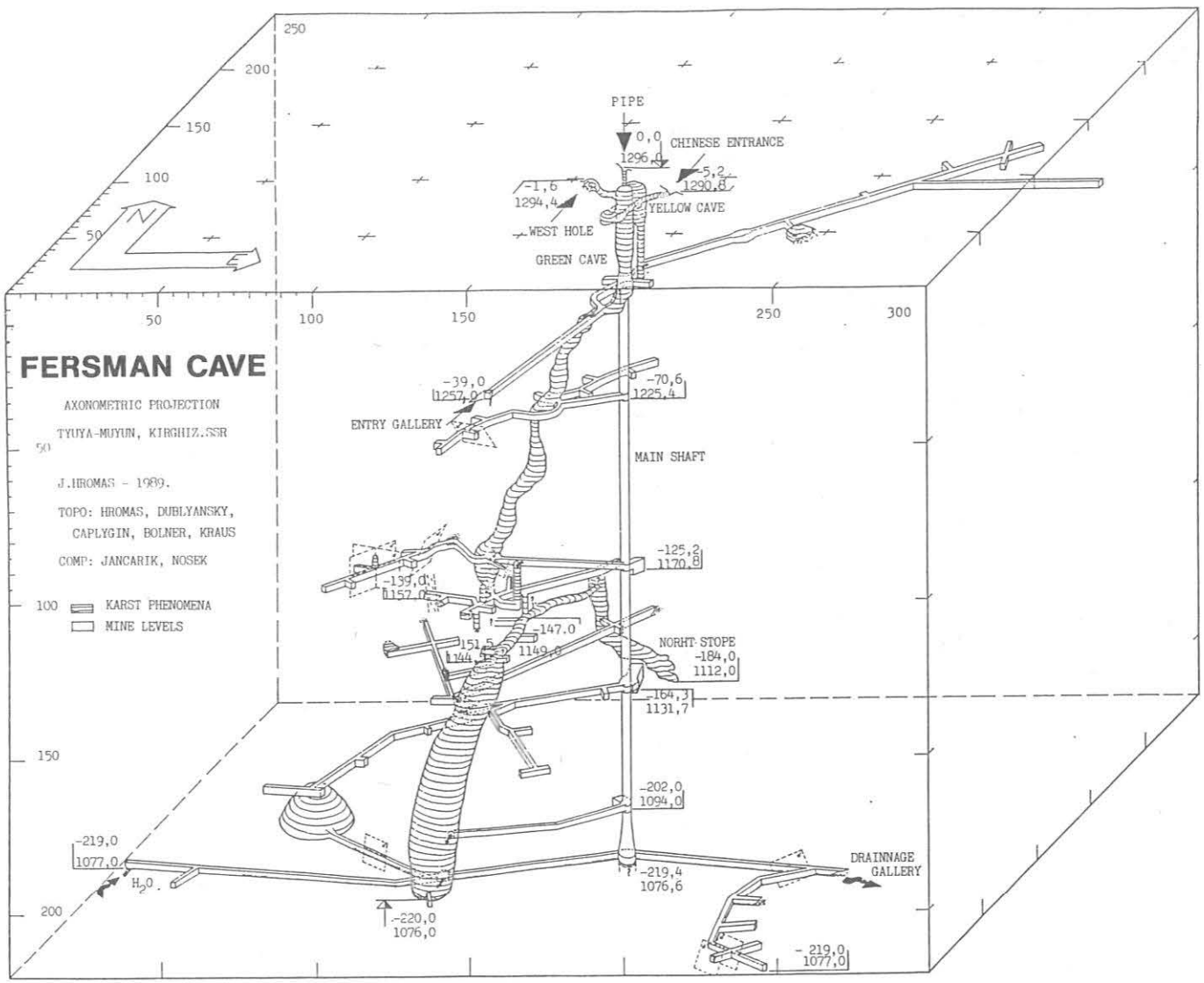


Figure 8. Mineralogy of the Main Ore Body



Mineral samples collected by the expedition were investigated by Dr. Václav CILEK, Prague by the methods of Energy Dispersive Analyser of X-rays /EDAX/, Microsond JEOL JXA 5o A and Finnigham Mat 251. The preliminary results point to three main mineralisation phases:

1. Normal karstic sedimentation (kaolinite, illite, K-feldspar and quartz)
2. Ore precipitation (calcite - quartz - hematite, baryte and U-vanadates)
3. Normal karstic sedimentation (terra rossa), karstification, supergene changes.

According to Dr. Cílek's view, the origin of the deposit is probably the combination of "normal cold" karst and ascending hydrothermal karst along the same tectonical fissures. The precipitation could take place in the zone of mixing between low temperatured, shallow seated hydrothermal solutions containing Pb + Zn, Ba, Cu (?) and cold, descending karst waters enriched by ore elements (U + V + K) from weathering prophiles of granitic and other rocks.

Figure 9. is a simplified scheme to exhibit how by interaction between limestones and crystalline rocks during weathering + karstification the characteristic mineralisation of Tyuya-Muyun could evolve. The analyses resulted a newly found mineral, too: carnotite proved to be rather common crystals associated with tyuyamunite and tangeite, that were described first from this deposit.

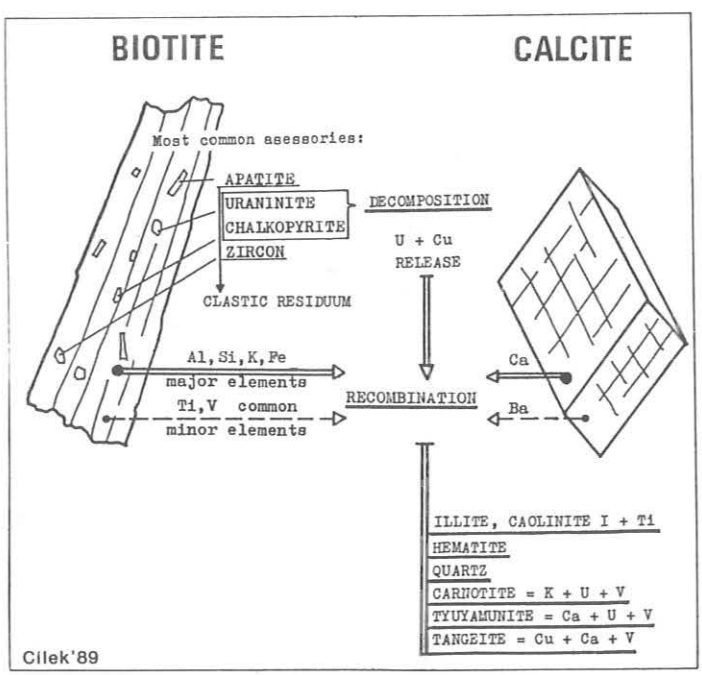


Figure 9.

Non-ore caves /Kraus, S. - T. Bolner, K./

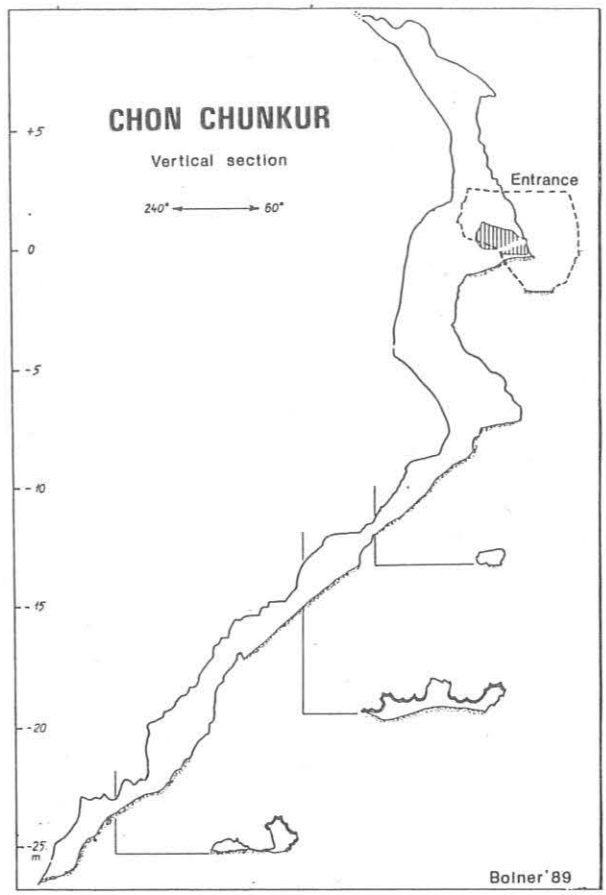
The caves of the eastern part of the massif contain no ore minerals. The four largest of them are GREAT BARYTE CAVE /surveyed length 114 m; vertical extension 56 m/ and ASHADAR-UNKUR /Dragon Cave, 80 m; 26 m/ at the southern margin of the massif, CHON-CHUNKUR /60 m; 35 m/ at the northern margin and SURPRISE CAVE /220 m; 80 m/ in the eastern wall of the Gorge Danghi.

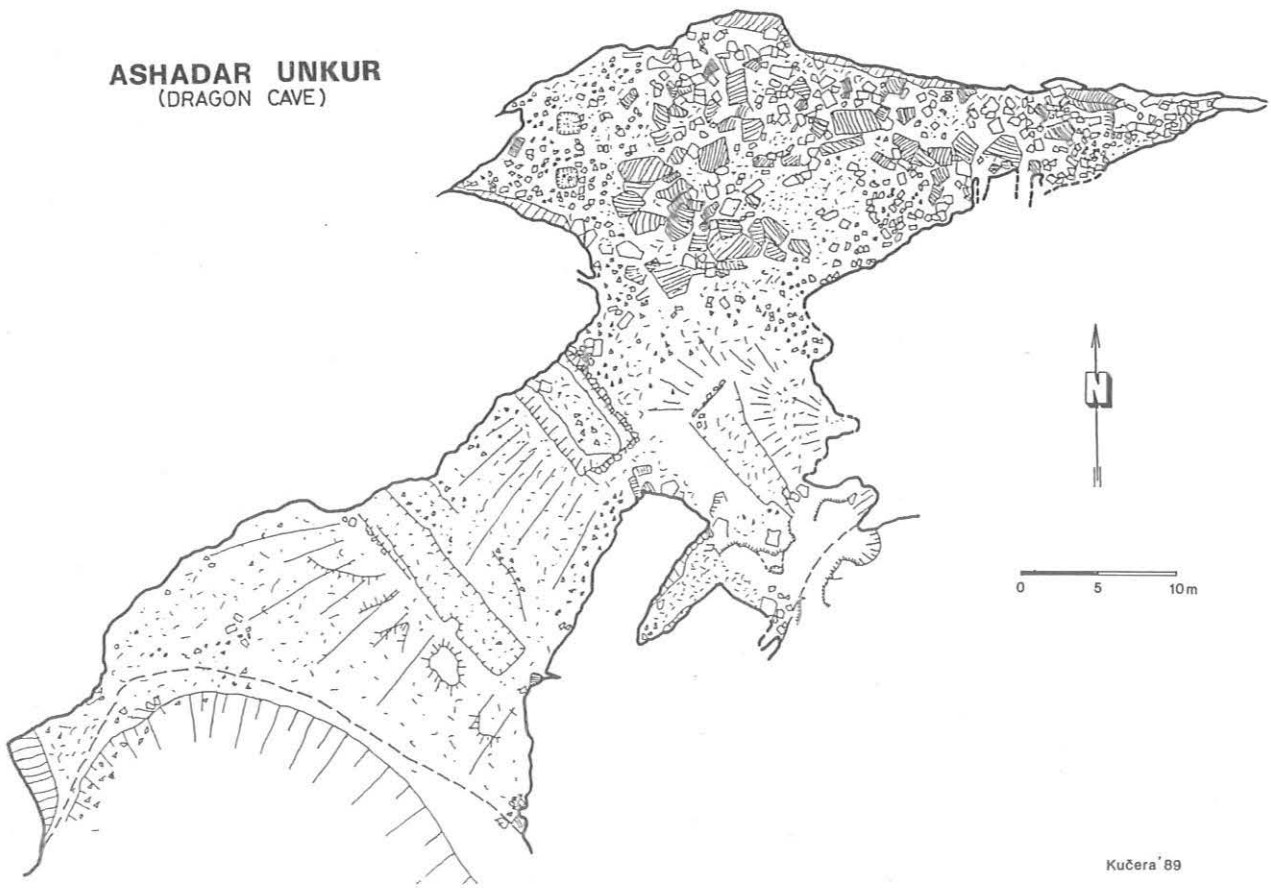
The shape of these caves refer to phreatic origin. The first three of them situated in similar levels of about 1200-1250 m are characterised by rather simple structures (Fig.10. and 11), while Surprise Cave evolved one hundred m deeper represents a complicated, multilevelled system (Fig.12). All these caves are inactive now, and only Surprise Cave reaches the present water table in form of a small pond.

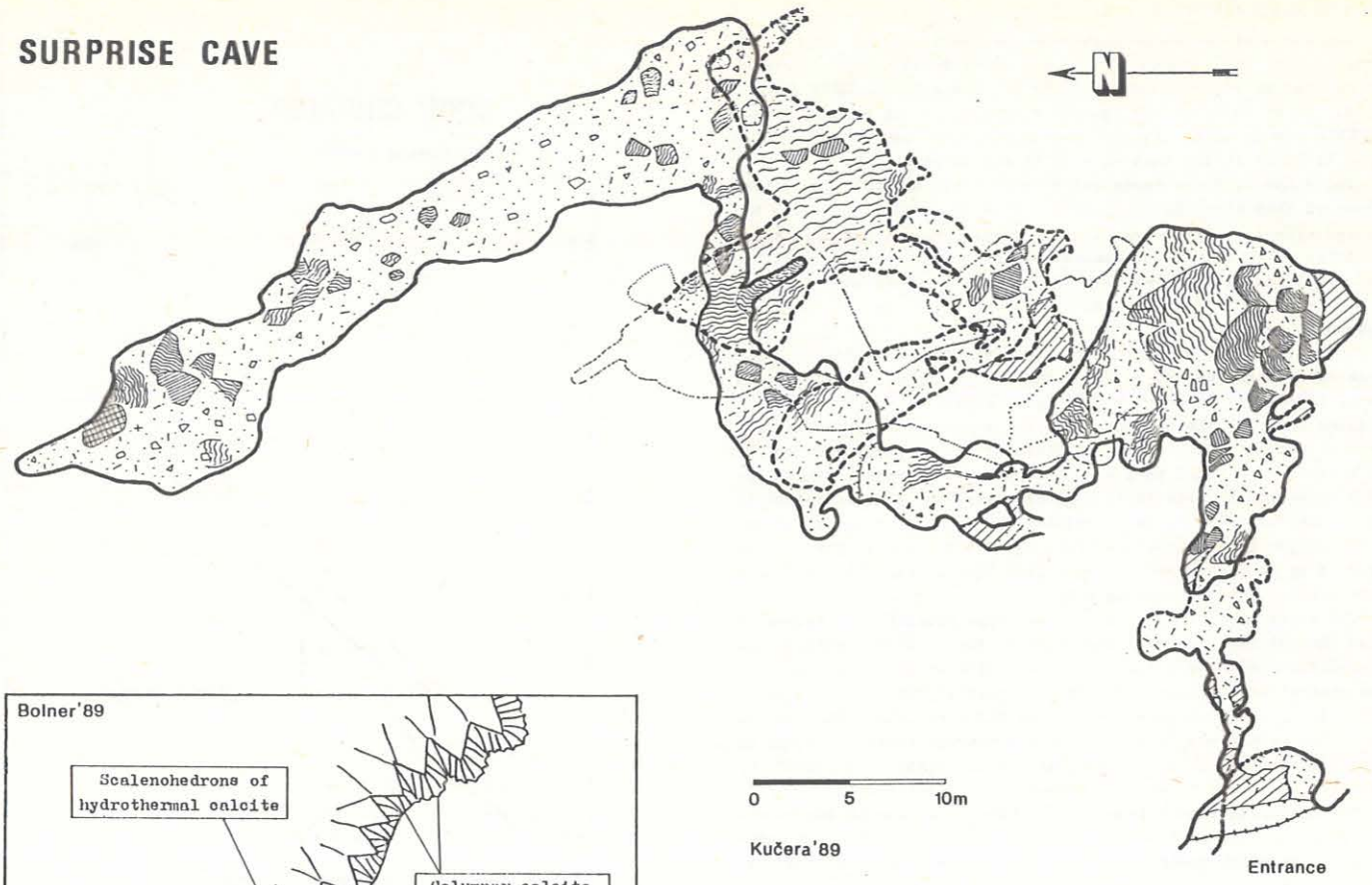
In spite of the absence of ore minerals, some elements of their mineral association can be well compared to those of the Main Ore Body, especially in Great Baryte Cave (Fig.13). The huge scalanohedrons covering the bedrock here are supposed to be the homologues of "ore marble", the temperature of formation proved to be 70°C or less by fluid inclusion analyses. Interesting, that the same formation is present in Surprise Cave, while it is absent in the other two caves situated between them. The occurence of the honey-yellow baryte decreases from west to the east: its thickness is up to 1 m in Great Baryte Cave, but we find it in Dragon and Surprise Caves in traces only.

The white calcite crust of "cloud" type covering the baryte or just the calcites in Great Baryte Cave; the columnar calcite in Chon-Chunkur and the bedrock in Dragon Cave seems to belong to a new mineralisation phase of different physiko-chemical conditions. Its total absence in Surprise Cave is far more interesting as the formation is present in a small cavity nearby. Another change in the hydrochemical or hydrodinamical characteristics is shown by dissolution of the former precipitations in some places.

The precipitations supposed to be deposited near to the water-air boundary are represented by popcorn-like calcites in Chon-Chunkur; by thick masses of calcite platelets (very similar to







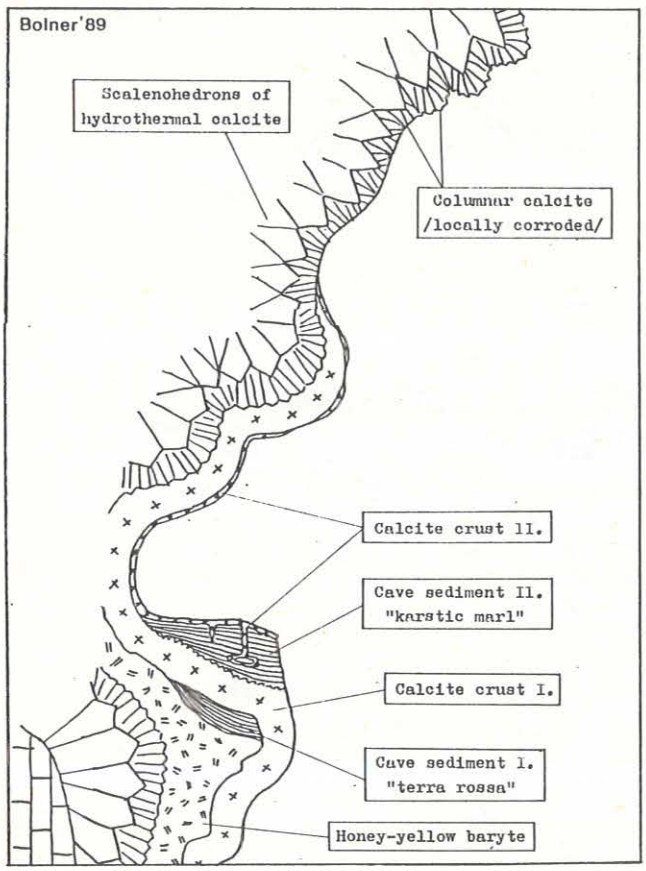


Figure 13. Mineralogy of Great Baryte Cave

those in Budapest caves of thermal water origin) in Dragon Cave and by popcorn-like calcites as well as groups of fine calcite needles in Surprise Cave, where the lime ribs marking the ancient water level can be recognised, too. Drying marks in "karstic marl" filled by a younger generation of calcite crust in Great Baryte Cave and a stalagmite in the base of the calcite platelets in Dragon Cave prove an intermediate dry period in their development.

The effect of inflowing surface waters is proved in Surprise Cave by sand layers, while the loess, that occures as a remain of a former filling in Chon-Chunkur and forms a 2 m thick layer in the entrance room of Dragon Cave is of eolic origin. The remains of small vertebrata collected from the cave sediments mentioned above - very likely the first findings from caves in Kirghizia - were investigated by Dr. Dénes JÁNOSSY and Dr. György TOPÁL, Budapest. The samples represent mainly bat-, shrew-, vole- and bird species, the preliminary results point to their Holocene or Upper Pleistocene age.

The above observations refer to a complicated, multiphased cave development in the area. The analyses being in progress and further investigations on the age and the physiko-chemical conditions of the mineral precipitations in the different caves as well as sedimentological and paleontological studies might help to fit these phases to the geological - geomorphological development of the region.

Tectonic investigations /Mucke, D./

The reconstruction of karstification and mineralisation processes needs to distinguish tectonic fractures as hydraulic active during cave origin; mechanical cutting planes for breakdowns; fissure ways for hydrothermal solutions; unimportant for cave genesis and mineralisation. Relation between tectonics and surface morphology should be known.

More than 2000 fractures had been measured on surface, in caves and mines. Computer aided statistic analysis will give an answer for understanding these processes by comparison of all values of the investigated area; the different subunits of the area; the hydrologic importand fractures as well as the geo- and speleomorphologic important fractures.

Detailed results of the expedition "Tyuya-Muyun '89" will be published by the Kirghizian Academy of Sciences.

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FODOR, ISTVÁN

President of the Hungarian Speleological Society
Président la Société Hongroise de Spéléologie
President der Ungarischen Gesellschaft für Karst- und Höhlenforschung
Presidente de la Asociación Húngara de Espeleologia
Presidénte della Societá Speleologica Ungherese
Председатель Венгерского Общества по Исследованию Карстовых Явлений и Пещерь

Ladies and Gentlemen !

Honoured Congress !

I am honoured to say a hearty welcome to all the participants of the 10th International Congress of Speleology in Budapest.

Special greetings are due to

Prof. Dr. Derek Ford, President of the International Union of Speleology,

Prof. Dr. Hubert Trimmel, Secretary General of the International Union of Speleology,

Dr. László Maróthy, Minister of Environmental Protection and Water Management,

Prof. Dr. István Láng, Secretary General of the Hungarian Academy of Sciences,

Dr. József Bielek, President of the Council of the Capital Budapest,

and Dr. Károly Füredi, Deputy Secretary General of the Hungarian Association of Technical and Scientific Societies.

I am happy to convey the feelings of all our friends engaged in speleology throughout the world when I greet you here in Budapest, not only the capital of Hungary but regarding its wonderful cavés, it can be called a speleological capital. In the area of Budapest there are more than 90 caves with more than 30 km total length of subterranean passages. We have been anticipating your arrival to Hungary with much joy as we thought, in addition to visiting the beautiful caves and romantic landscapes of Hungary, the knowledge offered by the achievements of Hungarian cave exploration of long tradition is valuable for the speleologists of the world.

Our achievements are intricately interlinked with work in almost every speleological workshop of the world. This international meeting of speleologists takes place at a time when the flow of information can hardly be detected and therefore the exchange of information seems to be indispensable. Our congresses have to take a more and more active role in this process as they do indeed.

To the effect of restructuring in world economy the development of science and the utilisation of scientific knowledge have fantastically accelerated by the last decades of the 20th century. This is also the case in karst research and speleology. This world-wide expansion of tourism links continents and karst objects, caves undertake a spectacular part in this process. Along with traditional disciplines, the topics requiring an interdisciplinary approach are of increasing importance also in speleology.

Among others, the problems of ecological crisis, deeply affecting speleology, also belong here. The environmental crisis, caused by pollution, hase become a world-wide one and it does not leave karst regions their natural biota and mineral world intact either. This problems is further aggravated by the accumulation of waste, particularly toxic waste. Only in Hungary the waste accumulating year by year ban be estimated at 100 million tonnes. Although a significant part of this is detoxified or eliminated, large amounts find their way into nature, loading it and upsetting its natural balance. The danger to karst regions is especially great, since karsts are very susceptible to contamination form the surface. With infiltrating water pollutants reach the depth of karst easily even to the remotest points. At the same time the process of self-purification is slow. The present-day stresses call for a new path of speleological research.

As you know it from literature, Budapest is exceptionally rich in thermal waters and caves. In addition to the traditional fields of speleology, for this reason we offered the scientific theories on thermal caves as a topic of discussion.

The venue of this congress offers excellent opportunities not only to discuss these issues in theory but to get acquainted with the actual processes either in Budapest or in the broader environs, in the karst regions of Hungary.

I hope that the 10th Internation Congress will be a really important international event, all the more so since it is unprecedented that the participants arrived in equal numbers from western and eastern countries.

I am convinced that - besides fruitful discussion - you will have a good time in Hungary.

I open the 10th International Congress of Speleology.

Mesdames et Messieurs !

Messieurs les conférenciers !

J'ai l'honneur de vous saluer, tout les participants du 10ème Congrès International de Spéléologie a Budapest.

Je salue plus particuliérement:

Monsieur le Professeur Dr. Derek Ford, le président de l'Union Internationale de Spéléologie,

Monsieur le Professeur Dr. Hubert Trimmel, le Secrétaire Général de l'Union Internationale de Spéléologie,

Monsieur Dr. László Maróthy, le ministre de l'environement et de l'aménagement des eaux,

Monsieur Dr. István Láng académicien, le Secrétaire Général de l'Académie des Sciences de Hongrie,

Monsieur Dr. József Bielek, le maire de Budapest, capitale de la Hongrie,

Monsieur Dr. Károly Füredi, vice-secrétaira Général de l'Union des Sociétés Techniques et des Sciences Naturelles de Hongrie.

Moi, je sius très heureux de tout mon coeur parce que je peut vous saluer au nom de tout les spéléologues du monde ici à Budapest, qui est non seulement la capitale de la Hongrie, mais elle peut être considérée aussi comme la capitale des grottes avec ces merveilleuses grottes, puisqu' uniquement dans la zone de Budapest il y a plus de 90 grottes aves leures galéries dont la longueur totale dépasse 30 km. Nous vous avons attendu avec beaucoup de joie et d'affection en Hongrie, car nous pensons que notre pays peut offrir nombreuses possibilités pour découvrir nos merveilleusement belles grottes, nos régions pittoresques et tendrement romantiques, sans mentionner les traditions historiques da la prospection spéléologique hongroise. A partir de nos études et recherches scientifiques on peut fournir des connaissances et des expériences connvenables au spécialistes venus du monde pour voir la Hongrie.

Nos résultats sont en liaison étroite avec presque tout les ateliers spéléologiques des continents.

La rencontre internationale de Budapest des spéléologues se déroule au cours d'une période quand le courant des informations se caractérise par une certaine surintensification, ainsi l'échange des informations par contacts directs est de plus en plus indispensable.

Ainsi nos congres devrons jouer un rôle de plus en plus considérable. Notre rencontre est également un bon exemple de ce pont vue.

Sous l'effet des changements structureaux de l'économie mondiale au cours des derniéres décennies du XX^{ème} siécle, le développement des sciences et la mise en application des résultats scientifiques se sont accéléres d'une facon spéctaculaire. On constat le même essor aussi dans les domaines karstologiques et spéléologiques. Le développement mondial du tourisme rédit les distances entre les continents, et grâce aux formations karstiques et aux grotte qui y contribuent. En outre des domaines scientifiques de la spéléologie il y a des thèmes qui exigent une approche interdisciplinaire.

Parmi les domaines scientifiques interdisciplinaires on doit mentionner aussi les crises écologiques et d'environnement. La crise écologique provoquée par la pollution de l'environnement résulte des problémes à echelle mondiale, et hélas, cette crise touche également les espaces et les régiones karstiques. L'accroissement continu de la pollution de l'air, l'acidification des sols et de la précipitation ont des effets tres défavorables sur les karsts, et la biospére des régiones karstiques, y compris les minéraux des zones de karst. Ces problémes sont aggravés par les accumulations massives des déchets toxiques et nuisibles. Seulement en Hongrie on estime une formation d'un volume annuel de 10 million tonne des déchets. Bien qu' une partie de ces déchets est détoxiquée et incinérée, un volume important est recyclée dans la nature, et la partie non traitée charge l'environnement dans une profondeur considérable provoquant un état diséquilibre et modifie les processus d'équilibre. Ces changements résultent un danger dans les zones karstiques puisque le karst est très sensible aux pollutions de surface. Les polluants véhiculés par les eaux d'infiltration descendent très vite à l'intérieur du karst dans des profondeurs importantes, y compris les périphéries karstiques, les poins les plus éloignés. Cependant le processus d'autoépuration est très lent et longue. A cause des effets de pollution contemporaine, il serait indispensable de mettre sur les noveaux trajets des recherches karstiques et spéléologiques.

Aussi, à partir de la littérature technique vous avez des idées précises sur la richesse en eau thermale et en grotte thermale de Budapest qui sont unique au monde. Par conséquence nous avons proposé une discussion spécialisée aux théories scientifiques de la formation et de l'évolution des grottes thermales, bien évidemment en outre des domain s classiques de la recherche spéléologue.

Les sites du congrés offrent des excellentes possibilités pour étudier sour places des problémes scientifiques, en complétant les bases théoriques et des connassances de littérature. Il s'agit des sites de Budapest et son environnement, ainsi que des régions karstiques de Hongrie.

J'espère trés sincerement que le 10ème Congrès International de Budapest soit une renconctre importante des spéléologiques, puisque c'est la premiére fois dans l'hìstoire des congrès internationaux où la moitié des participants représente des spéléologues d'ouest et l'autre moitié représente l'est.

j'espére sincerement qu'audelà des discussions scientifiques fructueuses vous allez passer des jours trés agréables en Hongrie.

Mesdames et Messieurs, je déclare l'overture du 10ème Congrés International de Spéléologie.

Meine Damen und Herren !

Werter Kongress !

Ich begrüsse mit aufrichtiger Achtung und Liebe alle Teilnehmer des 10. Internationalen Kongresses für Speläologie in Budapest.

Besonders begrüsse ich

Herrn Prof. Dr. Derek Ford, den Vorsitzenden der Internationalen Unio für Speläologie,

Herrn Prof. Dr. Hubert Trimmel, den Generalsekretär der Internationalen Unio für Speläologie,

Herrn Dr. László Maróthy, Minister für Umweltschutz und Wasserwirtschaft,

Herrn Akademiker Dr. István Láng, den Generalsekretär der Ungarischen Akademie der Wissenschaften,

Herrn Dr. József Bielek, den Vorsitzenden des Rates der Hauptstadt Budapest,

Herrn Dr. Károly Füredi, den stellvertretende Generalsekretär des Verbandes der Technischen und Naturwissenschaftlichen Vereine.

Ich freue mich von Herzen, dass ich Sie hier in Budapest in Vertretung aller Fachleute der Welt, die sich mit Speläologie befassen, begrüssen kann. Budapest ist nicht nur die Hauptstadt Ungarns, man kann sie auf Grund ihrer wunderbaren Höhlen auch als Hauptstadt der Höhlen betrachten. Allein im Raum von Budapest sind mehr als 90 Höhlen zu finden, deren Gänge mehr als 30 KM umfassen. Wir haben Sie mit Freude und Liebe hier in Ungarn erwartet, weil wir der Meinung sind, dass die wunderschönen Höhlen unseres Landes, das Kennenlernen unserer durch ihre Liebliche Romantik anziehenden Landschaften, sowie die historischen Traditionen der ungarischen Höhlenforschung und die Ergebnisse unserer wissenschaftlichen Forschungen gleichermassen geeignet sind den in Ungarn einen Besuch machenden Experten nützliche Kenntnisse zu übermitteln.

Unsere Ergebnisse sind durch sehr viele Fäden mit fast allen speläologischen Werkstätten der Welt verbunden. Das Budapester grosse internationale Treffen der Speläologen findet zu einem Zeitpunkt statt, wo man dem Strom der Informationen kaum folgen kann, und gerade darum ist der Austausch der Informationen immer unerlässlicher. Unsere Kongresse müssen in diesem Prozess eine immer bedeutendere Rolle übernehmen, was sie auch tun.

Auf Grund des Einflusses der sich im XX. Jahrhundert vollziehenden Strukturveränderung der Weltwirtschaft, hat sich die Entwicklung der Wissenschaften und die Nutzung der wissenschaftlichen Ergebnisse beschleunigt. So ist das auch auf dem Gebiet der Karst- und Höhlenwissenschaften. Die weltweite Entwicklung des Fremdenverkehrs verbindet heute bereits Kontinente und dabei übernehmen die Karstobjekte, die Höhlen eine attraktive Rolle. Neben den traditionellen Gebieten der Wissenschaft (Wissenschaftszweige), sind auch in der Speläologie die interdisziplinär handhabbaren wissenschaftlichen Themen von immer grösserer Bedeutung. Ein solches ist u.a. auch der Problemenkreis der ökologischen, der Umweltkrise, die die Speläologie immer tiefer berührt. Die durch die Verschmutzung der Umwelt verursachte ökologische Krise hat sich im Weltmasstab erweitert und diese Umweltkrise schont auch die Karstregionen nicht. Die ständig wachsende Verschmutzung der Luft, das Versauern des Bodenwassers und des Niederschlags wirken sich ungünstig auf den Karst, auf seine natürliche Lebewelt und die Minerale aus. Das Problem wird durch die sich in immer grösserem Masse anhäufenden Abfälle, besonders durch die gefährlichen, nur noch erschwert. Allein in Ungarn kann man die jährlich anfallenden Abfälle auf ca 100 Mill. To schätzen. Wenn auch ein bedeutender Teil davon unschädlich gemacht, bzw. vernichtet wird, so gerät doch der andere bis zu einer bedeutenden Tiefe in die Natur, belastet diese und zerstört die Prozesse ihres natürlichen Gleichgewichts. In den Karstgebieten bedeutet das darum grosse Gefahr, weil der Karst besonders empfindlich auf die seine Oberfläche berührenden Verschmutzungen reagiert. Die Schmutzmaterialien gelangen mit dem einsickernden Wasser sehr schnell im inneren des Karstes zu der möglichst grössten Tiefe, inbegriffen auch die entferntesten Punkte der Höhle. Gleichzeitig ist aber der Prozess der Selbstreinigung sehr langsam und lang. Die heutigen, modernen Stresseinflüsse würden es wirklich aktuell machen, dass sich die Karst- und Höhlenforschung auf neuen Bahnen bewege.

Sie wissen aus der Fachpresse sehr wohl, dass Budapest - in der ganzen Welt allein dastehend - sehr reich an Thermalquellen und Thermalhöhlen ist. Auch darum haben wir, neben den traditionellen wissenschaftlichen Gebieten der Speläologie, auch die wissenschaftlichen Theorien, die sich auf die Thermalhöhlen beziehen, besonders für die Diskussion vorgeschagen.

Der Ort des Kongresses bietet ausgezeichnet Möglichkeiten dafür, dass wir all diese wissenschaftlichen Probleme nicht nur auf theoretischer Grundlage diskutieren, sondern uns auch mit den Prozessen in der Realität bekanntmachen, gleich, ob am Ort des Kongresses in Budapest, oder in der weiteren Umgebung, in den Karstregionen Ungarns.

Ich hoffe aufrichtig, dass der 10. Internationale Kongress zum grossen, internationalen Treffen des Speläologen in Budapest wird,

schon darum, weil es in der Geschichte der internationalen Kongresse noch niemals ein Beispiel dafür gab, dass die Teilnehmer annähernd halb und halb die aus dem Westen und dem Osten kommenden Speläologen vertreten.

Ich hoffe auch aufrichtig, dass sie sich, abgesehen von den ergebnisreichen wissenschaftlichen Diskussionen, in Ungarn wohl fühlen werden.

Ich eröffne den 10. Internationaler Kongress für Speläologie.

Señoras, Señores !

Respetado Congreso !

Con estimación y cariño saludo en Budapest a todos los participantes del 10 Congreso Internacional de Espeleológía.

Saludo con especial atención:
al profesor dr. Derek Ford, presidente de la Unión Internacional de Espeleológía;
al profesor dr. Hubert Trimmel, secretario general de la Unión Internacional de Espeleología;
al dr. László Maróthy, ministro de protección del ambiente y asuntos hidrológicos;
al académico dr. István Láng, secretario general de la Academia Húngara de Ciencias;
al dr. József Bielek, presidente de la municipalidad de la capital con asiento en Budapest;
al dr. Károly Füredi, vice secretario general de la Asociación Húngara de Comisiones de Ciencias Técnicas y Naturales.

De todo corazón me alegra, que en nombre y representación de todos los profesionales del mundo, que se ocupan con Espeleología los pueda saludar aquí en Budapest, que no solo es la capital de Hungría, sino que por sus maravillosas grutas subterráneas es considerada como la capital de las grutas. Si solo en la región que ocupa Budapest, se encuentran mas de 90 grutas que tienen mas de 30 kilómetros de galerías subterráneas. Con alegría y cariño los esperábemos a Uds en Hungría, porque consideramos que nuestro pais con sus maravillosamente bonitas grutas y con el aterciopelado romanticismo que sus paisajes irradian aparte de hacerse conocer, en base de las tradiciones históricas de las investigaciones húngaras de espeleologia y los resultados científicos obtenidos, ofrecerán conocimientos semejantes a los profesionales del mundo que visitan Hungria.

Nuestros resultados con muchos lazos nos atan a casi todos los talleres de ensayos espeleologicos del Mundo. El encuentro internacional en Budapest de los espeleologícios se realiza en un momento, cuanda apenas pueden ser seguidas de cerca las corrientes de informaciones, justamente por ello el cambio de informaciones cada vez, se hace mas imprescindible. En este proceso nuestros congresos deben jugar cada vez un papel mas importante y esto lo estamos cumpliendo.

Por efectos de los cambios de estructruras que se llevan a cabo en la economía mundial, en las últimas décadas del siglo XX. se aceleró en forma fantástica el desarrollo científico y el aprovechamiento de los resultados alcanzados. Así ocurre tambien en el ramo de los sedimentos calcáreos y en la ciencia espeleológica. El desarrollo mundial del turismo hoy ya une continentes y en ello ocupan un sitio privilegiado los objetivos sedimentados y las grutas subterráneas. Junto a los ramos tradicionales de las ciencias, en la espeleología también mas temas científicos elaborados con caracter interdisciplinario de cada vez mayor importancia.

Entre ellos encontramos, los problemas de la crisis del ambiente, relacionado a la ecología, que cada vez afecta mas profundamente a la espeleologia. La crisis ecológica producida por la polulización del ambiente hoy ya toma magnitudes mundiales y esta crisis del ambiente tampoco contempla las regiones de sedimentos calcáreos. El constante aumento del aire polulizado, la creciente acidez de los suelos y el agua de lluvia tiene efectos muy desfavorables sobre las sedimentaciones calcáreas y su mundo natural viviente y a sus correspondientes minerales.

El problema se agrava con el constante crecimiento de los deshechos y en especials con la presencia de deshechos peligrosos. Solo en Hungría se calculan en 100 millones de toneladas los deshechos que se producen año tras año. Si bien es cierto una parte significativa de los mismos se neutralizan o se suprimen, una gran cantidad sin embargo, afecta a la naturaleza profundamente, sobrecarga y desvía el natural equilibrio de los procesos que la componen. En las regiones de sedimento calcáreos esto significa gran peligro porque el sedimento es especialmente sencible a las polulizaciones que afectan su capa cubierta. Los materiales de contaminación con el agua infiltrada llegan rapidamente al interior del sedimento y en su mayor cantidad indluso a los puntos mas distantes. Al mismo tiempo el proceso de autopurificación es muy lento y largo. Los modernos efectos de stres tendrían, que hacer actual, el deslizade de las investigaciones del sedimento y espeleología hacia nuevos caminos.

Ustedes conocen bien gracias a las publicaciones profesionales, que Budapest es única en el mundo en sus riquezas en aguas termales y en grutas subterráneas termales. Debido a ello junto a los tradicionales sectores científicos de la espeleología recomendamos a discutir destacadamente las teorías científicas relacionadas a las grutas subterráneas termales.

El lugar del congreso ofrece excelentes posibilidades, para que estos problemas científicos no solo sean discutidos en forme teórica, sino que en la realidad también podamos conocer sus procesos, tanto aquí en Budapest, como en el ambiente mas amplio que lo rodea, las regiones sedimentadas de Hungría.

Sinceremente espero que el 10. Congreso Internacional será el encuentro internacional de los espeleologos en Budapest, también por el hecho que en la historia de los congresos internacionales jamás se dió el caso, que los participantes en proporciones casi iguales puedan representar a los espeleologos provenientes de occidente y a los de oriente.

Deseo francamente que junto a discusiones profesionales útiles a realizarse, se encuentren a gusto en Hungría.

Con esto abro las sesiones del 10. Congreso Internacional de Espeleología.

Signore e signori !

Spettabile Congresso !

Vorrei salutare a Budapest con sincero rispetto e affetto tutti i partecipanti del X. Congresso Internazionale di Speleologia.

Vorrei salutare a parte:
il sig. prof. Dr. Derek Ford, presidente dell' UIS
il sig. prof. Dr. Hubert Trimmel, segretario generale dell' UIS
il sig. Dr. Maróthy László, ministro di Ministerio per la Protezione dell' Ambiente e l' Acqua
il sig. Dr. Láng István, accademico, segretario generale dell' Accademia Ungherese delle Scienze
il sig. Dr. Bielek József, sindaco della capitale
il sig. Dr. Füredi Károly, vice segretario generale ungherese dell' Associazione delle Società Techniche e di Scienze Naturalli.

È un vero onore per me che posso salutarle nella rappresentanza di tutti gli specialisti di speleologia del tutto il mondo qua a Budapest, otre che la capitale di Ungheria possiamo ritenerla anche, per tutte le sue bellissime grotte, la capitale delle grotte. Giacché solo nei dintorni di Budapest ci sono 90 grotte con una lunghezza insieme oltre di 30 km. Le aspettavamo in Ungheria con affezione perché pensiamo che oltre le conoscenza delle bellezze delle grotte e dei paesaggi della nostra patria, le nostre tradizioni nella speleologia e i risultati delle richerche scientifiche possono dare informazioni degne per gli specialisti del tutto il mondo che sono venuti in Ungheria.

I nostri risultati sono legati com molti fili a quasi tutte le officine di speleologia del tutto il mondo. La riunione internazionale degli speleologi tenuta a Budapest ha luogo in un momento, quando lo scorrere delle informazioni è quasi irraggiungibile e perciò

lo scambio delle informazioni diventa indispensabile. I nostri congressi devono assumere una funzione notevole in questo processo, e infatti lo fanno.

Per l'effetto degli scambi delle strutture nell'economia mondiale negli ultimi decenni si è accellerato incredibilmente lo sviluppo delle scienze e l'utilizzazione dei risultati scientifici. È così questo anche nell'ambito delle scienze speleologiche e carsiche. Lo sviluppo di vasta portata del turismo ormai connette continenti, e di questo prendono gran parte anche gli obietti carsici e le grotte. Oltre le discipline convenzionali anche nella speleologia hanno sempre più importanza gli interdisciplinari temi scientifici.

È tale tra l'altro il problema della crisi dell'ambiente, dell'ecologia che riguarda sempre di più anche la speleologia. La crisi ecologia, causata dell'inquinamento dell'ambiente, ormai è di grandezza mondiale, presente anche negli ambiti carsici. L'aumento dell'inquinamento dell'aria, l'acidificazione del suolo e dell'acqua di precipitazione, hanno effetto sfavorevole ai posti carsici, al loro mondo minerale e vivente naturale. Il problema è aggravato dalle immondizie accumulate sempre in maggior quantità, e soprattutto i rifiuti pericolosi. Solo in Ungheria è quasi 100 milioni di tonnellate l'immondizia formatasi da un anno all'altro. Benché la maggior parte dell'immondizia viene resa innocua oppure annientato, anche così penetra nel suolo fino ad una profondità notevole, aggrava e turba i processi dell'equilibrio naturale. Questo significa gran pericolo negli ambiti carsici, perché il carso è molto sensibile agli inquinamenti della superficie. Le materie novice sciolte nell'acqua infiltrata arrivano molto presto alla profondità possibile, intendendo anche i punti più lontani del carso. Nello stesso tempo l'autopurificazione è un processo molto lungo e lento. I moderni effetti dello stress rendono attuale che anche le ricerche speleologiche e carsiche abbiano nuove strade.

Loro sanno bene degli studi speciali che Budapest è ricca di acque termali e grotte termali - unicamente al mondo. Perciò abbiamo consigliato accentuatamente le teorie scientifiche che riguardano le grotte di origine termale, oltre a quelle convenzionali della speleologia.

Il posto del Congresso offre delle possibilita eccellenti che questi problemi non siano discutati solo teoricamente, ma che i processi siano conosciuti anche nella realtà - sia al posto del congresso, a Budapest, sia nelle regioni carsici dell'Ungheria.

Spero molto che il X Congresso Internazionale di Speleologia sarà una grande riunione internazionale degli speleologi a Budapest, anche perché questa è la prima volta nella storia degli speleo-congressi che i partecipanti rappresentino in 50 % gli speleologi dell'Est e nell'altro 50 % quelli dell'Ovest.

Spero molto che anche voltre le efficaci discussioni scientifiche si sentiranno bene in Ungheria.

Inauguro il X Congresso Internazionale di Speleologia.

Дамы и господа!

Уважаемый конгресс!

С искренним уважением сердечно приветствую в Будапеште всех участников Десятого международного спелеологического конгресса.

Разрешите мне особо приветствовать:

- господина профессора Дерека Форда, председателя Международной унии спелеологов,
- господина профессора Хуберта Триммеля, генерального секретаря Международной унии спелеологов,
- господина Ласло Мароти, министра охраны окружающей среды и водного хозяйства Венгрии,
- господина академика Иштвана Ланга, генерального секретаря Венгерской Академии Наук,
- господина Йожефа Биелека, председателя горсовета Будапешта,
- господина Кароя Фюреди, заместителя генерального секретаря Союза научно-технических обществ.

От глубины души я рад тому, что могу приветствовать вас, представляющих всех специалистов мира, занимающихся спелеологией, здесь в Будапеште, который является не только столицей Венгрии, но - благодаря своим замечательным пещерам - может быть сочтен и столицей спелеологии. Ведь в районе Будапешта можно найти более девяноста пещер с ходами, превышающими длину 30 километров. С большой радостью мы ждали вашего приезда в Венгрию, считая, что специалисты, приехавшие со всего мира в Венгрию, смогут ознакомиться не только с прекрасными пещерами и романтичными пейзажами нашей страны, но и с историческими традициями венгерской спелеологии, и с достойными внимания результатами наших научных исследований.

Наши результаты весьма многими узами связаны почти со всеми спелеологическими школами мира. Крупная международная встреча спелеологов проводится в Будапеште в такое время, когда почти немыслимо следить за потоками информации, и именно поэтому обмен информацией всё больше становится необходимым. В таком процессе наши конгрессы должны играть и играть все более важную роль.

Под действием преобразований структуры мировой экономики в последние десятилетия XX века бесподобно ускорились развитие наук и использование научных результатов. Такова же обстановка и в области изучения карстов и пещер. Благодаря всемирному масштабу развития ныне уже туризм связывает континеты, а в этом видную роль сыграли карстовые объекты и пещеры. Наряду с традиционными областями наук, в спелеологии всё большее значение придается интердисциплинарно разрабатываемым научным темам.

Таковой является и проблематика экологического кризиса, всё глубже затрагивающего спелеологию. К настоящему времени экологический кризис, причинённый загрязнением окружающей среды, приобрел всемирный масштаб, причем он не пощадил и карстовые регионы.. Непрерывний рост загрязненности атмосферного воздуха, кислотные осадки и окисление почв весьма неблагоприятно влияют на карсты, на их природный живой мир и минеральный состав.

Проблема усугубляется тем, что скапливаются все больше количества отходов, а особенно опасных отходов. Только лишь в Венгрии насчитывается около ста миллиона тонн отходов, обновляющихся из года в год. И хотя значительная часть этих отходов обезвреживается и уничтожается, все же они довольно глубоко проникают в природу, обременяя и нарушая процессы её естественного баланса.

В карстовых регионах это весьма опасно потому, что карстовая порода особенно чувствительна к загрязнениям, затрагивающим её поверхность. Вместе с просачивающейся водой загрязняющие вещества весьма быстро проникают в карст до величайших глубин, до самых дальних скрытых мест. В то же время процесс самоочищения происходит в карстах весьма медленно и длительно. Сегодняшние современные стрессовые воздействия могут сделать по настоящему актуальным вопрос перехода исследований карста и пещер на новые пути.

Из специальной литературы вам хорошо известно, что Будапешт уникален в мире по своему богатству термальных вод и термальных пещер. Поэтому - наряду с традиционными областями спелеологии - мы и рекомендовали особо обсудить научные теории, касающиеся термальных пещер.

Место проведения конгресса предоставляет отличные возможности обсудить все эти научные проблемы не только на теоретических началах, но ознакомиться с процессами и в натуре, на месте проведения конгресса - в Будапеште, или же в более широком окружении - в карстовых регионах Венгрии.

Я искренне надеюсь, что Десятый международный конгресс в Будапеште будет видной международной встречей спелеологи, Запада и Востока были представлены в равных пропорциях.

Я искренне надеюсь, что наряду с успешными научными диспутами, вы сможете приятно провести время в Венгрии.

Открываю Десятый международный конгресс спелеологов.

MARÓTHY, LÁSZLÓ

Minister of Environment and Water Management
Le ministre de l'environment et de l'aménagement des eaux
Minister für Umweltschutz und Wasserwirtschaft
Ministro de protección del ambiente y asuntos hidrológicos
Ministro di Ministerio per la Protezione dell' Ambiente e l' Acqua
министр охраны окружающей среды и водного хозяства Венгрии

Honoured Congress !

Ladies and Gentlemen !

On behalf of the Government of the People's Republic of Hungary I welcome the participants of the 10th International Congress of Speleology, the leaders of the Speleological Union with special regard to the President, Prof. Derek Ford and the General Secretary, Prof. Hubert Trimmel.

It is considered a great honour that this international society of high respect has chosen Hungary for the venue of its meeting. Hungary is glad to act as a host country for any event which serves scientific progress, the exchange of experience between specialists of different nationalities - and works for cooperation between nations, increasingly dependent on each other. It is particularly so when we can be the hosts of a conference which seeks to answer in its special field the eternal and today also actual problems of mankind: the exploration and harmonic coexistence with nature.

In 1972 in Stockholm more than two thousand scientists, representatives of the widest range of disciplines formulated a massage addressed to the United Nations: 'We are from different climates, have various cultures, languages, customs, political and religious affiliations, but the common danger unites us. There are various reasons for this danger, similar to which have not menaced mankind in its history. The Earth, which seemed so big once, is now studied in its minority. We live in a closed system, the existence of our and the next generations entirely depends on our planet and our relations with each other. Therefore, what divides us is endwarfed by our interdebtedness and the looming danger uniting us.'

However, the above are unique phenomena. It is well known that our country is faced by a socio-economic and also environmental challenge. We aim at performing the reform of economic structure in an environment-friendly way. The assigned ways of development should ensure the exploitation of natural systems and also provide efficient defence against deleterious impacts as well as promote planned development, expansion of resources and the maintenace of ecological stability.

Unfortunately, in the almost two decades since then only saw the deterioration of the situation. Destruction is present in our everyday life and it is to be feared that - as it often happens with every-day things - we will get used to it unnoticed.

This could thrust us into a fatal tragedy. Therefore, all governments, professional and political organisations share the responsibility of increasing consciousness of the hazards of existing trends in environmental changes.

Here in Hungary the government has taken the first steps. I do not only think of investments into environmental protection, large-scale ones in our present economic situation. Some time ago we joined the international agreement on the conservation of the ozone shield. In addition we initiated international agreements for environmental protection or contributed to them. They include the restriction of inter-frontier air pollution and transport of sulphur and nitrogen oxides and toxic waste over borders. We signed documents on nature conservation such as the Bonn (on migratory animals), the Paris (World Cultural and Natural Heritage), Ramsar (major aquatic habitats) and Washington (international commerce of animal and plant species) agreements. Our joining to the Bern agreement is under way.

Among home matters, I would like to make only a brief mention of our decision on the closure of the Nyírád bauxite mine, which was taken in the interest of the Hévíz lake, unique in its endowments. This decision balanced ecological, economic and employment considerations on the basis of the priority of environmental interests. Feeling its responsibility for the protection of the environment stopped temporarily the construction of the Nagymaros barrage and initiated an international investigation to review the situation of the whole project.

Dear Guests !

In Hungary - to our knowledge without precedent in the world - all caves are protected national monuments since 1961. At present 108 of the 2400 known caves of Hungary are strictly protected. Our two major karst regions, the Bükk Mountains and the Aggtelek karst, are national parks, while smaller and more dismembered karst terrains are protected landscapes. Here in the vicinity of the capital it was proved to anyone sceptical about it that the separate protection of single elements of the physical environment is a hopeless and meaningless venture. Below the barely 8 km^2 karst surface occupied by Budapest, highly susceptible to pollution, there are 75 caves of various size and the length of passages is more than 23 km. Their unpaired world of minerals, almost sterile air is endangered by urban sprawl. The same processes (partial deficiencies of utilities, salting of roads and use of chemicals) are a menace to the renowned thermal waters issuing along the mountain foot, by the Danube. Such natural phenomena are not frequent under metropolises and undoubtedly caves may also endanger some surface technical establishments, buildings and pipe systems.

We are convinced, however, that in this field as well as in other fields of environmental protection, social consensus is indispensable to achieve our objectives. Circumstances have to be created for citizens where they should accept the restrictions and expenses and express politically their demands and readiness for action.

For alleviating the problems a comprehensive program was prepared. For its implementation intention and intellectual background and academic capacities are provided, but - as usual - we are still seeking the financial securities.

The Ministry of Environmental Protection and Water Management was established in December 1987. In spite of the short time available we meant to give every support for the organisation of this world-wide meeting. Among others, we began and partly finished the reconstruction of eight touristic caves and restoration and maintenance works are going on in several caves of the nation. You will have the opportunity to get acquainted with our achievements and troubles.

We evaluate them as follows:

The fact itself that the International Union of Speleology invited the speleologists of the world to Budapest on this occasion is an acknowledgement perhaps of not only our physical wealth, but the results of Hungarian karst and speleological research.

I wish that the jubilee conference of the karst and cave explorers of the world be successful in every respect: they know the results, novel scientific values be born along with professional and human contacts. Have a good time in Budapest and in Hungary.

Messieurs les conférenciers !

Mesdames et Messieurs !

Au nom du gouvernement de la République Populaire de la Hongrie je salue les participants, les délégues, les chercheurs des 36 pays membres du 10ème Congrès International de Spéléologie.

Je salue messieurs les chefs de l'Union, et plus particuliérement monsiuer le Professeur Derek Ford, monsieur le président et monsieur le Professeur Hubert Trimmel, monsieur le secrétaire général.

Votre Union Internationale à grande réputation a choisi la Hongriecomme siége de ce congrés. C'est une marque d'honneur pour nous. La Hongrie assure avec plaisir les possibilités d'organisation de toutes les manifestations qui contribuent au progrés scientifique de l'humanité, aux échanges des expériences des spécialistes des différents pays afin pour mieux servir la coopération entre les peuples à intéret commun. Nous sommes particuliérement contents dans le cas où nous sommes la hôte d'un tel évenement international qui contribue à rechercher la répons sour la question la plus profonde et actuelle de l'humanité dans la recherche de la nature, et dans la recherche de la nature, et dans la recherche pour les conditions de vie en harmonie avec la nature.

En 1972 à Stockholm, plus de deux mille savants, représentant des différents branches de la science ont formulé un message adressé à l'ONU. Voici une petite partie de ce message: "Nous somme venus des différents continents, nous avons des cultures, des langues, des habitudes différentes, nous, n'avons pas les mêmes vues politiques et nos réligions sont également différentes, mais il y a un fait qui nous réunit, c'est le menace de danger incomparablement importante qui nous unifie. Ce danger a des causes différentes, mais il n'a jamais existés auparavant pour l'humanité. La Terre a semblé trés grande, mais maintenant, elle est petite à étudier. Nous vivons dans un système fermé, ainsi notre vie, et la vie des futures générations dépent totalement de notre planéte et de notres rapports internes. Pour conséquence, les faits qui nous séparent, ils sont incomparablement petits par rapport à l'importance de la solidarité et par rapport a l'importance de la menace de danger qui nous réunit."

Il est connu que notre pays est devant un défi économique-social et en même temps un défi d'environnement. Notre buts consiste à exécuter un changement structural en respectant les critéres de la protection de l'environnement. Nous devons définir les trajets de développement qui garantissent l'utilisation des systémes naturels comme éléments de l'environnement, et la protection efficace contre les effets nuisibles, le développement planifié, l'accroissement des ressources naturelles, ainsi que l'endurance de la stabilité écologique.

Hélas, au cours de la derniére deux déceinnes la situation et les conditions se dégradait. Malheureusement, les dégradations de l'environnement font la partie de notre vie de tout les jours, et il est trés regréttable que nous y habituons par une simple banalisation des faits.

Co cimportement humaine peut nous entrainer vers une tragédie fatale. Pour conséquence les gouvernements et toutes les organisations professionnelles et politiques ont une résponsabilité commune pour attirer l'attentien de l'humanité sur les risques et les dangers des dégradations de l'environnement naturel liées aux tencendes de changement actuelles.

Nous, ici en Hongrie nous avons fait les pas initiaux. Je pense non seulement aux investissements pour la protection de l'environnement. Ces investissement sont considérables par rapport à nos possibilités de financement. Nous avons déja participé à l'accord international pour la protection de la couche d'ozone. En outre nous sommes les participants, et même les initialisateurs des accords internationaux importants pour la protection de l'environnement. Nous avons participé a l'accord international pour la limitation de la pollution de l'air.

Il s'agit d'une pollution qui ne respecte pas les frontiéres d'État. Nous participons aussi aux accords concernant le transport international des déchets dangereux. Dans le domaine de la protection de la nature, nous avons participé aux accords internationaux sur les animaux migrateurs (Bonn), les patrimoines mondiaux culturels et naturels (Paris), les sites hydriques importants (Ramsari), la commerce internationale des animaux et des plantes (Washington). Notre participation à l'accord de Berne est en cours.

En Hongrie, nous avons pris une décision importante sur la mine de bauxite de Nyírád pour sauver le lac de Hévíz à eau thermale qui a une réputation et importance internationale. Cette décision est basée sur les critéres prioritaire de la protection de l'environnement à partir d'une harmonisation des intérets écologiques, économiques et d'emploi. Sous le signe de la responsabilité d'environnement, le gouvernement a suspendu les travaux de Nagymaros sur le tronçon hongrois du Danube. Le gouvernement a prévu une étude internationale et une analyse d'éclaircissement de la situation d'investissement au point de vue des critéres de la protection de l'environnement.

Chers participants !

En Hongrie, depuis de 1961-selon nos connaissance uniquement dans notre pays-toutes les grottes sont considérées au niveau national comme une valeur naturelle protégée. Actuellement 108 grottes protégées sont surveillées plus fermement. Il s'agit 108 grottes sur prés de 2400. Nous avons deux importantes régions karstiques: la montagne de Bükk et le Karst d'Aggtelek. Ce dernier constitue un parc national qui a une protection régionale. Il y a aussi des périmètres de protection des zones karstiques. Justement ici à Budapest nos experts ont démontré que la protection des éléments de l'environnement de nature est impossible à part. Une partie de 8 km^2 de Budapest est une zone karstique qui est trés sensible a la pollution de surface.

Dans cette zone il y a 75 grottes plus ou moins importantes dont la longueur totale des galeries dépasse 23 km. Les ressources minérales imcomparables et leur air presque sterilement pur sont risqués par une extension surdimensionnée de l'urbanisation. Les déficiences partielles de l'infrastructure, l'épandage du sel sur les chaussées en hiver, l'utilisation des engrais chimiques risquent la qualité des sources thermales qui s'émergent le long du Danube au pied du mont. Ces sources ont également une réputation internationale. Ces formations se situant au dessous de la zone d'habitation d'une métropole sont rélativement rares, et il est induscutable qu'elles sont également des sources de risque les grottes provoquent des problémes techniques au point de vue de la fondation des batiments et des canalisations.

Selon notre avis, pour résoudre ces problémes et ceux de l'environnement en général il faut avour un consentement général. Nous devons créer des conditions acceptables aux citoyens, y compris les limitations et les dépenses.

Pour traiter ces problémes, nous avons élaboré un programme générale de développement. Pour l'exécution de ce programme, nous avons la capacité de projet et la base scientifique, mais - comme l'habitude nous manquons la capacité de financement.

Le gouvernement en 1987 a créé le Ministére du l'Environnement et de l'Aménagement des Eaux, et pendant cette courte période nous avons fait tout les efforts pour soutenir l'organisation de ce Congrès International de Spéléologie. A titre d'exemple, nous avons commencé et en partie nous avons achevé les réconstructions des 8 grottes, et en Hongrie il y a plusieures grottes où les travaux de rénovation et de maintien sont en cours.

Au cours de cette rencontre internationale vous aurez les moyens de se familiariser avec nos résultats et nos soucis.

Selon notre appréciation, le fait selon lequel l'Union Internationale de Spéléologie a invité les spéléologues du monde voir les grottes de Vudapest et de la Hongrie, et pour échanger les idées, il indique un intéret non seulement pour nos ressources naturelles, mais il représente le signe de reconnaissance de nos résultats de prospection et de protection spéléologiques.

Je souhaite que cette dixiéme renconcte mondiale des spécialistes des karsts et des grottes soit réussite de tout les point de vue: connaissance mutuelle des résultats de recherche, naissance des nouvelles valeurs scientifiques, renaissance des prises de contacte personelles et professionnelles.Je souhaite un bon séjour à Budapest et en Hongrie.

Werter Kongress !

Meine Damen und Herren !

Im Namen der Regierung der Ungarischen Volksrepublik begrüsse ich den 10. Weltkongress für Speläologie, seine Delegierten aus 36 Ländern, die Forscher, den Generalstab der Union und persönlich, mit besonderer Achtung den Vorsitzenden Herrn Prof. Derek Ford, sowie den Generalsekretär Herrn Prof. Hubert Trimmel.

Wir betrachten es als ehrenvoll, dass die internationale Gesellschaft von grossem Ansehen unser Land zum Ort ihrer Beratung wählte. Ungarn gibt mit Freude jeder Veranstaltung Platz, die dem wissenschaftlichen Fortschritt der Menschheit, dem Erfahrungsaustausch der Fachleute verschiedener Nationen und dadurch der Zusammenarbeit der Völker der Erde, die immer mehr auf einander angewiesen sind, dient. Unsere Freude erhöht sich noch, wenn wir Hausherren eines Ereignisses sein können, das auf seinem eigenen Wege Antwort auf die ewige und heute zutiefst aktuelle Frage der Menschheit, auf die Frage des Kennenlernens der Natur und der mit der Natur harmonisch verbundenen menschlichen Existenz sucht.

Im Jahr 1972 haben in Stockholm mehr als 2000 Wissenschaftler, die Vertreter der verschiedensten Wissenschaftszweige, eine Botschaft gerichtet an die UNO formuliert. Die Botschaft enthält u.a. folgendes: "Wir kommen aus verschiedenen Himmelsrichtungen, unsere Kultur und unsere Sprachen sind unterschiedlich, anders sind unsere Gewohnheiten, unsere politische und religiöse Zugehörigkeit sind nicht identisch, uns vereint aber, dass uns allen eine beispiellos grosse Gefahr droht. Diese Gefahr wurde durch verschiedene Gründe ausgelöst, die Menschheit hatte noch niemals mit einer ähnlichen zu tun. Die Erde, die so gross erschien, ist jetzt in ihrer Kleinheit zu untersuchen. Wir leben in einem geschlossenen System, unsere Existenz und die Existenz der zukünftigen Generationen hängen in vollem Masse von unserem Planeten und den Beziehungen die uns miteinander verbinden ab. Darum ist das, was uns trennt, verschwindend klein im Vergleich dazu, dass wir auf einander angewiesen sind und im Vergleich zu den uns bedrohenden Gefahren, die uns vereinen."

Das Obige aber ist eine Einzelerscheinung. Es ist allbekannt, dass unserem Land eine wirtschaftlich-gesellschaftliche und gleichzeitig eine Herausforderung durch die Umwelt bevorsteht. Es ist unser Ziel, die wirtschaftliche Strukturveränderung auf eine Umweltfreundliche Weise durchzuführen. Wir müssen solche Richtungen der Entwicklung bestimmen, die die Nutzung der natürlichen Systeme der Umwelt, einen effektiven Schutz gegen die schädlichen Einflüsse, eine planmässige Entwicklung, die Vermehrung der Kraftquellen und das dauerhafte Bestehen der ökologischen Stabilität sichern. Leider hat sich die Lage in den seitdem vergangenen bald zwei Jahrzehnten noch verschlechtert. Die Zerstörungen sind bereits in unserem täglichen Leben präsent und man muss befürchten, dass wir uns, - wie das oft mit alltäglichen Dingen geschieht, ohne das zu bemerken, an sie gewöhnen. Das aber kann uns in eine verhängnisvolle Tragödie hineinreisen. Darum tragen die Regierungen und alle fachlichen und politischen Organisationen eine gemeinsame Verantwortung dafür, dass sie die Gefahren der Veränderungen, die sich in der natürlichen Umwelt vollziehen, bewusst machen. Hier in Ungarn haben wir seitens der Regierung die ersten Schritte getan. Hier denke ich nicht nur an Investitionen zum Schutz der Umwelt, die unter Berücksichtigung unserer jetzigen materiellen Möglichkeiten bedeutend sind. Wir haben uns schon früher der internationalen Konvention zum Schutz der Ozonschicht angeschlossen. Gleichzeitig hatten wir Anteil, ja waren manchmal auch die Initiatoren der wichtigsten internationalen Abkommen mit dem Thema des Umweltschutzes. Wir haben uns auch den Verträgen über die Beschränkung der über die Grenzen gehenden Luftverschmutzung und über den Transport des Schwefeldioxids, der Stickstoffdioxide, des gefährlichen Abfalls über die Landesgrenzen angeschlossen.

Wir haben Anteil an den internationalen Abkommen, die auf dem Gebiet des Naturschutzes zustande kamen und haben uns so den folgenden angeschlossen: Bonner Abkommen über wandernde Tiere, Pariser Abkommen über das kulturelle und Naturerbe der Welt, Ramsaer Abkommen über das Leben der bedeutendsten feuchten Medien, Washingtoner Abkommen über den internationalen Handel mit Tier- und Pflanzenarten. Unber Anschluss an das Berner Abkommen ist im Gange.

Was unsere eigenen Angelegenheiten anbetrifft, so möchte ich nur unsere Entscheidung über die Schliessung der Bauxitgrube in Nyírád erwähnen, die gefasst wurde um die auch weltweit beispiellosen Gegebenheiten des Sees von Hévíz zu retten. Diese Entscheidung hat auf der Grundlage des Primats der Umweltschutzinteressen die ökologischen, die wirtschaftlichen Interessen und die Interessen der Arbeitsbeschäftigung koordiniert. Die Regierung hat im Zeichen ihrer Verantwortung für den Umweltschutz den Bau in Nagymaros suspendiert und die Initiative für eine gemeinsame internationale Untersuchung ergriffen, die die Lage der ganzen Investition von der Seite der Forderungen des Umweltschutzes überprüft.

Werte Gäste !

In Ungarn sind seit 1961 - soweit wir wissen ist das in der Welt allein da stehend - alle Höhlen, auf Landesebene, geschützte Werte der Natur. Von den derzeit bekannten ca 2400 Höhlen sind 108 besonders geschützt. Unsere zwei grössten Karstgebiete, das Bükk Gebirge und der Karst von Aggtelek sind als Nationalpark regional geschützt, die kleineren, gegliederteren Karstorte bilden Teile der Naturschutzkreise. Gerade hier, im Raum der Hauptstadt wurde den noch Zweifelnden bewiesen, dass es ein hoffnungsloser und sinnloser Versuch ist einzelne Elemente der natürlichen Umwelt gesondert zu schützen. Unter der Karstoberfläche Budapests mit einer Grösse von kaum 8 km^2, die übrigens besonders empfindlich gegenüber Verschmutzungen ist, kümmern wir uns um 75 Höhlen, kleinere und grössere, deren bekannte Ganglänge über 23 KM hinausgeht. Ihre beispiellose Welt der Minerale, ihre fast sterile Luft wird von der sich Furcht erregend ausbreitenden Urbanisierung gefährdet. Es sind die gleiche Prozesse (das teilweise Fehlen der Infrastruktur, das Salzen der Strassen, Benutzung von Chemikalien), die auch am Fuss des Berges die Qualität unserer weltberühmten Thermalquellen gefährden. Solche Naturerscheinungen unter der Oberfläche einer Weltstadt sind selten und man kann auch nicht darüber streiten, dass auch die Höhlen gewisse Gefahren für die technischen Einrichtungen der Oberfläche, der Gebäude, der Leitungen bedeuten.

Wir vertreten aber die Meinung, dass auch auf diesem Gebiet, wie auf anderen Gebieten des Umweltschutzes, unsere Ziele nur durch gesellschaftlichen Konsens erreicht werden können. Wir müssen Bedingungen dafür schaffen, dass die Staatsbürger die damit verbundenen Beschränkungen und Kosten acceptieren und ihren Anspruch und ihren Willen etwas zu tun mit politischem Gewicht zum Ausdruck bringen.

Wir haben, um den Sorgen abzuhelfen, ein in alle Einzelheiten eingehendes Programm ausgearbeitet. Für die Durchführung desselben sind die Absicht, die geistige Deckung, die wissenschaftliche Kapazität gegeben, was die Deckung der Kosten anbetrifft, so suchen wir - wie das zu sein pflegt - dieselbe noch.

Seitens des Ministeriums für Umweltschutz und Wasserwirtschaft, das im Dezember 1987 geschaffen wurde, waren wir in der uns zur Verfügung stehenden ziemlich kurzen Zeit bemüht der Vorbereitung des Welttreffens alle uns mögliche Unterstützung zu gewähren. U.a. haben wir mit der Rekonstruktion von 8 Schauhöhlen begonnen und die Arbeit zum Teil beendet, und im ganzen Land wurden in zahlreichen Höhlen von grossem Wert bedeutende Renovierungs- und Bewahrungsarbeiten durchgeführt.

Sie werden Gelegenheit haben, unsere Ergebnisse und Sorgen kennenzulernen.

Wir selbst schätzen die Dinge so ein: Die Tatsache an sich, wonach die Internationale Union für Speläologie die Höhlenforscher der Welt jetzt nach Budapest eingeladen hat, ist nich nur mit unseren natürlichen Gegebenheiten verbunden, sondern gilt vielleicht auch den bisherigen Ergebnissen der ungarischen Karst- und Höhlenforschung und ist die uns ehrende Anerkennung derselben.

Ich wünsche, dass die X. Jubileumsheerschau von Weltmasstab der Karst- und Höhlenforscher in jeder Hinsicht erfolgreich sein möge: lernen Sie gegenseitig die neuen Forschungsergebnisse kennen und mögen neue wissenschaftliche Werte, menschliche und fachliche Beziehungen zustande kommen. Fühlen Sie sich in Budapest und in Ungarn wohl!

Respetado congreso !

Señoras, Señores !

En nombre del gobierno de la República de Hungrya, saludo a Uds representantes de 36 países miembros en el 10 Congreso Mundial de Espeleologia, a la dirección de la Unión, a los investigadores y de forma especial al profesor dr. Derek Ford presidente y al profesor dr. Hubert Trimmel secretario general.

Nos honra el saber que una sociedad internacional de tanto prestigio eligió nuestra patria como sede de estas deliberaciones. Hungria con mucho gusto da lugar a todo acto que sirve al adelanto científico de la humanidad, al intercambbio de esperiencias entre profesionales de distintas nacionalidades y con ello promueve la colaboración entre los distintos pueblos que cada vez se ven mas obligados a apoyarse mutuamente en los resultados alcanzados.

Aumenta nuestra satisfación, cuando podemos ser los anfitriones de acontecimientos que sirven en contestar cuestiones profundamente actuales y eternas de la humanidad, el conocer la naturaleza y buscar de modo propio una vida humana armónica correspondiente.

En Estocolmo en el año 1972 mas de dos mil científicos en representación de las mas distintas ramas de la ciencia, enviarion a la ONU un mensaje redactado cojuntamente. Entre otros stablece los siguiente: "Provenimos desde distintas regiones difiere nuestra cultura, nuestras lenguas y son otras nuestras costumbres, noes similar nuestra pertenencia política y religiosa, nos une sin embargo que a todos por igual nos amenaza el mismo inmenso peligro. Muy diferentes son las causas que han motivado esta situación semejante a la cual la humanidad no se ha enfrentado hasta ahora. El mundo que parecía ser tan inmenso, ahora puede examinarse ya en su minisculicidad. Vivimos en un sistema cerrado, nuestra existencia y la de nuestros sucesores depende en completo de nuestro planeta y de la relación mutua de los pueblos. Debido a ello lo que nos sepera es ínfimo comparado a nuestro soburdinamiento y al peligro que nos amenaza uniéndonos en la angustia."

Estos son sin embargo fenómenos aislados. Es sabido que nuestra patria enfrenta un desafió económico-social y a la vez ambiental. Nuestro propósito es que el cambio de estructura económica se lleve a cabo en un ambiente amigable. Debemos senalar metas de desarrollo que aseguren el aprovechamiento de los sistemas que forman el ambiente natural, la defensa eficaz contra los efectos perjudiciales, el desarrollo planificado, la multiplicación de las fuentes de suminítro, la mantención duradera de la estabilidad ecológica.

En el período de casi dos décadas desde entonces transcurridas, por desgracia la situación solo ha empeorado. La destrucción ya está presente en nuestra vida diaria y es de temer como suele suceder, en las cuestiones diarias, sin darnos cuenta nos acostumbramos a ella.

Esto puede desembocar en una tragedia fatal. Debido a ello, tanto los gobiernos como todas las organizaciones profesionales y políticas tienen reponsabilidad domún en hacer comprender perfectamente los peligros de las tendencias existentes en los cambios ambientales de la naturaleza.

Nosotros aquí en Hungría, de parte del gobierno hemos dado los pasos iniciales. No solo pienso en las inversiones llevadas a cabo con el propósito de proteger el ambiente, las que comparadas con nuestras posibilidades materiales actuales son considerables. Y anteriormente nos hemos adherido al acuerdo internacional dirigado a la protección de la capa de ozono que nos rodea. Junto a ello fuimos participantes, pero muchas veces iniciadores de los mas importantes acuerdos internacionales respectivos a la defensa del ambiente. Nos hemos inforporado al sistema de limitaciones de la polulización que se extiende a través de las fronteras, del diósido de azufre, de los óxidos nitrosos de los deshechos peligrosos en acuerdos firmados para su obstaculizado. Somos partícipes de acuerdos internacionales firmados con respecto a la defensa y protección de la naturaleza, nos hemos sumado al de Bonn (sobre los animales migratorios); al de París (sobre el Patrimonio Mundial de la Cultura y la Naturaleza); al de Ramsari (con respecto a las mas significantes aguas vivas) y la de Washington (del comercio internacional de animales y vegetales). Nuestra adhesión al convenio de Berna está en trámites.

Con respecto a nuestras cuestiones internas solo quisiera recordar nuestra decisión con respecto al cierre de las minas de bauxita de Nyírád; motivada para salvar el lago de aguas termales Hévíz mundialmente único en su género. Esta resolución en base a la prioridad de los valores ecológicos, con los intereses económicos y los puntos de vista de la coupación de la mano de obra. En vías de la responsabilidad por la protección del ambiente, el gobierno interrumpió la construcción del dique de Nagymaros e inició una investigación internacional común, que desde el punto de vista de las exigencias de la defensa del ambiente reviss la situación de toda la inversión.

Estimadas Visitas !

A partir desde el año 1961, en Hungría toda gruta subterránea es considerada como calor protegido de la naturaleza, según tenemos entendido en esto somos únicos en el mundo. Actualmente de las 2400 grutas subterráneas conocidas, 108 gozan de protección rigurosa. Nuestras dos mayores regiones de sedimentado: la zona montanosa de Bükk y el declarado parque nacional protegido de Aggtelek, forman una parte del sector de naturaleza defendido de capa de suelo constituído en menores conglomerados. Justamente aquí, en la región de la capital quedó demonstrado, que defensa por separado de cada uno de los elementos del ambiente natural, es una empresa sin sentido y destinada al fracaso. Budapest, con una capa de suelo de sedimentado con apenas 8 km^2 de superficie, debajo de la cual se encuentran 75 grutas subterráneas muy sencibles a la polulización, cuyo largo de galería pasa los 23 km. La ubanización detemible magnitud amenaza su imcomparable mundo cistalino y su aire casi puro. Los mismos procesos de contaminación (las deficiencias parciales de la infraestructura, la sal hechada a los caminos resbaladizos, el empleo de preparados químicos en la agricultura, etc.), los cuales peligran en el valle de las montañas y a crillas del Danubio, la calidad de las mundialmente fomosas aguas termales. Estos fenómenos naturales son raros debajo de la población de una capital de importancia mundial, pero no cabe duda, que al mismo tiempo representan ciertos peligros para las obras de construcción que se encuentran encima de la capa de suelo, con sus edificios y los sistemas de conductos, canerías, canalización y desagues necesarios.

Tenemos bien entendido sin embargo, que al igual que en otras esferas de la protección del ambiente, los propósitos establecidos, solo podran alcanzarse por medio del acuerdo social público. Debemos crear las condiciones adecuadas, para que los ciudadanos acepten y hagan suyas las obligaciones y los gastos que significan y manifiesten con el peso político correspondiente sus deseos y su disposición al cumplimiento de los planes.

Para la solución de las preocupaciones hemos preparado un programa con contenido detallado. Para su realización, contamos con los buenos propósitos, la capacidad técnica y científica; pero como en estos casos suele suceder, estamos buscando la forma de como cubrir los gastos.

De parte del Ministerio de Protección del Ambiente y de Asuntos Hidrológicos creado en el mes de diciembre de 1987, pese al corto tiempo disponible, tratamos de asegurar todo el apoyo necesario para la preparación exitosa de este Encuentro Mundial. Entre otros propósitos hemos comenzado y en parte terminamos la reconstrucción general de 8 grutas subterráneas turísticas y en el territorio del pais continuamos con la significativa renovación y conservado de otras grutas subterráneas de gran valor.

Durante su estadía en nuestra capital, tendrán oportunidad de conocer mejor nuestros resultados y también nuestras preocupaciones.

Nosotros valoriazamos de la siguiente forma:

El hecho en sí, que la Unión Internacional de Espeleológía decidió invitar a los investigadores profesionales del mundo a Budapest, no se debe solamente a la estimación de nuestras condiciones naturales sino creemos, que es en parte el reconocimiento que honra, de los resultados alcanzados por los espeleologos húngaros en sus investigaciones y en la defensa de las grutas subterráneas.

Deseo que el décimo encuentro de los espeleologos e investigadores de sedimentados y grutas subterráneas, se exitoso en todo sentido; sean transmitidos los nuevos resultados de investigación logrados, sean creados nuevos valores científicos, nuevas amistades personales y profesionales. Les deseo a todos, que durante su permanencia en Budapest y en Hungría se sientan como si estuvieran en Vuestras casas.

Spettabile Congresso !

Signore e Signori !

A nome del governo della Repubblica Popolare Ungherese saluto i ricercatori, i partecipanti del X Congresso Internazionale di Speleologia, la Presidenza dell' UIS e con particolare rigurdo il signor presidente prof. Derek Ford e il signor segretario generale prof. Hubert Trimmel.

È un vero onore per noi che la Vostra autorevole societa abbia scelto come luogo di conferenza la nostra patria. L' Ungheria ospita con molto piacere ogni riunione, congresso che serve il progresso scientifico dell' umanità, lo scambio delle esperienze tra gli specialisti internazionali - e cosi anche la collaborazione tra i popoli della Terra che hanno sempre più bisogno l' uno dell' altro. Il nostro piacere è ancora maggiore quando possiamo dare luogo ad avvenimenti che si occupano dei problemi eterni, oggi ancora più profondamente attuali, dell' umanità, che cercano risposta al conoscere la natura e all' essere umano armonico con la natura.

Nel 1972 più di duemila scienziati, riuniti a Stockholm, rappresentanti delle più diverse discipline scientifiche hanno composto un messaggio indirizzato all' Onu. Il messaggio contiene tra l' altro il seguente passo: "Proveniamo dai diversi punti cardinali della Terra, abbiamo civiltà e lingue diverse, diversi abitudini, professiamo diverse religioni e apparteniamo a diversi sistemi politici, ma ci riunisce la consapevolezza del pericolo molto grave che minaccia tutti noi. Diversi fatti hanno provocato questo pericolo - ma l' umanità non ebbe mai da fare con uno cosi grave. La Terra che sembrava essere talmente grande, oggi viene esaminata nella sua piccolezza. Viviamo in un sistema chiuso, la nostra esistenza e quella delle generazioni che seguiranno dipende totalmente dal nostro pianeta e dai rapporti tra di noi. E per questo, quello che ci divide diventa sempre meno importante rispetto alla nostra interndipendenza e al pericolo minacciante che ci riunisce."

Ciò di cui sopra però sono fenomeni individuali. È noto che la nostra patria è dinanzi ad una sfida economico-sociale e nello stesso tempo ambientale. Il nostro scopo è quello di farsi che il cambiamento delle strutture venga fatto in maniera il più possibile naturale. Dobbiamo assegnare le direzioni del progresso in modo che quelle assicurino l' utilizzazione dei sistemi componenti l' ambiente, la tutela efficace contro gli effetti nocivi, il progresso progettato, l incremento delle risorse di energia, la sussistenza consistente nella stabilità ecologica.

Purtroppo negli ultimi due decenni la situazione è soltanto peggiorata. Queste rovine sono già presenti nella nostra vita quotidiana e dobbiamo temere di abituarci senza rendercene conto, come succede molto spesso con le cose quotidiane.

Questo ci può portare ad una tragedia fatale. Per questo i governi e tutte le organizzazioni politiche e tecniche hanno la responsabilità di rendere consapevoli dei pericoli e delle tendenze presenti nei cambiamenti ambientali.

Qui in Ungheria da parte del governo sono già stati fatti i primi passi. Non si tratta solamente degli investimenti ecologici che rispetto alle attuali possibilità economiche del paese, sono notevoli. Già prima abbiamo aderito all' accordo internazionale che cerca di salvaguardare lo strato di ozono. Oltre questo siamo interessati e tal volta eravamo anche in iziatori dei più importanti accordi internazionali di ecologia. Abbiamo aderito ai contratti stipulati sulla limitazione dell' inquinamento aereo diffusosi nei confini; del trasporto da un paese all' altro delle scorie nocive, di anidride solforica e nitrica. Abbiamo aderito agli accordi die tutela della natura: a quello di Bonn (sugli animali migratori), a quello di Parigi (Eredità Culturale e Naturale del Mondo), a quello di Ramsar (le biosfere più importanti) e a quello di Washington (commercio internazionale di razze di animali e di piante). La nostra adesione all' accordo di Bern è in corso.

Tra i fatti della nostra patria vorrei soltanto mezionare l' esemplare decisione di chiudere la miniera di bauxite di Nyírád, per salvare il Lago di Hévíz ricco di proprietà terapeutiche uniche al mondo. Questa decisione è in accordo con la supremazia degli interessi ecologici, economici e quelli di occupazione degli operai. Il governo, riconoscendo la responsabilità ecologica, ha sospeso i lavori della costruzione della diga e della centrale idroelettrica a Nagymaros, ed ha iniziato un esame internazionale che dal punto di vista delle esigenze ecologiche può fare un quadro sintetico sulla situazione dell' investimento.

Cari Ospiti!

In Ungheria dal 1961 - secondo la nostra conoscenza, unici al mondo - tutte le grotte sono definite valori naturali sotto tutela nazionale. Per il momento 108 grotte delle 2400 conosciute sono particolarmente tutelate. Abbiamo due aree carsiche - la montagna del Bükk e il carso di Aggtelek - che sono Parchi Naturali; i territori carsici minori e più articolati fanno parte dei circuiti di protezione della natura. Proprio qui, nei dintorni della nostra capitale è stato provato il fatto che la tutela separata di singoli elementi dell' ambiente naturale e un' impresa disperata e inutile. Sotto la superficie carsica di Budapest, estesa appena 8 kmq eccessivamente sensibile all' inquinamento, conosciamo 75 grotte, più grandi-più piccole, con una lunghezza in totale che oltrepasssa i 23 km. Il loro mondo unico di minerali e la loro aria quasi del tutto sterile vengono minacciati dall' estensione enorme dell' urbanizzazione. Gli stessi processi (i difetti parziali dell' infrastruttura, il fatto del salare le strade, l' uso dei prodotti chimici) minacciano anche la qualità delle acque termali, sorgenti al piede del monte, lungo il Danubio. Sono rari questi fenomeni sotto la superficie della zona di domicilio di una metropoli, ed è incontestabile il fatto del pericolo, provocato dalla presenza delle grotte, che riguarda gli stabilimenti, gli edifici e i sistemi di conduttura.

I nostri scopi possono essere raggiungibili, qui come dappertutto, solamente a prezzo di consensi sociali. Dobbiamo creare le condizioni che i cittadini accettino gli impegni e le spese accluse e che esprimano le loro esigenze e il loro volere di partecipazione, dandoci importanza politica.

Per il rimedio dei problemi abbiamo elaborato un vasto programma che dà retta a tutti i particolari. L' intenzione, lo sfondo intellettuale e la capacità scientifica ci sono, per l' esecuzione di questo programma, ma come capita nella maggior parte dei casi, i fondi monetari mancano ancora.

Noi da parte del Ministro di Tutela Ambientale, costituito nel dicembre 1987, nonostante la breve durate del tempo che avevamo a disposizione, cercavamo di dare il massimo appoggio alla preparazione fruttuosa del Congresso Internazionale. Tra l' altro abbiamo cominciato e in parte abbiamo pure finito la ricostruzione di 8 grotte turistiche, e del resto abbiamo svolto attività rinnovativa e difensiva in altre grotte di gran valore in tutto il territorio dell' Ungheria.

Durante questo congresso avrete la possibilita di conoscere i nostri risultati e anche i nostri problemi.

Noi stessi li valutiamo cosi:
Il fatto che l' Unione Internazionale di Speleologia questa volta ha invitato i suoi soci e tutti gli speleologi del mondo a Budapest, significa forse anche il riconoscimento dei nostri risultati nel campo della ricerca carsica e speleologica, in quello della tutela dell grotte e dei territori carsici, oltre i dati di fatto naturali del paese.

Auguro che la decima rassegna abbia successo in ogni campo: che conosciate i risultati degli altri, nascano nuovi valori scientifici, rapporti di lavoro e personali. Vi auguro di trovari bene a Budapest e in Ungheria!

Уважаемый конгресс!

Дамы и господа!

От имени правительства Венгерской Народной Республики приветствую делегатов, исследователей тридцати шести стран-участниц Десятого всемирного конгресса спелеологов, главный штаб Унии, с особым уважением приветствую господина председателя в лице профессора Дерека Форда и господина генерального секретаря профессора Хуберта Триммеля!

Мы считаем для себя почётным, что весьма авторитетное международное общество именно нашу страну избрало местом проведения совещания. Венгрия с радостью берет на себя роль хозяина любого мероприятия, которое служит научному прогрессу человечества, обмену опытом специалистов различных наций, и вместе с этим служит сотрудничеству народов Земли, всё больше зависящих друг от друга. Особо радостно, когда мы можем быть свидетелями такой организации, которая ищет ответ на вечный и на самый актуальный современный вопрос человечества - как узнать природу, как человеку гармонично сосуществовать с ней.

В Стокгольме в 1972 году собралось более двух тысяч ученых, представителей самых разных отраслей науки, которые сформулировали послание, адресованное ООН. Наряду с прочим, в послании говорилось и следующее: "Мы с разных сторон света, у нас разные культура, язык, обычаи, у нас различные политические и религиозные взгляды, однако нас объединяет то, что все мы подвергаемся бесподобно большой опасности. Она вызвана различными причинами и с подобной опасностью человечество ещё никогда не встречалось. Землю, казавшуюся столь огромной, сейчас приходиться изучать во всей её малости. Мы живет в замкнутой системе. Наше существование и жизнь грядущих поколений в полной мере зависят от нашей планеты и от наших отношений. Поэтому то, что нас разделяет, ничтожно по сравнению с тем, что мы не можем обойтись друг без друга, по сравнению с угрожающей нам опасностью, что и объединяет нас всех."

Однако, вышеизложенные явления уникальны. В то же время общеизвестно, что нашей стране брошен социально-экономический и экологический вызов. Поэтому мы ставим себе цель изменить структуру экономики с учетом окружающей среды. Мы должны наметить такие направления развития, которые обеспечат и использование, и эффективную защиту от вредных воздействий, и планомерное развитие природных систем, составляющих окружающую среду, которые обеспечат наращивание ресурсов и продолжительное сохранение экологической стабильности.

К сожалению, в течение прошедших почти двадцать лет положение лишь ухудшалось. Нарушения сказываются уже и в нашей повседневной жизни и есть опасение, что - как это часто бывает с обыденными делами - мы незаметно привыкнем к ним.

Это может привести к роковой трагетии. Поэтому правительства и все профессиональные и политические организации несут общую ответственность за то, чтобы довести до сознания людей опасность тенденций, кроющихся в переменах природного окружения.

Венгерское правительство уже предприняло первые шаги. Здесь речь идет не только об инвестициях с целью охраны окружающей среды, которые по объему довольно крупные, если учесть наши сегодняшние материальные возможности. Мы уже присоединились к международному соглашению по охране озоносферы. Наряду с этим, мы участвовали, и даже иногда инициативно, в важнейших международных соглашениях по охране окружающей среды. Мы присоединились к соглашению об ограничении трансграничных загрязнений атмосферного воздуха, к соглашению о перевозке через границы двуокиси серы, окисей азота и опасных отходов.

Мы подписали международные соглашения на тему защиты природы, так, мы присоединились к боннскому соглашению (о мигрирующих животных), к парижскому соглашению (о всемирном культурном и природном наследии), к рамсарскому соглашению (о важнейших гибробиотопах) и к вашингтонскому соглашению (о международной торговле видами флоры и фауны). В настоящее время мы готовимся присоединиться к бернской конвенции.

Из числа актуальных дел в нашей стране я лишь упомяну о решении относительно закрытия нирадского бокситового рудника, которое было принято в интересах спасения озера Хевиз, обладающего бесподобными в мире свойствами. В этом решении - при соблюдении приоритета охраны окружающей среды - были увязаны интересы экологии, экономики и трудоустройства. Прочувствовав ответственность на защиту среды, правительство прекратило строительство гидроузлов на Дунае и предложило провести такое совместное международное обследование, которое бы дало обзор положения всего капитального строительства с точки зрения требований охраны окружающей среды.

Уважаемые гости!

С 1961 года в Венгрии - по нашим сведениям, в единственной стране мира - все пещеры провозглашены заповедной природной ценностью. Из известных до сих пор около 2400 пещер 108 находятся под особой охраной. Наши самые большие карстовые территории - горы Бюкк и карст Аггтелек - являются национальными парками и взяты под региональную защиту; меньшие, пересеченные карстовые рельефы являются частями краевых заповедников. И именно тут, на территории нашей столицы, и перед еще сомневающимися получило подтверждение то, что безнадежно и бессмысленно было пытаться по отдельности охранять отдельные элементы природного окружения. В Будапеште, под карстовой поверхностью не более 8 км^2, особенно чувствительной к загрязнениям, мы имеем 75 больших и меньших пещер, а длина разведанных проходов превышает 23 километра. Распространение урбанизации в ужасающих масштабах является угрозой для уникального мира минералов, для почти стерильного воздуха пещер. Это те же процессы (частичная невыстроенность инфраструктуры, соление улиц, применение химикатов), которые угрожают качеству наших термальных вод мировой известности, пробивающихся у подножья горы, вдоль берега Дуная. Под жилой зоной мирового города редко можно встретиться с такими природными явлениями, хотя бесспорно, что и пещеры могут представлять опасность для наземных технических сооружений, зданий и сетей трубопроводов.

Однако мы считаем, что и в этой области, как и в других областях охраны окружающей среды, достичь наших целей мы сможем только путем достижения общественного консенза. Мы должны создать такие обстоятельства, чтобы граждане согласились с обусловленностями и расходами, чтобы с должным политическим весом они могли выражать свои нужды и волю.

Для решения проблем мы составили комплексную программу, охватывающую все детали. Для её осуществления имеются намерение, умственные ресурсы и научные мощности, а финансовое покрытие - как это обычно бывает - еще не обеспечено.

Основанное в декабре 1987 года Министерство охраны окружающей среды и водного хозяйства, вопреки тому, что в распоряжении имело довольно мало времени, постаралось сделать всё возможное, чтобы успешно подготовить эту всемирную встречу. Наряду с прочим, мы начали и отчасти закончили комплексную реконструкцию восьми пещер, принимающих посетителей, а по стране, во многих других ценных пещерах ведутся значительные работы по обновлению и консервации состояния пещер.

Вам представится возможность ознакомиться с нашими результатами и трудностями. Однако сам факт, что Международный союз спелеологов именно в Будапеште пригласил спелеологов мира, мы считаем, что объясняется не только нашими природными данными, а может быть является и почетным признанием наших результатов, достигнутых до сих пор в области исследования и охраны венгерских пещер и карста.

Желаю, чтобы десятый, юбилейный смотр исследователей карста и спелеологов мира был во всех отношениях успешным: чтобы вы взаимно ознакомились с новыми результатами исследований, чтобы появились новые научные ценности, чтобы расширялись личные и профессиональные контакты. Желаю вам хорошо себя чувствовать в Будапеште, в Венгрии!

LÁNG, ISTVÁN

Secretary General of the the Hungarian Academy of Sciences
Le Secrétaire Général de l'Académie des Sciences de Hongrie
Generalsekretär der Ungarischen Akademie der Wissenschaften
Secretario general de la Academia Húngara de Ciencias
Segretario generale dell'Accademia Ungherese delle Scienze
генеральный секретарь Венгерской Академии Наук

Ladies and Gentlemen !

Dear Colleagues !

On behalf of the Hungarian Academy of Sciences, I welcome all participants of the 10th International Congress of Speleology. It is a pleasure to have you here. I wish you a most fruitful scientific session and hope that you will have a wonderful time in Hungary.

Having heard Minister Maróthy's welcoming address, I find it a real challenge to speak about something new in your particular field of inquery, as the Hungarian Minister of Environment Protection and Water Management has a personal interest in cave exploration. However, my own scope of science, is different from this, as my concern being an agrochemist, is related to the chemical and biological processes on the soil surface and in the layer near to it. Still, I submit, the perspectives of speleologists and soil scientists - agrochemists are not too disparate.

We have a shared interest in the complex investigation of natural resources. The focal point of research in both perspectives, is the interaction of rocks, water, air and the living organizmus.

Also, a common feature is the claim and desire for obtaining new scientific knowledge and to meet this researchers are willing to take huge intellectual and physical efforts and sacrifice.

Then scientists of these respective fields have shared concern in quest of methods and pats for practical utilization, so that their discoveries elicit some kind of social impact.

And again we all do acknowledge the necessity of international cooperation, as in most cases, scientific autarky is insufficient for attaining new scientific results.

Those who are searching for the new, the unknown on the surface of the Earth or below it, are people who whish to serve the prosperity of humankind.

Now, to conclude, I repeat my welcome to you on behalf of the Hungarian Academy of Sciences. I hope you will find new friends, acquintances and personal contacts.

Thank you for your attention.

Mesdames et Messieurs !

Chers Collégues !

Au nom de l'Académie des Sciences de Hongrie je vous salue avec beacoup d'affection, tout les participants due 10ème Congrès International de Spéléologie. Por moi, c'est un grand plaisir que vous soyez lá, en Hongrie. Je souhaite des sessions scientifiques efficaces et fructueuses por vous, et j'espére que vous soyez bien à son aise dans notre pays.

Aprés la parole de salutation de Monsieur le Ministre Maróthy, il est difficile de dire de neuf concernant les domaines de votre activité professionnelle, puisque lui même, monsieur le Ministre s'intéresse personnellement a la spéléologie. Mon domaine de spécialité est différent, car moi - en qualité d'agrochimiste - je m'occupe des processus chimiques et biologiques qui se forment a la surface du sol et dans la zone d'aération du sol. Cependant il faut y noter que les modes d'approche de recherches des spéléologues et des pédologues-agrochimistes ne sont pas loin de l'un à l'autre.

Notre domaine de recherche commun consiste à étudier d'une facon complexe les ressources naturelles. Dans toutes les deux approches, la question principale consiste a étudier les interactions entre les roches, les eaux, l'air et les organismes vivantes.

Nous efforçons á obtenir des nouveaux résultats scientifiques, et pour ce but, les chercheurs ne se reculent pas même en cas où on doit déployer des efforts d'esprit et physiques.

Les chercheurs scientifiques de ces deux grands domaines étudient les modalités et les possibilités por mettre au poit, mettre en oeuvre et mettre en application de leurs résultats au profit de la société, ainsi leur découverts seront reconnus par la société.

Nous trouvons nécessaire de coopérer au niveau international, puisque notres propres résultats scientifiques généralement ne sont pas suffisants pour satisfaire les besoins de développement.

Nous, tous qui recherchons les lois de la nature soit sur la surface de la Terre, soit dans couches de l'écorce terrestre, nous avons l'intention de contribuer à la prospérité de l'humanité.

Pour finir ma parole, je répéte mes salutations au nom de l'Académia des Sciences de Hongrie. J'espére que des nouvelles amitiés, nouvelles prises de contact, nouveaux rapports personnels seront formés.

Merci pour votre attention.

Meine Damen und Herren !

Liebe Kollegen !

Im Namen der Ungarischen Akademie der Wissenschaften begrüsse ich alle Teilnehmer des 10. Internationalen Kongresses für Speläologie herzlich. Es ist eine grosse Freude für mich, dass Sie zu uns gekommen sind. Ich wünsche Ihnen erfolgreiche wissenschaftliche Sitzungsperioden und ich hoffe, dass Sie sich in Ungarn sehr wohl fühlen werden.

Nach der Begrüssungsrede des Herrn Minister Maróthy ist es schwer etwas neues in Ihren Interessenkreis zu erwähnen, da sich ja der ungarische Minister für Umweltschutz und Wasserwirtschaft auch persönlich für die Speläologie interessiert. Mein Fachgebiet ist abweichend, nachdem ich als Agrochemiker mich mit den chemischen und biologischen Prozessen befasse, die sich auf der Bodenoberfläche, bzw. in den naheliegenden Schichten vollziehen. Ich muss aber bemerken, dass sich die Methoden der Annäherung seitens der Speläologen und der sich mit dem Boden befassenden Agrochemiker nicht allzu sehr von einander unterscheiden.

Unser gemeinsamer Interessenkreis besteht in dem komplexen Studium der natürlichen Kraftquellen. Im Falle beider Annäherungen besteht die zentrale Frage in der Wechselwirkung zwischen dem Gestein,

dem Wasser, der Luft und den lebenden Organismen.

Wir alle streben nach der Aufdeckung neuer wissenschaftlicher Ergebnisse und in diesem Interesse schrecken die Forscher auch vor mächtigen geistigen und physischen Kraftanstrengungen nicht zurück.

Die auf beiden Gebieten tätigen Forscher denken daran alle die Methoden und Möglichkeiten ausfindig zu machen, durch die ihre Ergebnisse in der Praxis nutzbar werden und ihre Entdeckungen dadurch gesellschaftliche Anerkennung gewinnen können.

Wir alle halten die internationale Zusammenarbeit für notwendig, weil die wissenschaftliche Selbstversorgung in den meisten Fällen nicht ausreicht um wissenschaftliche Ergebnisse zu erreichen. Alle die auf der Erdoberfläche, oder darunter das Neue und Unbekannte suche, wünschen dem Aufblühen der Menschheit zu dienen.

Zum Schluss wiederhole ich meinen Gruss im Namen der Ungarischen Akademie der Wissenschaften. Ich hoffe, dass neue Freundschaften, Bekanntschaften und persönliche Beziehungen zustande kommen.

Ich danke für Ihre Aufmerksamkeit.

Señoras, Señores !

Estimados Colegas !

En nombre de la Acadmia Húngara de Ciencias, saludo a los participantes del 10. Congreso Internacional de Espeleologia. Nos alegra constatar que nos visitaron. Les deseo a Uds. fructíferas deliberaciones científicas y espero de que se sientan a su agrado en Hungría.

Después de las palabras de saludo del Sr. Ministro Maróthy es bastante difícil decirles algo nuevo en relación a las cuestiones de espeleologia. Mi profesión científica difiere de la mencionada, pues como químico agrario me ocupo con el estudio de los procesos químicos y biológicos que se desarrollan en el suelo o en las capas cercanas a él. Cabe destacar sin embargo que en las formas de apreciación no están muy distantes los expeleologos y los químicos agra. rios de suelos.

Nuestro interés común es el estudio científico detallado de las fuentes naturales. En ambas apreciaciones la cuestión principal es la roca, el agua, el aire y los efectos mutuos entre los organismos vivos.

Todos nosotros en nueastra labor tratamos de lograr nuevos resultados científicos y por interés de ello los investigadores no escatiman en realizar esfuerzos teóricos y físicos gigantescos.

Los investigadores que trabajan en ambas esferas se esmeran en encontrar los modos y las posibilidades con ayuda de los cuales los resultados logrados puedan ser aprovechados en la práctica y con ello sus apreciaciones ganan el reconocimiento de la sociedad.

Todos nosotros consideramos necesaria la cooperación internacional, puesto que el autoabastecimiento científico en la mayoría de los casos no es suficiente para lograr en las ciencias resultados exitosos.

Todos aquellos, quienes sobre la tierra o debajo de ella, buscan lo nuevo, lo desconocido, desean de todos modos servir el adelanto de la humanidad.

Para finalizar, repito el saludo en nombre de la Academia Húngara de Ciencias. Espero que nazcan nuevas amistades, relaciones personales y conocimientos mutuos.

Gracias por la atención prestada.

Signore e Signori !

Cari colleghi !

A nome dell' Accademia Ungherese delle Scienze vorrei cordialmente salutare tutti i partecipanti del X Congreso Internazionale di Speleologia. È un grande piacere per me che Voi siate venuti qua. Vi auguro una seduta scientifica molto efficace e spero che Vi troverete molto bene in Ungheria.

È difficile dire qualcosa di nuovo del Vostro interessamento dopo le paroìe del signor ministro Maróthy, visto che il ministro ungherese del Ministro di Tutela ambientale è pure interessato della speleologia. La mia specializzazione non è questa, anzi è abbastanze diversa da questa - essendo agrochimico mi occupo dei processi biologici e chimici dello strato de suolo. Devo però dire che il modo di avvicinamento degli speleologi e quello degli agrochimici non è tanto lontano l'uno dall altro.

Il nostro interessamento comune è lo studio complresso delle risorse naturali. In tutti e due i modi di avvicinamento, il problema centrale è l'influsso reciproco tra il minerale, l'acqua, l'aria e gli organi viventi.

Tutti noi tendiamo ad ottenere nuovi risultati scientifici, e per questo scopo i ricercatori non indietreggiano davanti agli sforzi intellettuali e fisici.

I ricercatori di tutte e due le discipline cercano di trovare le possibilità e i modi con i quali i risultati possono essere utilizzati nella pratica, e soci anche le loro scoperte riconosciute dalla società.

Tutti noi riteniamo necessari la collaborazione internazionale, perché l'autarchia scientifica nella maggior parte dei casi non è sufficiente per i nuovi risultati scientifici.

Tutti coloro che cercano lo sconosciuto, il nuovo sopra o sotto la superficie della Terra vogliono servire la prosperità del l'umanità.

Concludendo ripeto il mio saluto a nome dell' Accademia Ungherese delle Scienze. Spero che nuove amicizie, nuovi rapporti personali e nuove conoscenze nasceranno.

Grazie per l'attenzione!

Дамы и господа!

Дорогие коллеги!

От имени Венгерской Академии Наук сердечно приветствую всех участников Десятого международного спелеологического конгресса. Мы весьма рады вашему приезду. Желаем вам успешно провести научные сессии и надеемся, что ваше пребывание в Венгрии будет приятным.

После приветственной речи господина министра Мароти вряд-ли я смогу вам сказать что-либо новое из вашей сферы интересов, тем более, что министр водного хозяйства и охраны окружающей среды Венгрии и лично интересуется спелеологией. Моя научная область далека от неё, ввиду того, что я, как агрохимик, занимаюсь химическими и биологическими процессами, происходящими на поверхности почвы или в подпочвенном слое. Однако, я должен заметить, что методические подходы спелеологов и почвоведов-агрохимиков вовсе не так далеки друг от друга.

Наша общая сфера интересов - это комплексное изучение природных ресурсов. В подходе обеих профессий центральным вопросом стоит изучение взаимовоздействий пород, вод, воздуха и живых организмов.

Все мы стремимся добиться новых научных результатов, а в интересах этого исследователи прилагают огромные умственные и физические усилия.

Исследователи, работающие в обеих научных областях, стараются найти такие способы и возможности, благодаря которым их результаты можно было бы использовать на практике, чтобы их открытия получили общественное признание.

Все мы считаем необходимым иметь международное сотрудничество, ввиду того, что научная автаркия в большинстве случаев недостаточна для достижения новых научных результатов.

Все те, кто на поверхности или под поверхностью Земли ищут новое, ищут неизвестное, желают служить расцвету человечества.

В заключение разрешите мне повторить приветствие Венгерской Академии Наук в надежде, что вы найдете новых друзей, заключите новые знакомства и личные контакты.

Благодарю вас за внимание.

BIELEK, JÓZSEF

Mayor of the Capital Budapest
Le maire de Budapest, capitale de la Hongrie
Bürgermeister der Hauptstadt Budapest
Alcalde de la capital Budapest
Sindaco della capitale
председатель горсовета Будапешта

Mr. President !

Ladies and Gentlemen !

Honoured Congress !

It is an honour to me to welcome you and your congress in Budapest.

Budapest is the city of caves. No capital in the world can boast with so many and so interesting caves than the capital of Hungary.

Within the administrative area almost a hundred caves are known with a total length of nearly 30 km. Among them the Pálvölgy cave is the longest one with 7 km and so it is third in order in Hungary.

We are proud of the education of speleologists too. The Mátyáshegy cave is dedicated to the youth, young explorers can develop their skills of caving there.

Further explorations are our important tasks. This year it is the 70th anniversary of the exploration and opening to the public of the Pál-völgy cave. Since then our explorers do their best to present a suprise time after time to the friends of caves the world around. I would like to mention two of these. A great scientific sensation was the discovery of the 5 km long József-hegy cave, rich in unique crystal formations, five years ago. In autumn of 1986 the Szemlő-hegy cave was opened for the public. It is our manifest intention to promote tourism with broadening knowledge on the treasures of caves. It is our great pleasure that last year our caves were visited by about 150 000 people. However, we are not at all satisfied with this number, as we would like to show to more and more visitors the wonders of subterranean world below the capital.

The name 'Pest' comes from the Slavic word 'pestera' meaning cave. By the Germans Buda is still called 'Ofen', which in general means 'oven' but also 'cave' - as it is proved by many caves in German speaking countries.

After this there is no need for further explanation how glad this town with two caves in its name is to welcome the congress.

I wish you a pleasant time spent in Hungary, successful work and that you got acquainted with our caves but spare time to see the monuments on the surface of our thousand-year old capital. If you are still not able to wander all over the 30 km cave system below the capital to think you have not seen enough of the city do not hesitate to come back soon and again and again. Everybody is welcome at any date.

Monsieur le Président !

Mesdames et Messieurs !

Messieurs les conférenciers !

J'ai l'honneur de vous saluer et de saluer votre congres a Budapest. En fait, Budapest est la ville des grottes! Il n'y a pas d'autre capitale au monde qui a des grottes particuliéres comparable a celles de la capitale hongroise.

Dans la circonscription de Budapest nous avons prés de cent grottes dont la longueur totale des galeries est de 30 km. Parmi ces grottes, celle de Pálvölgyi est la plus longue, soit 7 km, ainsi elle se range aou troisième au niveau national.

Nous sommes fiérs de notre enseignement des jeunes spéléologues. Notre grotte de Mátyáshegy est une grotte des jeunes. Dans cette grotte les jeunes peuvent s'entraîner pour apprendre la marche dans les galeries.

Notre tâche importante consiste à exécuter nos programmes des recherche et des prospections pour découvrir des grottes inconnues.

Justement, il y a 70 années de la découverte et de l'overture de la grotte de Pálvölgyi au grand public.

Nos prospecteurs font des efforts pour surprendre le monde qui aime les grottes. Parmi les dévouvertes récentes des grottes je cite deux exemples. Il y a cinq années la découverte de la grotte du mont de József était un événement sensationnel pour le monde scientifique. Elle a une longueur prés de 5 km. Cette grotte est trés riche en formation cristalline. A l'automne de 1986 nous avons ouvert la grotte de Szemlőhegy pour le grand public.

A partir de la représentation de nos ressources en grotte, nous avons l'intention d'accroitre le tourisme international. Pour notre grande joie, l'année passée nous avons eu prés de 150 mille visiteurs. En effet, nous ne sommes par contents, puisque nous voudrions représenter la beauté de notre monde souterraine des grottes.

Budapest se compose de Bude et Pest. Le mot Pest est d'origine slave, étant donné qu'il dérive du mot pestera qui signifie: grotte. Buda est nommé Ofen par les alemands même aujourd'hui. Ofen signifie four et grotte. C'est-ádire le nom de la capitale hongroise renferme doublement la grotte. Cette ville salue avec beaucoup d'affection votre congrès.

Je souhaite un excellent séjour en Hongrie. Je souhaite également que vous puissez exécuter un travail professionnel efficace, mais vous puissez se familiariser aussi avec les beautés de surface de notre capitale y compris les monuments historiques, d'art et artistiques.

Si l'occasion viendra, et vous aurez l'intention à étudier tout les coins des grottes au dessous de Budapest dont la longeur totale est de 30 km, ou bien si vous voulez étudier la ville, je vous prie de bien vouloir répéter la visite. Vous étes toujuours bienveus.

Werter Herr Präsident !

Meine Damen und Herren !

Werter Kongress !

Es ist eine Ehre für mich Sie und Ihren Kongress hier in Budapest begrüssen zu dürfen.

Budapest ist die Stadt der Höhlen! Keine einzige Hauptstadt der Welt kann sich so vieler und so wertvoller Höhlen rühmen, wie die ungarische Hauptstadt.

Auf dem Gebiet der Stadtverwaltung sind fast 100 Höhlen bekannt, deren Gesamtlänge sich 30 KM nähert. Von diesen ist die Pálvölgyer Höhle die längste, sie ist 7 KM lang und nimmt somit den dritten Platz in der Reihe der Höhlen des Landes ein.

Wir sind auch stolz auf unseren Nachschub, den wir uns erzogen haben. Unsere Höhle im Mátyás Berg ist die Höhle der Jugendlichen, wo sich die jungen Höhlenforscher die Kniffe der Begehung der Höhlen aneignen. Wir betrachten die Forschungen und die immer neue Aufdeckung von Höhlen als eine unserer bedeutenden Aufgaben.

Gerade in diesem Jahr sind 70 Jahre seit der Erschliessung der Pálvölgyer Höhle und ihre Eröffnung für das Publikum vergangen. Unsere Forscher sind auch seitdem bemüht die Höhlen liebende Welt von Zeit zu Zeit mit je einer bedeutenden Neuigkeit zu überraschen. Zwei davon möchte ich erwähnen. Es war eine grosse Sensation der wissenschaftlichen Welt, als vor fünf Jahren, die an beispiellosen Kristallformationen reiche, fast 5 KM lange Höhle im József Berg entdeckt wurde.

Im Herbst des Jahres 1986 haben wir für die Besucher die Höhle im Szemlő Berg eröffnet. Wir wollen unsere Absicht nicht verheimlichen, wonach wir durch die Bekanntmachung unserer Höhlenschätze auch unseren Fremdenverkehr erhöhlen möchten. Es gereicht uns zur Freude, dass unsere Höhlen im Vorjahr von ca 150 tausend Besuchern aufgesucht wurden. Wir sind damit keinesfalls zufrieden, denn wir möchten möglichst viele unserer Besucher mit der interessanten Welt unter unserer Hauptstadt und ihren Schönheiten bekannt machen.

Der Name Pest ist slawischen Ursprungs und entstammt dem Wort "pestera", das Höhle bedeutet.

Buda wird von den Deutschen auch heute noch Ofen genannt, was im allgemeinen den Ofen, aber auch Höhle bedeutet, was die Benennung zahlreicher Höhlen im deutschen Sprachgebiet beweist.

Nach alldem muss ich wohl kaum besonders lange erklären, mit welcher Freude Sie von der Stadt, die bereits in ihren Namen zwei Höhlen enthält, anl. Ihres Kongresses begrüsst werden.

Ich wünsche Ihnen, dass Sie sich bei uns wohlfühlen, eine gehaltvolle, erfolgreiche, fachliche Arbeit durchführen und im Verlauf derselben auch unsere Höhlen kennenlernen mögen. Aber es sollte Ihnen auch Zeit dazu bleiben, die Schönheiten unserer Hauptstadt über der Erde und ihre Jahrtausende alten Denkwürdigkeiten kennenzulernen.

Wenn es sich so ergeben sollte, dass Sie jetzt nicht genug Zeit haben um alle Ecken und Enden der sich unter unserer Hauptstadt entlangziehen den Höhlen von 30 KM Länge zu begehen, oder wenn Sie meinen, nicht genügend von unserer Hauptstadt gesehen zu haben, so kommen Sie möglichst bald und möglichst häufig zu uns zurück! Sie sind alle, zu jeder Zeit sehr gern gesehen!

Estimado Señor Presidente!

Señoras, Señores !

Respetado Congreso !

Me corresponde el honor de poder saludar a Uds con motivo de la realización de este congreso en Budapest.

Budapest es la ciudad de las grutas subterráneas! Ninguna capital del mundo cuenta con la cantidad, la calidad de valiosas galerías subterráneas como las que tiene la capital húngara.

En el territorio perteneciente a nuestra capital contamos con cerca de cien grutas, cuyo largo total es aproximadamente de 30 km. Entre ellas la gruta Pálvölgyi es la mas larga pues tiene una longitud de 7 kilometros y con ello es la tercera entre las galerías subterráneas del pais.

Estamos orgullosos por la capacitación que aseguramos a nuestros cuadros profesionales. La gruta Mátyáshegy pertenece a la juventud, donde los jóvenes investigadores obtienen los conocimientos necesarios con que deben contar los expedicionarios de galerias subterráneas.

Consideramos importante tarea el desarrollo de las investigaciones y el descubrimiento de nuevas cuevas.

Justamente este ano se cumple el 70 aniversario del descubrimiento y la apertura al público de la gruta subterránea Pálvölgyi.

Desde entonces nuestros investigadores tratan periodicamente de sorprender con alguna significante novedad al mundo interesado en las grutas. Entre ellos cabe destacar dos descubrimientos. Una gran sensación científica mundial, fué hace cinco anos el descubrimiento de la gruta rica en incomparables formaciones de cristal del Monte József de cerca de 5 km de longitud.

En otono del año 1986 se procedió la apertura al público de la gruta subterránea del Monte Szemlő.

No ocultamos el propósito de aumentar el turismo dando a conocer los tesoros encontrados en nuestras grutas subterráneas. Nos llena de satisfación el hecho, que el ano pasado nuestras grutas fueron visitadas por cerca de 150 mil turistas. Pero desearíamos que cuanto mas visitantes de nuestro país acudieran a visitar y conocer las interesantes y bellas reliquias situadas desde miles de anos debajo de nueastra capital.

Si en esta oportunidad no tienen el tiempo suficiente para conocer todo rincón de las galerías de grutas subterráneas que a lo largo de 30 km se extienden debajo de nuestra capital, o no contaron con la posibilidad apreciar nuestra hermosa capital, cuanto antes y repetidamente vuelvan a ella.

A todos y en cualquiera oportunidad los esperamos muy gustosos!

Signore e Signori !

Spettabile Congresso !

È mio onore di poter salutare Voi e il Vostro congresso qui a Budapest. Budapest è la città delle grotte! Nessuna capitale del mondo può vantarsi di tante preziose e specifiche grotte come la capitale ungherese.

Nel territorio amministrativo della capitale conosciamo quasi 100 grotte, con una lunghezza totale vicino a 30 km. Di queste grotte la più lunga è quella di Pálvölgy, quasi 7 km, che occupa il terzo posto di lunghezze fra le grotte di Ungheria.

Siamo orgogliosi anche dell' educazione delle giovanni leve. La grotta di Mátyáshegy è infatti la grotta loro, dove i principianti possono imparare i trucchi della speleologia.

Riteniamo importante il compito delle richerche, delle nuove esplorazioni.

Quest anno c'è il 70-o anniversario dell apertura della grotta di Pálvölgy al pubblico. Gli esploratori da allora in poi hanno cercato e cercano di sorprendere ogni tanto con qualche novita importante tutti i simpatizzanti di speleologia del mondo. Vorrei fare due esempi. Era una gran sensazione del mondo scientifico, quando 5 anni fa hanno esplorato la Grotta di József-hegy, ricca di formazioni uniche di cristalli. Nell' autunno del 1986 abbiamo aperto al pubblico la Grotta di Szemlőhegy.

Non è un intenzione segreta che con l' apertura delle grotte al pubblico, vogliamo aumentare il turismo. Ci rende soddisfatti che l' anno scorso quasi 150 mila persone hanno visitato le nostre grotte. Ma non siamo soddisfatti del tutto, perché vorremmo ancora aumentare il numero di turisti che visitano le bellezze del mondo ipogeo della capitale.

Il nome della città "Pest" è di origine slava, deriva dalla parola "pestera" che significa "grotta". Buda ancora oggi viene chiamata dai tedeschi "Ofen", che in genere vuol dire "fornello" ma anche "grotta", testimoniato dal nome di moltissime grotte in area di lingua tedesca.

Detto questo è evidente come questa citta, che anche nel suo nome implica due grotte, saluta molto cordialmente il Vostro congresso.

Vi auguriamo un boun soggiorno in Ungheria, un lavoro proficuo, è di avere il tempo di visitare, oltre le nostre grotte, anche la hellezze epigee è i monumenti millenari della nostra capitale.

Se questa volta non avrete abbastanza tempo per visitare tutti gli angoli delle grotte lunghe in totale 30-km oppure pensate di non aver visto abbastanza della nostra capitale, tornate il piu presto possibile è anche piu volte da noi. Aspettiamo tutti è sempre con affetto.

Уважаемый господин председатель!

Дамы и господа!

Уважаемый конгресс!

Я почтён, что имею возможность приветствовать вас и ваш конгресс в Будапеште.

Будапешт - это город пещер! Ни одна из столиц мира не может похвастаться столькими, причем такими ценными, особенными пещерами, как венгерская столица.

На территории нашей административной единицы мы обнаружили почти сто пещер, общая длина которых составляет почти тридцать километров. Самая длинная из них - это пещера Палвёльди в семь километров, которая по длине является третьей пещерой в стране.

Мы гордимся подготовкой наших молодых кадров: пещера Матяшхеди - это полигон юных, где молодые спелеологи осваивают приемы хождения по пещерам.

Серьезной задачей мы считаем для себя исследование, нахождение все новых пещер.

Как раз в этом году исполнилось семьдесят лет тому, как мы вскрыли и открыли для публики пещеру Палвёльди. Наши спелеологи стараются и дальше от времени до времени удивлять какой-нибудь новинкой любителей пещерного мира. Пять лет тому назад крупной научной сенсацией было вскрытие пещеры Йожефхеди длиной почти в пять километров, обилующей бесподобными кристаллообразованиями, так что осенью 1986 года мы открыли для посетителей пещеру Семлёхеди.

Мы не скрываем намерения, что показом наших пещерных сокровищ нам хотелось бы оживить туризм. Мы рады, что в прошлом году в наших пещерах побывали сто пятьдесят тысяч посетителей. Конечно, мы ещё не удовлетворены успехом, так как нам хотелось бы как можно больше приезжающих к нам иностранцев ознакомить со специфической красотой подземного мира нашей столицы.

Одна часть названия нашей столицы - Пешт - имеет славянское происхождение, происходит от слова "пештера". Буду же и по сей день немцы называют "Офен", что в общем может означать и "печь", и "пещеру", как это подтверждают наименования многочисленных пещер на германоязычных территориях.

После этого мне и не придется особо разъяснять, с какой радостью приветствует ваш конгресс столица, имеющая в своем названии две пещеры.

Желаю вам хорошо себя чувствовать у нас, проводить содержательную и успешную профессиональную работу, ознакомиться с нашими пещерами, но помимо этого оставить себе время и на то, чтобы осмотреть и надземные достопримечательности, и тысячелетние памятники старины в нашей столицы.

Если же так получится, что сейчас вам не останется времени на то, чтобы обойти все закоулки 30-километровой пещерной системы под Будапештом, или же вы решите, что еще многое не видали в нашей столице, то приезжайте к нам как можно скорей и почаще. Всегда всех вас сердечно ждем!

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Reports concerning the activities of the Commissions and Working Groups will be published in the "UIS-Bulletin". All interested people is invited to contact the respectively Chairman and to collaborate.

Des rapports concernants les activités des Commissions et des Groupes de Travail sont et seront publiés dans l'"UIS-Bulletin". Chaque personne intéressée est invitée de contacter le président respectif et de collaborer.

Die die Tätigkeit der Kommissionen und Arbeitsgruppen betreffenden Berichte werden im UIS-Bulletin veröffentlicht. Alle an den bearbeiteten Themen interessierten Personen sind eingeladen, mit den jeweiligen Vorsitzenden Verbindung aufzunehmen und mitzuarbeiten.

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David McCLURG, 1610 Live Oak Place, Carlsbad, NM-88220, New Mexico, USA
Marcel MEYSSONNIER, 28 rue Sueur Janin, F-69005 Lyon, France
Dr. Friedrich OEDL, Getreidegasse 21, A-5020 Salzburg, Österreich
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Dr. Hubert TRIMMEL, Draschestrasse 77, A-1232 Wien, Österreich
Franco URBANI, c/o Sociedad Venezolana de Espeleologia, Apartado 47.334, Caracas 1041-A, Venezuela, South America
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FURTHER COMMUNICATIONS
COMTES RENDUS DIVERS
ANDERE MITTEILUNGEN
LOS OSTROS COMUNICADOS
ДРУГИЕ СООБЩЕНИЕ

Prizewinners of the 10th International Congress of Speleology

Le X éme Congrés de l ' Union Internationale de Spéléologie
Concours de Film et Photo
Les Prix Suivantes sont attribués

Liste der Gewinner des Höhlenphotowettbewerbes des 10. Internationalen Kongresses für Speläologie

Speleophoto Competition
Dans la categorie Photo
Photo

Black and white photos:
Blanche/noire:
Schwarz-weiss Kategorie: I. Benedek, László
II. Tasler, Radko

Colour photos:
Photo couleur:
Farbphoto Kategorie: I. Stibrányi, Gustav
II. Manek, Attila

Speleoslide:
Diapositifs:
Dia Kategorie: I. Hroarson, Björn
III. Benedek, László
III. Lénárt, László - Balla, Béláné

The special prize of the Hungarian Photoartists was awarded to Stibrányi, Gustav.

Un Prix Spécial a été attribué par l' Union Photographic Hongroise á Stibrányi, Gustav.

Sonderpreis des Verbandes der Ungarischen Photokünstler: Stibrányi, Gustav.

'Post-deadline' category
Il existe une seconde categorie qui concerne les photos en retarde
"Post deadline" Kategorie

Black and white:
Blanche/noire:
Schwarz-weiss Kategorie: Frantz, William

Colour:
Couleur:
Farbphoto Kategorie: Wooldridge, Jerry

VIDEO

Karst surface Features: Karst in China, Geomorphology
A Aspect du Karst en surface: I. Karst du Chine, Geomorphologie
Kategorie - Karstlandschaften: Karst in China, Geomorphologie

Speleology:
B Grottes (Exploration sous-terre):
Kategorie Speläologie:

U-Matic system: I. Atlantida- Favre, Gerald
II. La Souffre du Dragon - Favre, Gerald

VHS
Karst in China, Caves
I. Karst du China, Grottes
Karst in China, Höhlen

In the French Caves - Rozsnyai, Aladár
II. Dans les Grottes de la France
Im Tiefe französischer Höhlen

With Cavers in Hungary - Mucke, Dieter
III. Avec les Spelologues en Hongrie
Mit Höhlenforschern in Ungarn

FILM

16 mm
Caves in the Capital - Duló, Károly
I. Les Grottes dans le Capital
Höhlen in der Hauptstadt

Prisparation of Angels - Lakatos, Iván
II. La Sueur des Anges
Schweiss der Engel

III. Dong - Guinaud, Francois (China)

Special prize of the Hungarian Television:
Le Prix de la Radiotelevision Hongroise:
Sonderpreis des Ungarischen Fernsehens:

Saga under-ice
Saga au dessus de la glace — Favre, Gerald

Special prize of the Speleological Institut:
Le Prix de l'Institut Spéléologique Hongrois:
Sonderpreis des Instituts für Höhlenkunde:

Nullarbor dreaming (U-Matic) Australia
Nullarbor revées

Dr. FRANCE HABE ,POSTOJNA ,Jugoslavija

BERICHT DER KOMMISSION FUR KARST UND HÖHLENSCHUTZ DER UIS
für den zehnten Speläologischen Kongress in Budapest 1989

Die Kommission hat in der Zeit vom 9. internationalen speläologischen Kongress in Barcelona bis Budapest sehr wenige Berichte über die Arbeit für den Karst-und Höhlenschutz von den Mitgliedern der UIS erhalten. Darum musste ich viele Angaben nur aus den einzelnen Publikationen entnehmen. Der Stand des Höhlenschutzes in den 50 Mitgliedsstaaten der UIS ist sehr verschieden. Es gibt keine einheitliche Normative des Höhlenschutzes . So sind im Westen viele Höhlen als Schauhöhlen im Privatbesitz und manchmal nicht genug geschützt wie z.B. in Schweiz,unterdessen als in den östlichen sozialistischen Staaten alle unterirdische Räume und besonders noch die Schauhöhlen in den staatlichen touristischen, speläologischen oder auch wirtschaftlichen Organisationen stehen.
Bei der Vorstellung des Umweltschutzes in den Mitgliedsländern der UIS müssen wir volle Anerkennung gerade dem Ungarn geben . Nach den vorhandenen Berichten (Dr. J. Tardy 1983 - Umwelt und Naturschutz in der Speläologie; T.Bolner Katalin,1988 - Die Problemen des Karst- und Höhlenschutzes in Ungarn) können wir Ungarn zu den Staaten zählen, die dem Höhlenschutz volle Aufmerksamkeit widmen. Seit 1985 wird den Höhlenforschungsgruppen der Besuch der Höhlen genehmigt, wenn sie von den geprüften Forschungsleitern geführt werden. Den 11 ungarischen Schauhöhlen wird ein besonderer Schutz gewidmet. Das grösste Problem dieser Schauhöhlen bedeuten die Lampenflora , die sich in einigen Höhlen besonders stark erscheint. Deswegen war Ungarn einer der ersten Staaten , der in Budapest ein Symposium über Lampenflora. In ungarischen und auch in den anderen Karstländern bedeutet die Gefahr der Steinbrüche im Bereich der Höhlen besonderes Problem , das dort mit dem Komitee für Umweltschutz geregelt wird. Genauso stellt gerade in Budapest ein besonderes Problem des Höhlenschutzes Verunreinigung der Höhlenräume und besonders auch Verschmutzung des Tropfwassers in den städtischen unterirdischwn Räumen.
Einen besonderen Wert widmete dem Höhlenschutz Österreich , wo das Naturhöhlengesetz schon im Jahre des internationalen Höhlenschutzes 1975 herausgegeben wurde. Schon damals gab der Verband österreichischer Höhlenforscher als Einleitung in den Höhlenschutz kleine Broschüre mit dem Leitspruch aus : Nimm nichts als Bilder und Eindrücke, lass nichts zurück als die Spuren deines Fusses , schlag nichts tot als nur deine Zeit. So wurden schon 1975 insgesamt 158 Höhlen und 19 Höhlengebiete im gesamten österreichischen Bundesgebiet zum Naturdenkmal erklärt. Sie geniessen dadurch besonderen gesetzlichen Schutz. Sogar ein Drittel der Bevölkerung Österreichs versorgt sich mit Trinkwasser aus den Karstgebieten (F. Bauer , Karsthydrologie, Höhlenforschung in Österreich ,Wien 1979).Eben darum widmet Österreich besonderen Schutz der Karstgebiete. So gab der Landesverein für Höhlenkunde in Salzburg im Jahre 1983 Neufassung des Salzburger Höhlerechtes heraus. Jede Zerstörung der Höhlen und ihres Inhalts ist strafbar. Wegen ihrer Eigenart und Bedeutung werden aber viele Höhlen unter den besonderen Schutz gestellt. So ist auch in Kärnten zur Neuregelung des Höhlenschutzes beigetreten. Der Ausbau einer Höhle zur Schauhöhle wird nach diesem Grundgesetz nur mit Bewilligung der Landesregierung zulässig. Zur Führung von Personen in Naturhöhlen sind nur behördlich anerkannte Höhlenführer berechtigt. Nach dem Vorbild Österreichs , wo staatlich vorgeschriebene Höhlenführerschule eingeführt wurde, sollten wir in allen Ländern , wo der Karsttourismus entwickelt ist , solche Institutionen einführen. Wegen der menschlichen Eingriffe ist besonders der alpine Karst ober der Waldgrenze problematisch. Deswegen organisierte österreichisches Nationale Komittee - Arbeitsgruppe der österreichischen Gesellschaft für Natur -und Umweltschutz " Symposium über Ökologie und Schutz alpiner Karstlandschaften in Bad Mitterndorf 1988. Dabei wurde betont, dass auch unschuldige Formen des Tourismus , einschliesslich der gewöhnliche Alpinismus ohne grossen Bau und Konzentrazion der Leute (wie die Schiegrosszentren) für den Karst folgenreich sein können. Alpiner Karstquellen - nach der Natur reiner als andere- sind auch für die Verschmutzung empfindlich. Die Speläologen , die sonst bei dem Karstschutz unentberlich sind , können auch starke Belastung bedeuten, wenn sie nicht richtig erzogen sind. In Österreich und Schweiz kann Höhlentrekking für Karsthöhlen grosse Gefahr werden. Bewusste österreichische Höhlenorganisationen organisieren anstatt Trekkinge besondere Tätigkeit " Säuberen wir unsere Höhlen" .Auch in den anderen europäischen Höhlenforscherorganisationen dringt die Parole " der beste Höhlenforscher ist der , der nicht in die Höhlen geht". Die Diskussion am Symposium zeigte, dass eigentlich wie für den Alpinen- und auch fü den Dinarischen Karst besondere Polygone benötigen, wo wir vertieft einen Sektor des Karstes in Gänze als ökologische Einheit durchstudieren würden und aufgrund dessen Schutzmassnahmen treffen würden.Die Biospeläologische Arbeitsgemeinschaft in Wien widmet besondere Aufmerksamkeit den Fledermäusen, die in den letzten Jahren einen erschreckenden Rückgang verzeichnen. Deswegen gab diese Arbeitsgemeinschaft das Druckheft " Fledermäuse sollen leben" heraus.
Auch die Höhlenforscherorganisationen in der Bundesrepublik Deutschland legen seit 1975 grosse Aufmerksamkeit dem Höhlenschutz und gaben schon damals das Druckheft über den Höhlenschutz mit der Liste der geschützten Höhlen in den einzelnen Bundesländern heraus. Genauso wird dem Schutz der Fledermäuse besonderes Interesse gewidmet. Überall müssen sich Höhlenforscherorganisationen für die Erhaltung der Höhlen wegen schädlicher Eingriffe einsetzen. So setzte sich der Verband der deutschen Höhlenforscher für die Erhaltung der Höhle im Steinbruch der mitteldeutschen Hart-und Steinindustrie im Düstertal bei Bleiwäsche ein. Unsere Kommission wendete sich an den Minister für Umweltschutz und Raumordnung , der uns mitgeteilt hat, dass sich der Regierungspräsident darum bemühen wird , das Höhlensystem unversehrt zu erhalten.
In der Deutschen Demokratischen Republik sind alle Höhlen in staatlicher Hand , wo Veröffentlichungen über Höhlen nur mit Zustimmung der Behörden gestattet ist.
In allen osteuropäischen sozialistischen Staaten sind die Höhlen in staatlicher Hand und werden von verschiedenen staatlich gegründeten Höhlenforscherorganisationen oder von den verschiedenen Wirtschaftsorganisationen verwaltet. Wie es bekannt wird, werden in der Tschechoslowakei besonders die Schauhöhlen geschützt.
In Westeurops widmet Frankreich dem Schutz der Höhlen besondere Aufmerksamkeit. Das beweisen verschiedene Broschüre und spezielle Poster , die nicht nur die Höhlenforscher sondern auch die breite Öffentlickeit von diesem Problemen bekannt machen. Sogar in den Ländern wie Belgien, wo das Karstgebiet kleinere Flächen umfasst , legt man grossen Wert auf den Karstschutz, besonders wegen der Karstquellen. So wurde dort 1983 die Nationalkommission für den Karstschutz organisiert mit der Aufgabe der diesbezüglichen Verständigung , Sanierung der Oberfläche und Klassifikation der Karstphänomene vom Standpunkt des Naturschutzes.
Auch die Berichte aus den anderen Kontinenten beweisen, dass immer grössere Aufmerksamkeit dem Karst-und Höhlenschutz gewidmet wird.

So wurde am 26. internationalen Geographenkongress in Australien in Sidney in besonderer Arbeitsgruppe das Problem des Menschen in den Karstgebieten hinsichlich auf den Karst -und Höhlenschutz bearbeitet. Ebenso widmete sich dem Karstschutz und noch besonders den karsthydrologischen Problemen der 21.JAH (International Association of Hydrogeologists) 1988 in Guilin, in der südchinesischen Provinz Guangxi.
Am Ende möchte ich gern noch einige Worte über den Karst-und Höhlenschutz Jugoslawiens , wo der Dinarische Karst bis jetzt ca. 15.000 registrierte Höhlen uafweist , berichten. Von disem ist besonders bedroht der nordwestlichste Teil, der Slowenische Karst zwischen dem Becken Ljubljansko barje und der Triesterbucht. In der kleinen Volksrepublik Slowenien hat der Verband der slowinschen Höhlenforscher in hundert Jahren 6000 Höhlen erforscht. In diesem klassischen Karst befinden zwei in der ganzen Welt bekannten Schauhöhlen : die Postojnska jama und die Skocjanske jame, die 1986 in die Weltliste der Natur - und Kulturerbschaft bei UNESCO eingetragen wurde. Beide Höhlen werden durch die dortigen Ponorflüsse verunreinigt, so dass sie beider niedrigsten Schüttung im Sommer in die vierte ,niedrigste Qualitätsklasse gehören. Biospeläologische Forschungen in der hydrographischen Etage der Höhle von Postojna zeigten , dass die oberflächlichen Tiere in die Unterwelt vordringen und dort die Höhlentiere verdrängen. Wegen der verschmutzten Gewässer wird auch berühmtes Tier des Dinarischen Karstes Proteus anguinus bedroht. Die Biologen der Universität in Ljubljana stellten fest, dass in der Haut des Grottenolmes Konzentrazion schwerer Metalle sind, die leicht in der Zukunft zum Aussterben dieser einzigartigen Höhlentiere führen könnte.
Die bis jetzt starke Verunreinigung des Ponorflusses Reka und damit auch der Škocjanske jame wird langsam wegen des Überganges vom nassen Prozess der Panellplatten in Holzfabrik Lesonit und wegen der Klärungsanlagen in der Fabrik der organischen Säure (beide in Ilirska Bistrica) sowie zwei Wasserakkumulationen , die die niedrigste Sommerschüttung bereichen sollen ; verbessert.
Slowenisches Karstgebiet gibt mehr als ein Drittel des Trinkwassers. Darum legen die slowenischen Behörden grossen Wert auf die Erhaltung der Bevölkerung und auf die Abschaffung aller Verschmutzungen des Karstwassers wegen der Industrie. In Slowenien besteht Naturschutzgesetz seit 1970, doch geniessen einen besonderen Schutz vor allem die Schauhöhlen. Die Federation sowie auch auch republikanische

Verbände der Höhlenforscher widmen allen nationalen und auch internationalen Kongressen und Symposien über den Karst -und Höhlenschutz volle Aufmerksamkeit den Karsthöhlen. Doch müssen wir behaup behaupten, dass fast jede zehnte Höhle verschmutz wird. Darum ist der Verband slowenischer Höhlenforscher zur Ausarbeitung des Katasters der verunreinigten Höhlen beigetreten. Zum Zwecke des Karstschutzes diente auch internationales Symposium der internationalen geographischen Union in Postojna mit dem Thema " der Einfluss des Menschen im Karst 1987 in Postojna.

Unbedingt muss man jede Ausnützung der speläologischen Objekte für touristische und andere Zwecke seitens der Organisationen , die den speläologischen Objekten den entsprechenden Schutz und Valorisierung nicht bieten können , unbedingt verhindern. Nur die dazu berufene Organisationen und Fachkörper sollen entscheiden, wer und wie diese Höhlenobjekte verwaltet werden.

Diese Fachkörper sollen von den folgenden Institutionen formiert werden:
- Speläologische Organisationen des Staates (Dachorganisation)
- Staatliche Institutionen für den Umweltschutz
- Touristische Dachorganisation des Staates
- eventuelle spezielle Karstforschungsinstitute des Staates

Am Ende muss ich noch meinen persönlichen Ersatz als Vorsitzender der Kommission für Karst-und Höhlenschutz bei UIS berichten. Seit dem letzten speläologischen Kongress in Barcelona hielt ich 14 Vorträge über die Höhlen und ihren Schutz, so in Jugoslawien wie auch in Italien, Österreich, und Deutschland. Als Delegierter im republikanischen Ausschuss für dem Umweltschutz vertrat ich immer Interesse des Karstschutzes. Von den mehreren kleineren Beiträgen erwähne ich nur meine umfangreiche Arbeit in der Festschrift " Il TIMAVO", immagini, storie, ecologia, di unfiume carsico (Triest 1989 1- 358), die ein bedentender Beitrag zu den Problemen des Ponorfluss und der Škocjanske jame vorzeigt.

Ausserden beteiligte ich mich an mehreren Speläologischen Kongressen im In.-und Ausland , wo ich über Probleme des Karst-und Höhlenschutzes gesprochen habe.

Dr. France Habe

THE REPORT OF THE COMMISSION FOR KARST PROTECTION AND SHOW CAVES AT UIS

The report, treating the karst landscape and caves protection in the world is more composed by data gathered from publications than by data of members sent to the Commission. From the report it is obvious that the normatives for caves protection differ in western and eastern countries. Some Middle European and West European countries had protected the underground world by series of laws, somewhere else this protection is almost minimal. Not the tourists only, but the caves too, without speaking about the industry and economical needs, utterly destroy the karst underground. A special importance should be given to protection of show caves in the world as they are the most exposed either to destruction or to non-professional intervention into their content. Therefore the Commission from all the countries, members of UIS suggests to create a special professional commission for display, protection and economic exploitation of the cave, composed by:

- management of speleological organization of each country,
- state institutions for environment protection,
- management of touristic organizations of each country,
- special state institutions, institutes respectively, related to karst research.

I N F O R M A T I O N

During the last years, more and more interesting papers show the originality and abundance of caves of thermal origin (See fig. 1). Such hydrothermal karst caves are known in many countries of the World and were studied especially in Hungary, Soviet Union, Poland, Algeria and United States.

Hydrothermal karst appears not only as an original new world to be explored, different of the classical karst, but also as a geological object very important to be known from an economic point of view. Following many economic geologists, a large part of the ore deposits known as deposits in paleoKarst would be of hydrothermal karst origin.

Through the present literature, it appears that hydrothermal karst presents characters depending on the geological environment, very different from one country to another.

Here are the reasons why during the 10-th International Congress of Speleology, UIS General Assambly has decided to create a working group "Hydrothermal karst".

The first practical steps of the program will be:
- to group all the people exploring and studing hydrothermal karst;
- to list the main hydrothermal karst area;
- to make a bibliography of hydrothermal karst;
- to elaborate common working approach for hydrothermal karst studing.

The main theoretical questions to be solved in the first place:
- finding out different genetic types of hydrothermal karst;
- building of their dynamic models;
- definition of criteria for distinguishing hydrothermal karst from normal low-temperature karst.

Along with traditional forms of work, an organization of joint works of the working group members is planned to study the problem objects. The first step of this kind of work will be a speleological expedition to the Tyuya-Muyun massif (South Kirghizia, USSR) in autumn 1990.

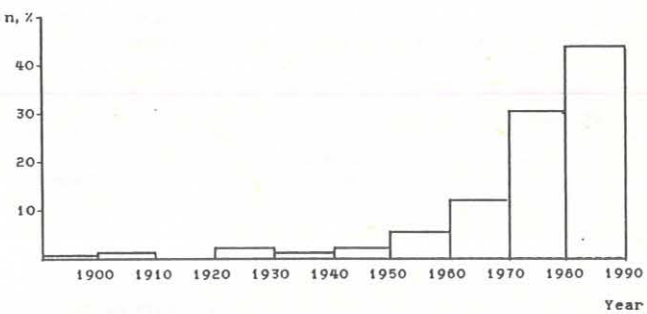

Fig. 1. Dynamics of publications on theme "Hydrothermal karst" (on the basis of 210 works published)

Specialitsts interested in development of works on hydrothermal karst contact please with group chairman, Yuri DUBLYANSKY.

Address for correspondence: USSR, 630090, Novosibirsk, Institute of geology and Geophysics, USSR Academy of sciences, Siberian Div.

tel.: 35-21-60
telex: 133 126 POISK SU

Dr. DUBLYANSKY, Yuri

Bericht über die Tätigkeit der Fachsektion für Speläotherapie.

Seit dem letzten Kongress der UIS /Barcelona 1986/ hielt die Fachsektion ihr internationales Symposium vom 23.bis 27.Sept. 1987 in Bad Bleiberg /Kärnten,Österreich/ wo die Möglichkeit der therapeutischen Nutzung eines aufgelassenen Bleibergwerkes der Sitzung eine besondere Aktualität gab und das Symposium eine grosse Gastfreundschaft und Unterstützung der Marktgemeinde genoss.

Am Symposium nahmen 66 Fachleute bzw.Begleiter aus 7 Länder /BRD,Italien,Jugoslavien,Norwegen,Österreich,Tschechoslowakei und Ungarn/ teil. Zu Beginn wurden die grossen Verdienste des bisherigen,am 13.V.1986 verstorbenen Vorstand der Fachsektion, dr. K.H.Spangenberg gewürdigt.Ausser den Fachvorträgen wurde der Möglichkeit einer therapeutischen Nutzung des hiesigen Bleibergwerkes besondere Aufmerksamkeit gewidmet;nach unserem Wissen sind dort gegenwärtig schon die nötigen Ausbauarbeiten beendigt.

Mitglieder der Fachsektion nahmen an der Vorbereitung der vom 17.bis 2o Mai 1989 in Prag gehaltenen IaTHUSPA-Konferenz aktiv teil und derlegten umfangreich die wissenschaftlichen Grundlagenforschungen und Ergebnisse der Speläotherapie,was von den Asthma-Ärzten sehr anerkannt wurde.

Als Erfolg der Kommission kann auch betönt werden,dass im Arbeitsplan des neugegründeten Speläologischen Institutes in Ungarn auch die laufende Messung und Auswertung der für das therapeutische Fachgebiet wichtigen speläoklimatologischen und bakteriologischen Faktoren vorgenommen ist.

Mit besonderer Freude können wir mitteilen,dass nach jahrelangem erfolglosen Versuchen endlich gelungen ist,mit den Fachleuten aus der Sowjetunion persönlichen Kontakt zu bekommen und ihre grossartige Arbeit kennen zu lernen,was wir den erfreulich geänderten politischen Verhältnissen verdanken können. Leider entbehren wir aber - sicherlich aus negativen politischen Gründen - die bisherige Miterbeit der Kollegen aus Rumänien.

Dr.Hubert Kessler
Sekretär

V O R S C H L A G
für die weitere Arbeit der Commission Internationale de Speleotherapie.

A.

1. Präsident : Dr. med. Tibor Horváth
2. Vicepräsident: Dr.med. Beate Sandri.
3. Sekretär: Dr.med.Drahoslav Ričnyi.
4. Representanten der einzelnen Ländern welche in der UIS vertreten sind.
   a./ medizienische,
   b./ naturwissenschaftliche.

   Der Generalsekretär der UIS soll die Landesverbände ersuchen je einen naturwissenschaftlichen und einen medizienischen Vertreter für die Commission namhaft zu machen.
5. Bibliographia Speleotherapeutica: Dr.med.Alfonz Piciocchi

B.

Aufgeben

1./ Präsident
   a./ Vertritt die Commission nach aussen in allen Belangen.
   b./ Entscheidet die Abhaltung wissenschaftlicher Tagungen.
   c./ Koordiniert die Kontaktaufnahme mit den verschiedenen naturwissenschaftlichen und medizienischen Gesellschaften und Institutionen.
   d./ Er regt die Bildung von Arbeitsgruppen zur Bearbeitung und Lösung bestimmter Detailfragen aus dem medizienischen,sozialmedizienischen Problemenkreis an.
2./ Vicepräsident vertritt den Präsidenten in obigen Fragen,Aufgaben.
3./ Sekretär
   a./ Aufstellung einer Kartei über alle Personen die sich mit den verschiedenen Fachgebieten der Speleotherapie befassen.
   b./ Einholung von Informationen über die Tätigkeit der 2 Representanten der einzelnen Länder.
   c./ Registrierung des Fortganges der Arbeiten aus den verschiedenen naturwissenschaftlichen und medizienischen Forschungen.
   d./ Macht Vorschläge über Aktivisierung und Verbesserung der Arbeiten
   e./ Er bereitet vor und organisiert die verschiedenen wissenschaftlichen Tagungen und Arbeitsgespräche.
   f./ Abfasseung von Berichten der Arbeitstagungen,Sitzungen.
   g./ Regelmässige Kontaktnahme mit dem Bibliographen.

4./Representanten.
   a./ Sie bearbeiten die speziellen medizienischen und naturwissenschaftlichen Probleme,die sich aus der Struktur ihres Landes ergeben.
   b./ Sie machen an die verschiedenen zuständigen Stellen entsprechende Vorschläge bzgl.weiterer Forschungen und Tätigkeiten.
   c./ Sie berichten regelmässig dem Sekretär über den Fortgang ihrer Arbeiten.
   d./ Sie berichten der Bibliographia Speleotherapica als zentrale Datenverarbeitungsstelle über ihre und andere im Lande erschienenen einschlägigen Publikationen.

Budapest,den 13.Aug.1989.

Sekretär — Vicepräsident

der Commission Internationale de Speleotherapia
/ UIS /

ABSTRACT OF THE INTERNATIONAL CAVE RESCUE COMMISSION FROM 1986 TO 1988.

- A Cave Rescue Symposium was hold in Madrid in July 1986 within the I.U.S. International Congress. Perhaps some will remember it was attended by 35 speleologists, amongst them only one foreigner, in addition to the 4 members of I.C.R.C.
  It was 2 1/2 years ago.

- In Augustus 1987 was hold in Italia - part in Cividale, part in Trieste -, the 7th International Rescue Meeting. It was a big success, 260 speleogists from 16 countries, took part to it.
  During this meeting, in addition to very interesting statements, some decisions were made :
  - establishment of a charter to which every country has to agree to if it wants to organize an international rescue meeting ;
  - creation of a Subcommission "Excavation" ;
  - since there have been no news for 11 months from Mike Meredith, President of the Commission, working in Malaysia, André Slagmolen, Secretary, is nominated as President a.i.
  It is to be emphasized that the infrastructure of this meeting was excellent. The participants did particularly benefit by the simultaneous translation of the statements.

- In 1988, 2 mini-committees were hold, as well as a meeting with the organisators of the Budapest Rescue Symposium of 1989.
  Mr. A. Slagmolen, President a.i., and Mr. G. Dénes, Vice-President, attended to the Safety and Rescue School organized in Bulgaria in October 1988.

- Are presently elaborated :
  - an address file of the Cave Rescue responsibles in the world as well as of the participants to the Congresses, Meetings and Symposia ;
  - a bibliographic file of articles about rescue.

* The I.C.R.C. received in 1988 a financial help from Belgian Union for Speleology and from its Cave Rescue Commission.

* It regularly receives the reports of British and American Cave Rescue associations, as well as the publications of French, Spanish (Andalusia) and Italian Cave Rescue associations.

* It instigated a bibliographic research about histoplasmose.

* The present concerns aim at reactivating the Medical Subcommission, grounded on the Medical Commission of French Federation for Speleology, and then, favourating the international rescue operations by making the frontier passage easier to rescue-speleologists with their material.

The I.C.R.C. Secretary
and President a.i.,

André SLAGMOLEN

RAPPORT DE LA COMMISSION INTERNATIONALE DE SECOURS (C.I.S.) DE 1986 A 1988.

Le symposium de Spéléo-secours qui s'est tenu à Madrid, en Juillet 1986, dans le cadre du Congrès International de l'U.I.S. avait, on s'en souvient peut-être, rassemblé 35 spéléologues, dont seulement un étranger, outre les 4 membres de la C.I.S.

Depuis, 2 1/2 ans ont passé.
- En août 1987, s'est tenue en Italie - partie à Cividale, partie à Trieste - la 7ème Réunion Internationale de Sauvetage, qui a connu un franc succès : 260 spéléologues, représentant 16 pays, y ont pris part. A cette Réunion, outre des exposés fort intéressants, diverses décisions ont été prises :
* Etablissement d'une charte à laquelle tout pays doit souscrire s'il veut organiser une réunion internationale de secours.
* Création d'une Sous-Commission "Déblaiement".
* Sans nouvelles depuis 11 mois du Président de la Commission, Mike Meredith, travaillant en Malaysie, nomination du Secrétaire, André Slagmolen, comme Président a.i.

A souligner que l'infrastructure de cette réunion était excellente. Les participants ont notamment bénéficié de la traduction simultanée des exposés.
- En 1988, deux mini-bureaux ont été tenus ainsi qu'une réunion avec les organisateurs du Symposium de Secours de Budapest de 1989.
- Mr. A. Slagmolen, Président a.i. et Mr. G. Dénes, Vice-Président, ont assisté à l'Ecole de Sécurité et de Secours organisée en Bulgarie, en octobre 1988.
- Sont en élaboration :
* un fichier d'adresses des divers responsables Spéléo-Secours dans le monde ainsi que des participants aux Congrès, Réunions et Symposiums;
* un fichier bibliographique des articles ayant trait au secours.
- La C.I.S. a reçu en 1988, l'aide financière de l'Union Belge de Spéléologie et de sa Commission Spéléo-Secours.
- Elle reçoit régulièrement les rapports des Spéléo-Secours britannique et américain, ainsi que les publications des Spéléo- Secours français, espagnol (Andalousie) et italien.
- Elle a suscité une recherche bibliographique sur l'histoplasmose.
- Les préoccupations actuelles sont de réactiver la Sous-Commission Médicale, en s'appuyant sur la Commission Médicale de la Fédération Française de Spéléologie et, ensuite, de favoriser les secours internationaux en facilitant le passage des frontières aux spéléos-secouristes, avec leur matériel.

Le Secrétaire et Président a.i.
de la C I S

André SLAGMOLEN

DECISIONS OF THE U.I.S. CAVE RESCUE COMMISSION MEETING HELD AT BUDAPEST LAST AUGUST 1989

The International Rescue Commission has held a Symposium prior to the Convention. The Symposium was organised by the Hungarian Cave Rescue which we thank warmly. Our appreciation goes as well to the Italian Cave Rescue which organised in 1.987 the VII International Cave Rescue Meeting.

We cannot avoid mentioning the excellent results which came out from the meeting of Safety and Rescue held in Bulgaria last year.

Doctors present in Budapest held a meeting; during the meeting the following decisions were adopted:

1. Doctors will meet by themselves during the Symposium and Conventions on Cave Rescue.
2. All speleologue doctors are invited to make available to the Commission thheir works, reports, studies and articles in order to be distributed by the Commissions to their coleagues.

The delegates of every national Cave Rescue organisation have decided to organise international training courses in order to enhance the technical level of rescue speleologues. The first course wil be held in 1.990 in France on basic techniques. The second wil take place in the United Kingdom, probably also in 1.990. This course wil have a higher technical level.

The Commission has decided as well to propose to the U.I.S. the appointment of Mr. André Slagmolen as President and to confirm Dr. György Dénes as Vice-President. Since the departure of Mike Meredith, three years ago, André Slagmolen has been acting President.

The Commission urges each country to communicate:

- The name of its offical delegate
- Names and addresses of doctors involved in cave rescue
- Names and addresses of those persons who will attend training courses in France and the United Kingdom.

These are the most importan decisions.

More detailed reports will be sent only to those delegates whose addresses are known to the Commission.

COMPTE-RENDU DE LA REUNION DE LA C.I.S. /BUDAPEST - AOUT 1989/

Avant le présent Congrès, la Commission Internationale des Secours a tenu un Symposium ; celui-ci était organisé par le Spéléo-Secours Hongrois, que nous tenons à remercier chaleureusement, de même que le Spéléo-Secours Italien, qui avait organisé la 7ème Rencontre Internationale en 1987.

Nous ne pouvons non plus passer sous silence l'excellent résultat de la Réunion de Sécurité et de Secours qui a'est tenue en Bulgarie en 1988.

De leur coté, les médecins ont tenu une Réunion, au cours de laquelle ils ont décidé :

1/ de continuer à tenir leurs réunions lors des Symposiums et Rencontres de Secours, mais en une session propre aux Médecins ;
2/ d'inviter tous les médecins spéléologues a communiquer à la Commission une copie de leurs rapports, travaux, études et tous articles afin qu'ils soient rediffusés à leurs Collègues par les soins de la Commisaion.

Les responsables des Spéléo-Secours nationaux ont, pour leur part, décidé :

- d'intensifier le niveau de formation technique des spéléo-secouristes dans le monde en organisantides sessions de

- qu'André Slagmolen, qui assumait depuis trois ans l'intérim de la Présidence de la Commission depuis le départ de Mike Meredith, soit proposé comme Préaident de la Commission Internationale des Secours et que le Dr G. Dénes soit reconduit comme Vice-Président.

La Commission demande instamment à chaque pays - afin que toute correspondance parvienne à qui de droit - de lui faire parvenir d'urgence :
- le nom de son délégué officiel à la Commission Internationale des Secours ;
- les noms et adresses de ses médecins exercant le secours spéléologique ;
- le nom des personnes qui seront envoyées aux sessions de formation en France et en Grande-Bretagne.

Céci constitue l'essentiel de nos décisions.

Un rapport plus complet sera envoyé uniquement aux délégués dont nous aurons reçu l'adresse.

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IFJ	=	Student participant Membre étudiant Student Estudiante Студент
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VEN	=	Guest Invité Gast Invitado Гость
REN	=	Organizer Organisateur Organisator Organizador Организатор

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