第十一届国际洞穴学大会文集

INTERNATIONAL UNION OF SPELEOLOGY

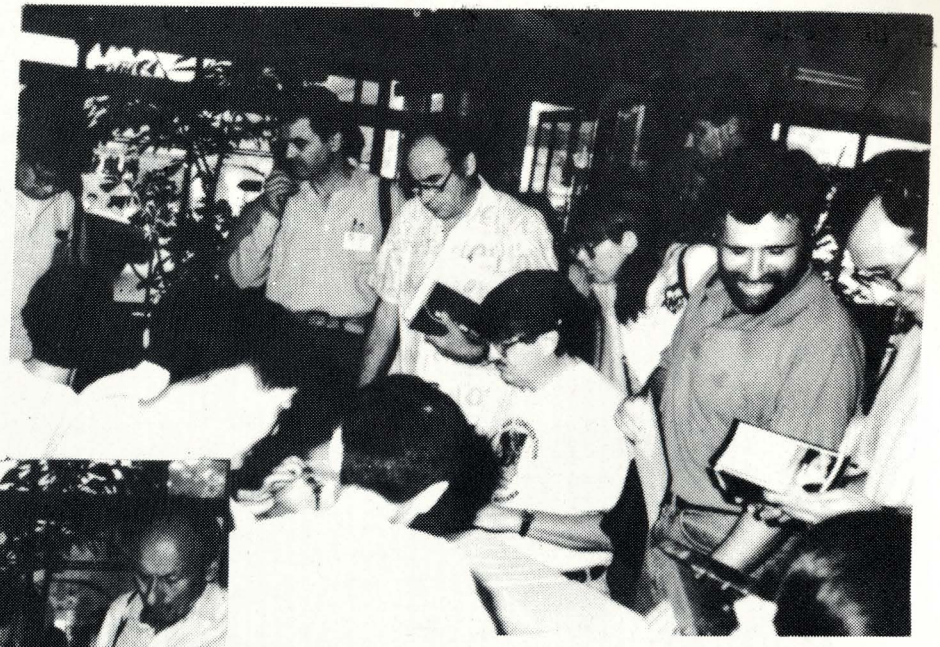
PROCEEDINGS

of the
XI INTERNATIONAL CONGRESS
of SPELEOLOGY

SUPPLEMENT

增刊

AUGUST 1993 BEIJING CHINA



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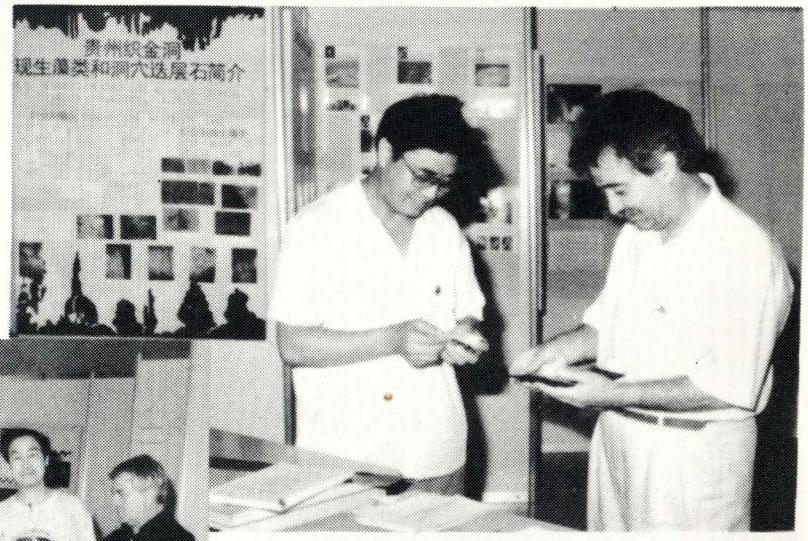

Above and left:
At the Exhibition Room

INTERNATIONAL UNION OF SPELEOLOGY

PROCEEDINGS

of the

XI INTERNATIONAL CONGRESS OF SPELEOLOGY

SUPPLEMENT

August 2 to 8 1993

BEIJING CHINA

CHIEF EDITOR

JIN YUZHANG

Issued in May 1994

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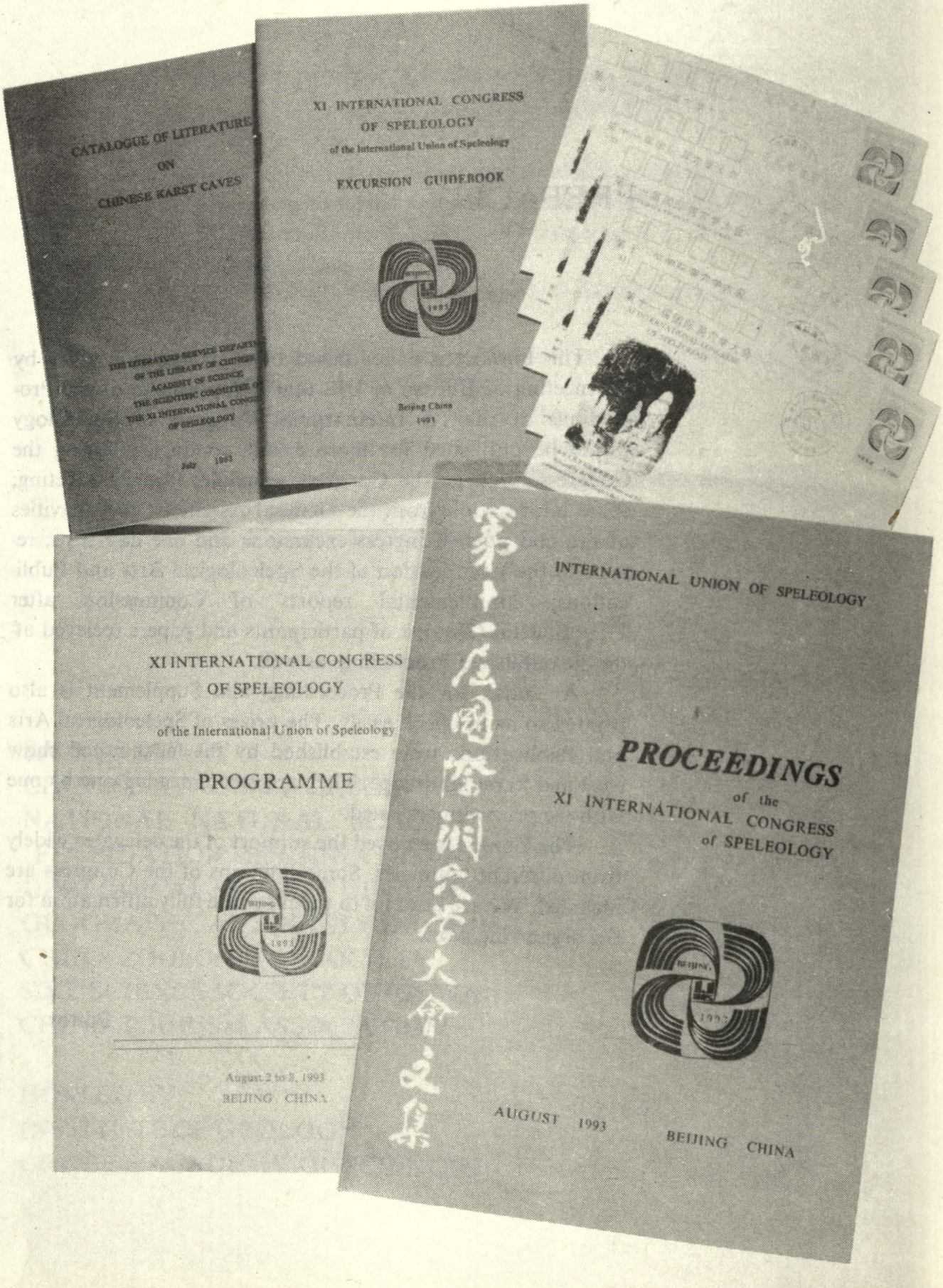
PREFACE

This booklet is edited based on the suggestion given by the meeting of Bureau of UIS that a Supplement of the Proceedings of the XI International Congress of Speleology would be published for those events conducted during the Congress, such as the Congress schedule; Plenary Meeting; some information from the General Assembly; the activities of pre and post–Congress excursions and one day trips; results of the Competition of the Speleological Arts and Publications; complemental reports of Commission after UIS–Bullelin (38); list of participants and papers recieved after the published Proceedings as well.

An index for the Proceedings and Supplement is also printed so as to check easily. The prizes of Speleological Arts and Publications were established by the most noted show cave and karst landscape. They are recommended one by one with the prizewinners listed.

The Congress enjoyed the support of the delegates widely from different countries. Some opinions of the Congress are included. We are grateful to them for the fully affirmation for the organizing work.

Editor


CATALOGUE OF LITERATURE
ON
CHINESE KARST CAVES
July 1993
XI INTERNATIONAL CONGRESS
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of the International Union of Speleology
EXCURSION GUIDEBOOK
Beijing China
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ADDITIONAL PAPERS AND ABSTRACTS

PROTECTION OF KARST AND CAVES IN THE CZECH REPUBLIC UNDER THE NEW ACT

Jaroslav HROMAS
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At the 6th international speleological congress in Olomouc in 1973 I acquainted the participants with regulations on the karst and caves protection in the then Czech Socialist Republic, under the Act No 40 / 1956 concerning the state nature protection. This practice under the rather progressive Act at that time, discontinued in 1992, when the Act was overcome by new related regulations, especially by new Acts on physical planning, building, forest and water management, agriculture etc. and when the protection of outstanding-karst phenomena was already far too little effective.

On 1st June 1992 a new Act has entered into force, which enabled to increase the effect of karst and caves protection, and which also considerably affected the work of speleologists. It is the Czech National Council Act No. 114 / 92 on the Protection of nature and the landscape, passed by the Czech parliament on 19th February 1992. It is necessary to remark that this "very effective" Act was compiled in the ecologically favourable "after – revolution euphoria" of the Czech politicians and that in the present "more rational" time it would probably in such a version not be passed.

The Act No 114 / 92 is amending quite newly the rights and duties of all nature and landscape users as well as of state authorities, ensuring their protection, and understandably is touching enough also the speleological work and caves as a subject of their interest.

In comparison with the former Act the new Act is very broad (including 83 § §) and is solving the given problems really in details. In addition there were edited to it procedural regulations and in turn according to the need also various methodical aids.

The Act, as it can be understood already from its title, is not concerned only with parts of nature a their special protection, but is striving to find a solution to preserve and restore the landscape as a whole, the conditions of its exploitation and urbanization. It adopts for the protection of nature and all the environment a quite new conception : it is protecting the complete landscape with all its components from destruction and excessive exploitation, all plant and animal species from extinction, while protecting particularly some territories and species. In this way the Act is dividing the nature conservation into a general and a particular ones.

The Act covers 8 basic parts :

1st part is giving the purpose of the Act ("to contribute towards the preservation and

restoration of the natural balance in the landscape, towards the protection of the diversity of all forms of life, natural values and beauty, and towards the economical management of natural resources"), it defines the nature conservation ("specified care for wild animals, wild plants and their communities, minerals, rocks, paleontological finds and geological wholes, ecological systems and landscape wholes, as well as for the appearance and accessibility of the landscape, carried out by the state and by physical and legal persons"). Further it specifies the terms used in this Act.

2nd part defines the so called general protection of nature and landscape. It is giving obligations to use the landscape, plants and animals in such a way which does not endanger the ecological stabilizing functions and the existence of plants and animals. It specifies the preservation conditions of so called territorial systems of ecological stability and significant landscape components, the protection of wood species growing out of forest, it prohibits to damage or destroy caves, protects the paleontological discoveries, the character of a landscape and to enable a prompt intervention of the nature conservation it gives the possiblility to proclaim operationally temporarily protected areas. The common landscape use can be changed in a more strict one by proclaiming a so called natural park.

3rd part is solving the protection of particularly protected area. It defines in a new way their categories, the number of which is in comparison with the recent Act redused. In the same way it is differentiating the territories according to their extent, but is introducing a new differentiation also according to their importance. The denomination of particularly protected areas of an international importance, or unique in the Republic, are completed by the attribute "national". According to the categories there are also for decision–making authorized the nature conservation authorities of different level. The Act defines the following categories of particularly protected areas:

(large–size PA)	national parks
	protected landscape areas
(small–size PA)	national nature reserves
	nature reserves
	national natural monuments
	natural monuments.

It is necessary to add, that the category of monuments represents the formations of a very small extent, mostly the geological and geomorphological formations, mineral deposits or fragments of ecosystems. The Act also automatically establish protective zones for all particularly protected areas in the width of 50m, if the establishment regulation does not determinate it in a different way.

4th part of the Act defines the conditions of proclamation and protection of memorable trees and particularly protected plant, animal and mineral species. The list of them issues the Ministry of Environment by a procedural regulations. I have to remark that it does not envisage, for the time being, to issue a list of protected mineral species. This part of the Act defines strictly the conditions of species protection, prohibits even to disturb them, and their sale or trade is very limited. Only the Ministry of Environment can permit their exportation.

5th part specifies limitations of some property rights, resulting from the protection, financial contributions in nature conservation, obligations for the preservation or the lim-

itation of the access to the landscape, public participation and right to information in nature conservation; it imposes some obligations on investors and is touching the sciences, research and the international co–operation.

6th part determines authorities and state administration in nature conservation and defines the scope of their activities. They have a different range of competecnes and territorial impact.

7th part treats the responsibility in the sphere of nature conservation and removal of the consequences of unauthorized interventions.

For the conservationist the sanctions are a powerful instrument. Apart from fines untill 1 million Kc (crowns Czech) the authority may order corrective or compensatory mesures and withdraw the unwarrantedly kept parts of nature. The punitive measures are understandably not affected.

8th part of this Act includes the common, temporary, final and cancelation provisions.

And so in which new way is this Act modifying the caves protection and speleology ?

The caves can be protected in several ways.

The basic protection to all caves, with the exception of those which are uncovered by mining of minerals permitted and executed in accordance with the mining law, gives § 10, reading verbatim :

1. Caves are an underground space caused by the effects of natural forces. For the purpose of this Act, caves are also understood to be natural phenomena on the surface of the Earth and underground, which are in direct causal nexus with caves.

2. It is prohibited to damage or destroy caves. The approval of the nature conservation authorities is required for accession to caves or their utilization, according to separate regulations.

Consequently, in case the cave does not enjoy a higher level protection, it is necessary to have for any activity, which could be described as damaging (and it means often also the speleological exploration) or use of a cave, a permission of the respective nature conservation authority (District Council, National Park Administration, Protected Landscape Area Administration).

The cave can be also registered according to § 6 as an "outstanding landscape component" with corresponding protection, so that for any activity in it the "binding standpoint" of the authorized District council is indispensable.

The karst region or the cave alone can have strict especial protection, if it is situated in a "protected landscape area", or in a "nature reserve".

The cave enjoys the most strict protection, if it is proclaimed as "national natural monument", or if it is situated in a "national nature reserve" or in a "national park". For any activity in so protected component, e.g. also the speleological exploration or research, only the qualified state nature conservation authority can give permission, which is in the case of the categories with the most strict protection only the Ministry of Environment.

A special protection enjoys also a cave which is a biotope of particularly protected species of animals or plants, e.g. bats. It is covered by § 50, saying that "particularly protected animals are protected in all their stages of development. The natural and artificial habitats they use, as well as their biotopes, are protected ". "It is prohibited to harmfully

intervene in the natural development of particularly protected animals, especially to catch them, hold them in captivity, disturb, injure or kill them. It is not permitted to collect, destroy, damage or transfer them in any of their stages of development, nor the habitats they use." An exception from these prohibitions, concerning the particularly protected species from the group of endangered species, can give only the respective nature conservation authority, and if there are severely or critically endangered species – only the Ministry of Environment.

On the protection of caves and speleological works relates also significantly § 11, which is protecting the paleological discoveries. It reads :

1. Whosoever makes a paleontological discovery, which he himself determines, must ensure its protection from destruction, damage and theft, and take down data on the circumstances of its discovery, particularly the place of discovery. Upon written summons, issued by the nature conservation authorities, he must also inform them of the circumstances of the discovery and enable access and submit documentatoin concerning the discovery to persons authorized by a nature conservatoin authority.

2. The owner of the land, on which a paleontological discovery was made, or the person who carries out activities, in the course of which the discovery was made, must – upon request of nature conservation authority – enable persons, authorized by this authority, to carry out paleontological salvage research, and during this period (max. within 8 days from the date of discovery, if not agreed upon otherwise by both parties), he must refrain from carrying out any activities at the place of discovery, which could lead to its destruction or damage. When the paleontological salvage research is completed, persons authorized by the nature conservation authority must be allowed to carry out professional paleontological supervision of further work.

3. The export of paleontological finds is permitted only with approval of the nature conservation authorities. (Ministries)

At this occasion it is necessary to point out § 23 of the Act of CNR (Czech National Council) No 20 / 87, on the state monuments protection, stipulating the conditions of archaeological finds ("archaeological find is a thing / group of things / , which is an evidence or remainder of the life of human being and his activity from the beginning of his development until the modern period and was preserved as a rule under the earth").

Both § § are similar, only the archaeological find, in contrary to the paleontological discovery, must be announced on the second day at the latest to the archaelogical institute or museum and the find is a state propriety.

According to the a / m legislative rules practically all caves in the Czech Republic are protected. In accordance with their importance the level of their protection is differentiated.

All important karst regions are parts of protected landscape areas and their most valuable core zones are strictly protected in the category national nature reserves. There belong also the protected landscape areas Moravsky kras (the Moravian karst), Cesky kras (the Czech Karst), palava (Pavlov Hills), important karst or pseudo - karst phenomena in national parks Krkonose (Giant Mountains) and Podyji (Thaya Valley), in protected landscape areas Cesky raj (the Bohemian Paradise), Broumovsko, Beskydy (Beskids).

Isolated important caves are proclaimed as national natural monuments or as parts of smaller karst regions are included in independent national nature reserves. There are included also all 12 public open caves and all the longest and deepest cave systems.

All these protected areas and public open caves are from 1991 managed directly and exclusively by professional bodies of the state nature conservation, incorporated into a unified organisation structure of the Czech Institute of Nature Conservation, directed by the Ministry of Environment of the Czech Republic.

In such a way is given to the protection and care of the karst regions and caves, inclusive the public open caves, the utmost attention from the state nature conservation

CONSERVATION AND MANAGMENT OF KARST AND CAVES IN PROTECTED AREAS — AN EXAMPLE FROM EUROPE CONDITIONS, CZECH REPUBLIC

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At present in the Czech Republic exist 3 national parks and 23 protected landscape areas (PLA) which cover 13, 5% of the State surface. Besides there are also about 850 small size protected areas (national nature reserves, nature reserves, national nature monuments, nature monuments). Practically all important karst areas and caves are in some of these protected areas (also all twelve our show caves).

There are three large karst areas and four pseudokarst areas in the Republic, which are declared as a protected landscape areas (some karst or pseudokarst features are also in some others PLA and NP). Management of these protected areas is made (as in others PLA) according to management plan. Management comes from a zonation of each protected area.

Large size protected karst and pseudokarst areas

	PLA	total area in km^2	forest in %	arable land in %	coverage of zones in %			
					I	II	III	IV
Karst	Czech karst	128	37,5	38,9	25,7	43,9	25,6	4,8
	Moravian karst	98,2	62,2	23,2	49,4 +43,8 zone Ia	1,2	5,6	–
	Pavlov Hills	83,1	30	40,8	10,0	49,8	31,4	8,8
pseudo–karst	Broumov Region	410	40,5	34	7,4	13,6	63,8	15,2
	Bohemian Paradise	91,7	48,6	25,5	13,5	4,9	44,4	37,2
	Kokorin Region	271,6	51,9	33,2	16,8	47,8	28,7	6,7
	Elbe Sandstones	325,5	69,9	11,3	15,0	29,0	40,0	16,0

Characteristics of zones:

I. zone: areas with the most valuable nature, mainly natural or little effected ecosystems

II. zone: areas with important nature values, forest ecosystems partly changed by a man and stable agriculture ecosystems (e.g. seminatural meadows)

III. zone: areas considerably changed by a man with dispersed dwelling and small settlements.

IV. zone (buffer): areas with intense economie utilization, with settlements, industry, exploitation

For comparison I zones of PLA have the same nature value as national categories of small size protected areas–national nature reserves and national nature monuments.

Small size karst areas are declared as national nature reserves or national nature monuments.

Property Funds in Specially Protected Areas

Ongoing process of privatization have prepared new risks for the nature conservation in relation to specially protected areas. The risks are particularly represented by intensive pressures from land users and owners in protected areas requesting the areas maximum economic exploitation without any regard to resons of their protection. This in the future will lead to enormous demands on reimbursement of loss caused by a purpose – oriented management of those areas according to management plans. According the new nature and countryside conservation act the land of state ownership in national categories of protected areas can not be alienated. But our aim is also to buy other land in I zones of national parks and protected landscape areas and in national nature reserves and national nature monuments. We form property funds and began to buy this land. Financial ensurance should be obtained in connection with the State budget and the State Environment Fund. Means can be also used frome incomes (rent from lands) and from other contribution or donation (e.g. we received grant from a film complany – according to the agreement – for permission to make some scenes of film in one tourist cave in Moravian karst).

From the state budged we receive also money for management of this state land, which we order. This also the only way, how to preserve great nature values of our karst areas.

Management and research

Management plan of protected landscape areas based on zonations is a strategic plan of nature conservation for collaborations and contacts with other partners – foresters, farmers, local authorities etc. Small size karst protected areas – national nature reserves, national nature monument are managed according to special management plan which come from the reality that nature conservancy is a manager of these areas.

Good management of protected areas needs an important use of it for research – not only for a management plan itself, but mainly for values of this rich nature. Our PLA Czech karst, Moravian karst and Pavlov Hills have great importance for research, especially for development of nature during Quaternary and they have longyear tradition in it.

One from these PLA, Pavlov Hills, was declared as B sphere Reserve – MAB programme. It is a mountainous island among the chernozem belt and therefore it shows a specific development in which the steppic formations do play a significant role. It's an ideal area for solving problems of thermophilous relicts surviving from interglacial period until present time.

Environmental Impacts

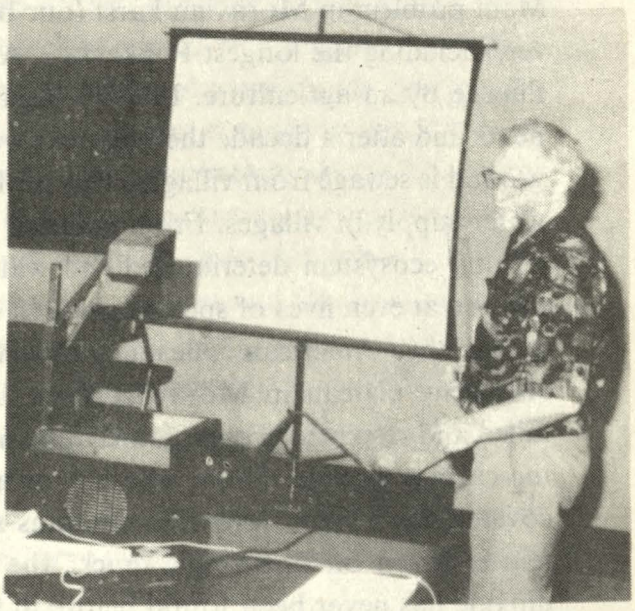
Air pollution affecting acidification, excessive use of chemicals, influence of agriculture, settlements – waste, water pollution bad managed tourism and recreation, mining belong to main threats of protected karst and pseudokarst areas. Forests threatened by imissions are mainly in PLA Broumov Region, Kokorin Region and Elbe Sandstone (mainly spruce and pine forests). Effects of acid rains on karst and pseudokarst aren't known yet. Pseudokarst phenomena, which are in our pseudokarst areas on Cretaceous sandstones, are under a strong influence of acid rains. Strong corrosion and gypsum crusts were described from those areas. Czech Institute for Nature Conservation for example now solves a problem of jeopardizing of Pravcicka gate, made in Turonian sandstones in PLA Elbe Sandstones. The gate is a very famous phenomena, 25m wide and 21m high. Problem of a threat is a corrosion on fissures. Crusts on the surface are there too. Main problem in Moravian karst (our best developed karst area with more then 1000 caves, including the longest Punkevni – Amaterska Cave, 30km) is water pollution and influence by an agriculture. In 1970 began a quick increase of a content of nitric components and after a decade their content was ten times higher. Other problem for the underground is sewage from villages. This problem becomes more serious with a construction of water supply in villages. From polluted water speleothems is being destroyed, the underground ecosystem deteriorated and water resources damaged. Bad managed agriculture can threat even lives of speleologists. In summer of 1989 the amateur speleologists together with their American colleagues undertook an excursion into a cave under one doline on Harbechy plateau in Moravian karst. Already in the depth of 25m the carbide lamps failed and respiratory complaints appeared. The reason was an increased concentration of the carbon dioxide. From where it resulted remained unclear. The cave system was discovered some years before. It contains shafts and inclined corridors 100m deep. The system is based on one single crack, the hollows also having a crack character. Carbon dioxide has never been found before in this caves. During the excursion mentioned above measurements shew 14% of CO_2 in the depth of 50 metres. With the help of the radoicarbon method it was proved that the CO_2 in the cave was a recent one. Thus even its origin was discovered. The source was a manipulation deposit of manure in a field approximally 200m from the doline, exactly in the place of the dislocation on which the cave is based. (J. OTAVA : CO_2 in caves. Speleoforum 90, Brno 1990).

Sustainable tourism – our objective

In present political and economic situation the Czech Republic is visited by 55 milion people in a year. But our karst and pseudokarst areas are still little used for tourism, though their high nature values and countryside attractivity. Our twelve show caves were visited by 752 350 visitors in 1992 (the most visited cave is traditionally Punkevni Cave in

the Moravian karst, with 252 780 visitors in 1992). Sustainable tourism (or ecotourism) is our objective for this areas. We must support development of environmentally friendly use of resources. The key concept determining the admissible limits are sustainable form of tourism and carrying capacity. Income from tourism may help for sustainable development of this protected areas and life of local people.

One step for more friendly tourism was for example made this year by excluding transport (cars, buses) from deep canyon like valleys in Moravian karst with four tourist caves and high number of visitors. Now there is a special machine for public transport, which excluded emissions from that valuable part of nature. Some reconstructions of hotels and services in main centres are on the way. Villages (with nature and sights attractions) and administrations of protected area are not involved in that process. But for solving of this problem a complex plan is necessary, made with collaboration of managers of protected areas local authorities, tourist agencies, decision makers of the state administrations, private sectors and of course banks – for supporting of long term development of a project for sustainable tourism.



At the Scientific Sessions room

Paleokarsts at the Permian-Triassic boundary in Southeast Asia. An introduction.

Claude Mouret[1]

Abstract: Paleokarst surface morphologies at the Permian-Triassic boundary and related underground fills have been observed in a number of countries in Southeast Asia. The main sites are here described and interpreted. Their old age is proved by stratigraphic relations and a high diagenetic evolution. Collapse breccias are common: they may be syn-karst and/or partly related to overload during burial and cqllapse of void vaults.

Paleokarsts formed in Permian carbonates and were onlapped by various Mesozoic silici-clastics. Their wide present extension in SE Asia does not correspond to a single carbonate area at the deposition time. A number a terranes, mostly rifted off from Gondwana and drifting northward, had each their own carbonate platform or system of platforms. They subsequently collided each other. The relative timing of collision and karstification cannot be ascertained, due to a lack of accurate enough geological data in SE Asia. The karst mainly formed in the most tectonized areas.

Warm climate and long emersion periods (up to 40-45 MA) boosted the karst evolution, up to well evolved stages such as tower karst.

The well-developed Permo-Triassic karst morphology mainly explains the modern one, apparently well evolved where carbonates are just being removed from their silici-clastic cover: it is an inherited morphology. It may also partly explain the limited underground development of modern karst in many areas in Thailand, due to the lack of huge enough remaining carbonate massifs.

The economic interest of the Permo-Triassic paleokarsts, in 1993, is still limited to buried karst hills, which can be a target for hydrocarbon exploration. So far known producing karsts did not form in that time period.

1. Introduction

The Latest Permian-Triassic period is a major erosion-non deposition period in North Central Thailand and Central Laos. There, in 1991, the author observed buried karst paleo-morphologies. The karstified Permian carbonates are usually onlapped by Late Triassic to Liassic fluvial silici-clastics. A variety of further field observations was also performed in other places in Thailand.

Additional information from literature, concerning Thailand (BAIRD, 1992; DOROBEK, 1992), Kampuchea (FONTAINE, 1964), Vietnam (DEPRAT, 1917; FONTAINE and WORKMAN 1978) and China (REINHARDT, 1988) indicates that the karst formation may have had a wide extension in Southeast Asia.

1. TOTAL KHORAT LTD, 20th Floor, BB Building, 54 Asoke Road, Sukhumvit 21, 10110 Bangkok, THAILAND

Interesting indications are provided by the characteristics of the unconformity PTU) which exists in a wide part of Southeast Asia at (or near) the Permo-Triassic boundary (PTB): distribution, angularity, time gap, type of sediments below and above the unconformity, amount of erosion involved.

A major difficulty encountered in reconstructing regional karst distribution results from the complicate geological configuration of Southeast Asia at that time, as there was no single continuous land (Fig. 8). Available geological data are often questionable and even conflicting.

This paper will present the paleokarst evidences and characteristics in Southeast Asia, the general geological setting of the area at the Permo-Triassic times, the factors of karst formation and some consequences on modern karst evolution.

2. Paleokarsts in Thailand

21. Late Permian - end Triassic paleokarst in Loei area, North Central Thailand

Hills of Permian carbonate buried below Mesozoic sediments are clearly demonstrated in Loei area (Fig. 1).

- Paleo-tower karst at Ban Suan Hom

The karstified Permian platform carbonate forms a protruding paleorelief surrounded by onlapping Lower Nam Phong Formation of the Khorat Group (Fig. 2). The Permian carbonate at the contact is likely Kubergandian to Murgabian. The Lower Nam Phong Formation is Rhaetian from regional knowledge (CHONGLAKMANI and SATTAYARAK, 1978; MARANATE and VELLA, 1986; MOURET and others, 1993). Therefore the apparent time gap corresponding to the unconformity is ca 50 MA long, i.e. from ca 265 to 215 MA.

The Lower Nam Phong sediments are mostly fluvial, red-coloured, sand-supported conglomerates rich in rounded to subrounded pebbles of volcanic rocks and sandstones. They are organized in fining up units with erosive bases and trough cross-bedding.

Structural corrections show that the protruding carbonate hills may reach a paleo-height up to 50 m and even 150 m. As the walls of these hills are often steep to subvertical, a buried paleo-tower karst is clearly evidenced.

- **Paleo-tower karst at Nam Som**

At Nam Som (Fig. 1), isolated carbonate (Sakmarian to Artinskian) tower-karst hills are organized along three main NNW-SSE subparallel trends. At the ground surface, they are clearly surrounded by red deposits, which have been interpreted as Triassic volcanics and silici-clastics by CHAIRANGSEE and others (1990). The stratigraphic gap is greater than 25 MA.

The size of the hills around Nam Som is variable: 500 to 600 m in width and up to 100 m in height. More to the SE, some are larger, elongated and rectilinear, which indicates a fault control.

Fig. 1 TECTONIC PLATES, LATE PERMIAN – TRIASSIC UNCONFORMITY AND RELATED PALEOKARSTS IN SOUTH – EAST ASIA

(BASED ON DATA FROM BAIRD 92, CARIDROIT AND OTHERS 93, CHARANGSEE AND OTHERS (1990), CHONGLAKMANI & SATTAYARAK 78, DEPRAT 17, FONTAINE AND OTHERS 93, HAHN 84, HELMCKE 82, HUTCHISON 89, METCALFE 1989, MOHD SHAFEEA BIN LEMAN 93, PHAN CU TIEN 90, RIDD 78, WAN AND ZHU 91 AND FROM THE AUTHOR.)

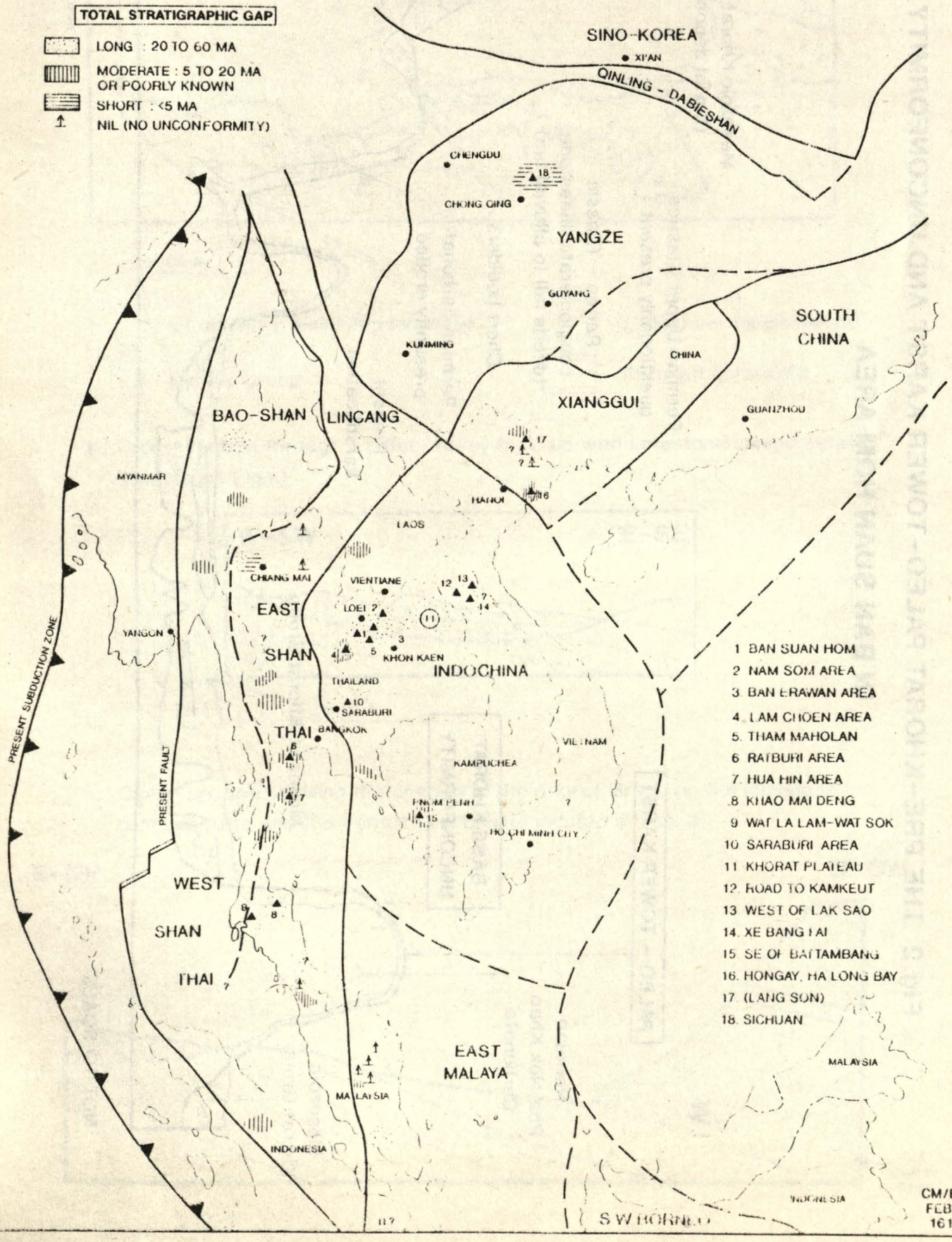


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Fig.2 THE PRE-KHORAT PALEO-TOWER KARST AND UNCONFORMITY IN BAN SUAN HOM AREA

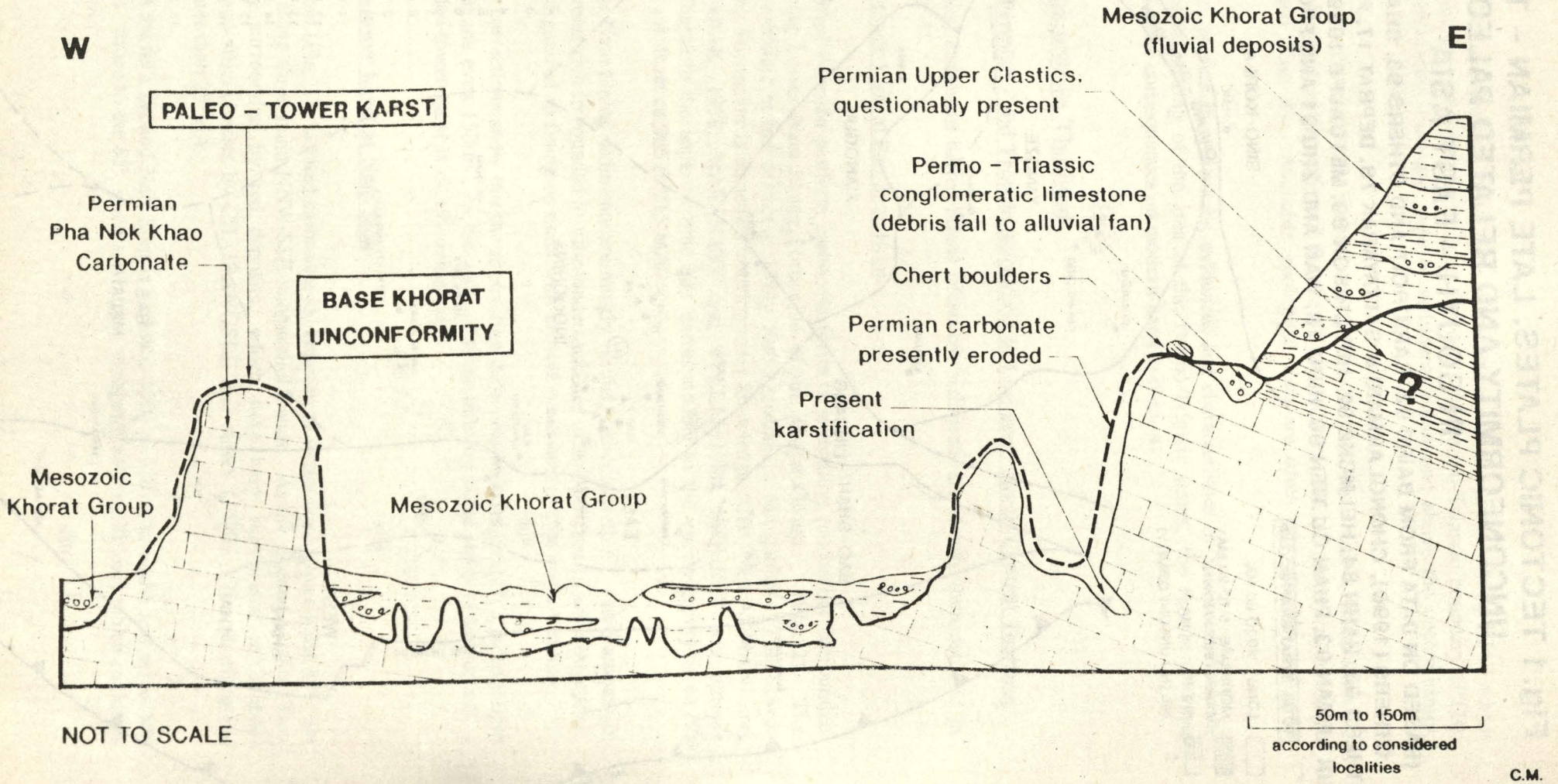
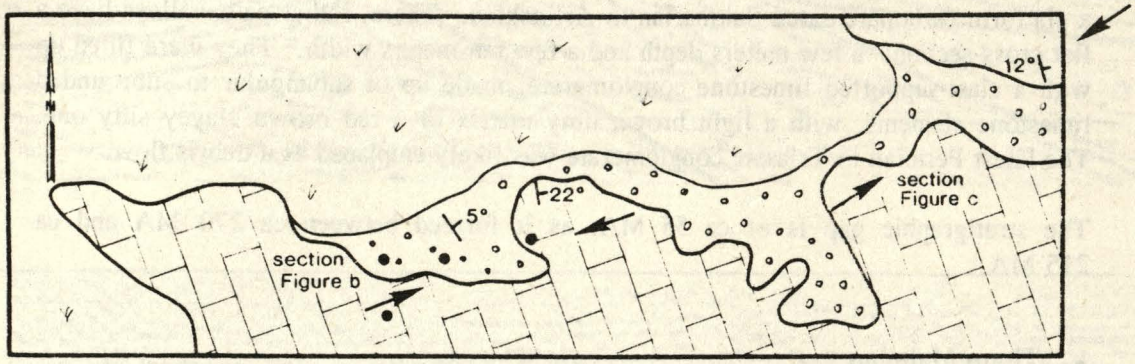


Fig. 3 AREA TO THE NW OF BAN ERAWAN

(VERTICAL SCALE EXAGGERATED)

a. Sketch map showing paleo-valleys on the Permian limestone filled up by limestone conglomerate



≃ 200 m

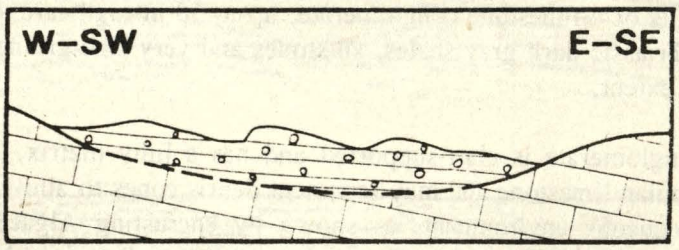
Quaternary alluvium (swampy)

Limestone conglomerate

Khorat Group

Permian carbonate

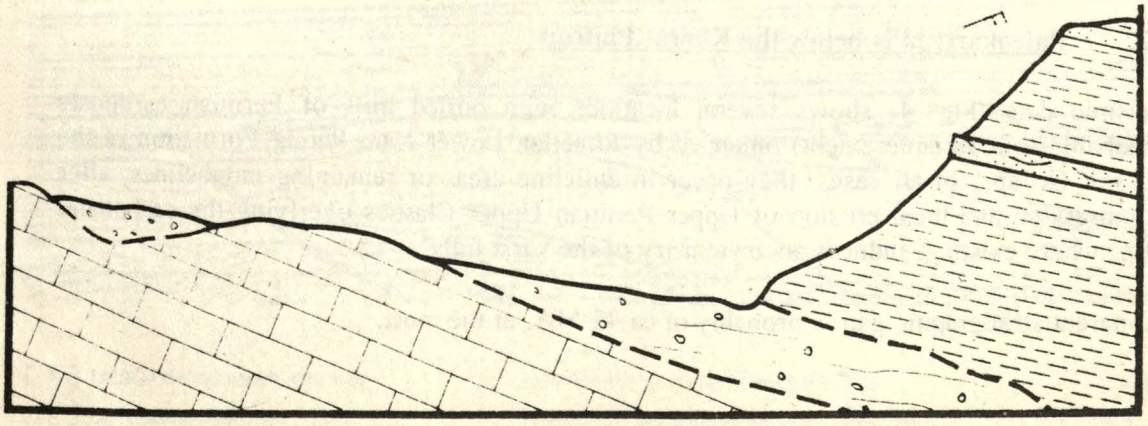
b. Cross-section through a paleo-valley filled up with limestone conglomerate (located on Fig.a)



≃ 100 m

c. Cross-section showing the contact of the Khorat Group on the limestone conglomerate and the Permian carbonate located on Fig. a

E-NE W-SW



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≃ 100 m

- **Paleokarst to the NW of Ban Erawan**

A low elevation several kilometers wide outcrop (Fig. 3) to the NW of Ban Erawan shows the Rhaetian Upper Nam Phong Formation onlapping buried low rolling hills of a platform carbonate dated Sakmarian to Artinskian. There, radial paleovalleys have a flat cross-section: a few meters depth and a few ten meters width. They were filled up with a clast-supported limestone conglomerate, made up of subangular to subrounded limestone elements, with a light brown limy matrix or a red brown clayey silty one. The latest Permian to Triassic conglomerate was likely emplaced as a debris flow.

The stratigraphic gap is of ca 55 MA, as it formed between ca 270 MA and ca 215 MA.

- **Tham Maholan**

Paleokarst breccias filling pockets or opened fractures have the same compaction that the bearing Permian limestone. Karst fractures filled up with red calcite are displaced by horizontal thrust planes and compaction-related stylolytes, which shows the old age of karstification. Limestone breccias along fractures have a fine sandy clayey matrix, while others have a dominantly limy matrix (similar fact to Ratburi-Hua Hin area, Paragraph 25).

- **Paleokarst in Lam Choen area**

Possible buried hills of a limestone conglomerate, up to 50 m high, are surrounded by lacustrine Upper Triassic dark grey shales, siltstones and very fine-grained sandstones, limy to a variable extent.

The limestone conglomerate is clast-supported and has a limy matrix. It is derived from adjacent Permian limestone and may represent debris cones to alluvial fans, partly deposited in an aqueous environment, as shown by encrusting Algae around some elements. It necessarily formed after the erosion of Upper Permian, Upper Clastics cover (Fig. 5) in the Uppermost Permian to (?) pre-Upper Triassic times, before the deposition of the lacustrine beds.

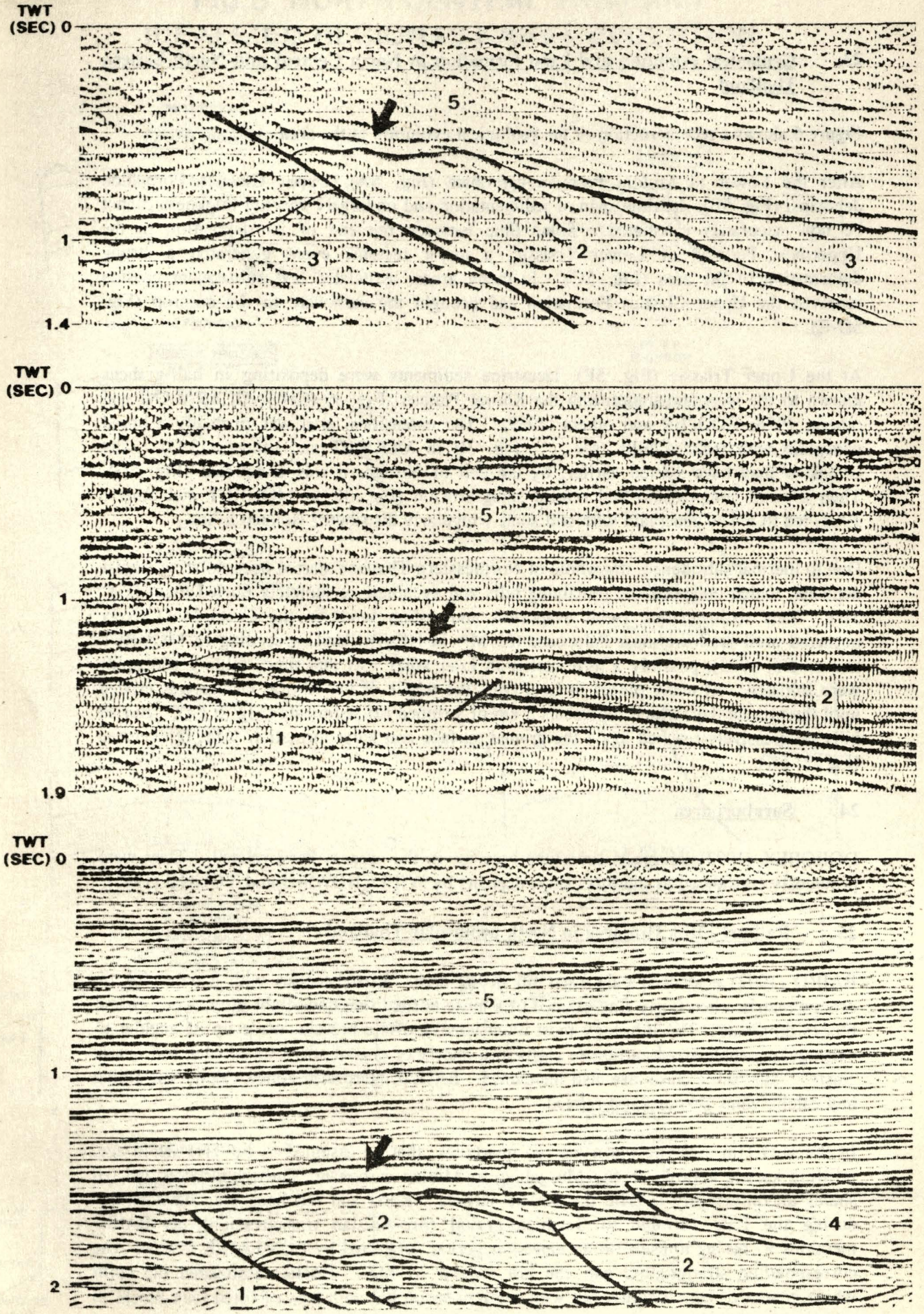
Though the contact between the two lithologies is complex and disturbed by minor faults, vertical Upper Triassic beds along the conglomerate are interpreted as a draping (compaction effect) around older hills. This requires that the limestone conglomerate was sufficiently lithified for forming protruding hills.

22. Paleokarst hills below the Khorat Plateau

Seismic data (Fig. 4) shows several locations with buried hills of Permian carbonate (probable to a variable extent) onlapped by Rhaetian Lower Nam Phong Formation of the Khorat Group. In all cases, they occur in anticline areas or remaining monoclines, after compression and local erosion of Upper Permian Upper Clastics overlying the carbonate. Dip, where existing, induces an asymmetry of the karst hills.

Apparent stratigraphic gap is probably of ca 45 MA, at the most.

FIG.4 EXAMPLES OF PROBABLE BURIED PALEOKARSTS BELOW THE KHORAT PLATEAU



23. Geological evolution and karst formation in North Central and North-Eastern Thailand

Figure 5 shows a reconstruction of the geological evolution in the area.

After the Lower to Middle Permian carbonate (Fig. 5A), Upper Clastics Formation deposited (Fig. 5B). Its time span of sedimentation and its largely varying thickness cannot be now accurately calculated. Some time between the end of its deposition in the Uppermost Permian or Lower Triassic, a major tectonic event generated a strong deformation of the area (Fig. 5C). In many areas, associated and subsequent erosion removed the Upper Clastics Formation and brought the carbonate to the outcrop (Fig. 5D-E).

At the Upper Triassic (Fig. 5F), lacustrine sediments were depositing in half-grabens known to the west and underneath the Khorat Plateau (Fig. 1) (CHONGLAKMANI and others, 1978; COOPER and others, 1989). The extensional area was probably a broad peneplain with isolated hills (see Fig. 3B in MOURET and others, 1993). The extension may have started earlier; by the end of Norian, it was completed (Fig. 5G). Then a small compression and related short erosion (Fig. 3C in MOURET and others, 1993) led to a new peneplain with still some irregularly distributed isolated hills.

Due to thermal subsidence, the whole of Northeastern Thailand started accumulating fluvial deposits, which onlapped the remaining hills and eventually completely buried them (Fig. 5H). This sedimentation (with evaporites and eolian sands in the Cretaceous) likely occurred until the lowermost Paleocene (65 MA in NE Thailand, according to MOURET and others, 1993), possibly a little earlier in Loei area). At that time, folding and uplift were initiated. At many places in Loei area, the whole of the Khorat Group was eroded until the present day, which represents 5 km of stripped off sediments (Fig. 5 I-J). Buried hills progressively reached again the ground surface and karst formation went rejuvenated (Fig. 2; 5K).

24. Saraburi area

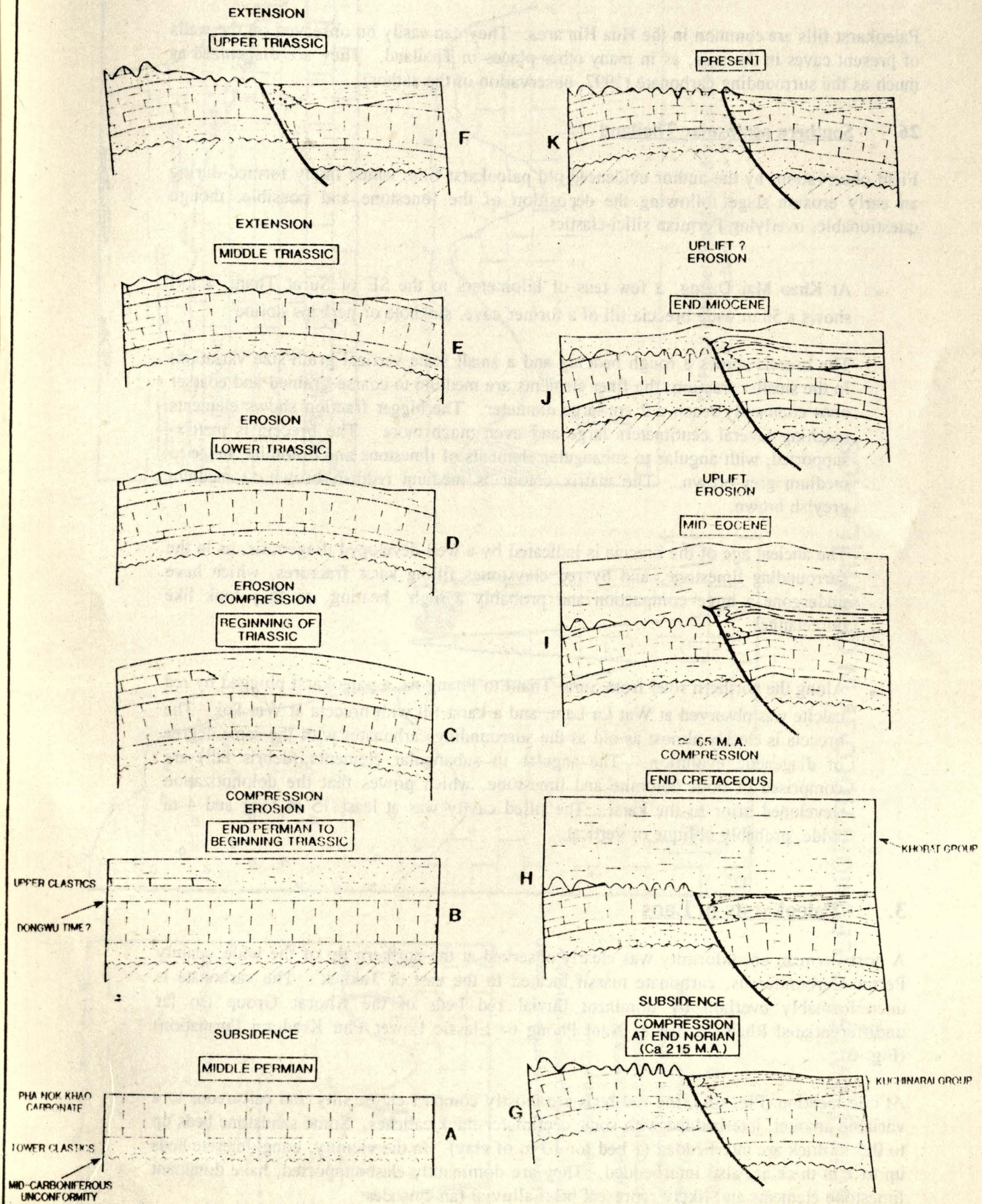
DOROBEK (1992) interprets limestone breccias in the area as karst-related. They were previously considered as platform slope deposits by WIELCHOWSKI and YOUNG (1985).

25. Ratburi - Hua Hin area in North peninsular Thailand

BAIRD (1992) evidenced paleokarst fill in the area: "karst breccias with a pale pink or orange matrix when fairly fine-grained or a more normal limestone light grey, when coarse blocks dominate. The lithology most often identified is a breccia, made up of angular to subangular pebble-sized carbonate clasts in a matrix of crystal silt, iron oxydes and quartz clasts". Sandstone clasts are also mentioned. BAIRD interpreted zoned calcite vug-filling and calcite veins also as karst-related.

In the Hua Hin area, he observed red quartzites, that he assumed to be Triassic in age, infilling karstic hollows in the Murgabian to Midian carbonate. These quartzites and red shales unconformably overlie the karstic surface. Karst and red beds may have formed during the Late Permian to Scythian period (pre-Anisian transgression), as BAIRD mentions it, basing himself on an emersion period suggested by FONTAINE (1986). The corresponding stratigraphic gap can last around 15 MA. BAIRD associated the uplift which generated karstification not with a compression but with tops of tilted fault-blocks in an extensional regime.

Fig.5 NORTH CENTRAL THAILAND
IDEALIZED REGIONAL KARST EVOLUTION



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Paleokarst fills are common in the Hua Hin area. They can easily be observed on the walls of present caves in the area, as in many other places in Thailand. They are diagenized as much as the surrounding carbonate (1992, observation of the author).

26. Southern peninsular Thailand

Field observations by the author evidenced old paleokarst fills, which likely formed during an early erosion stage following the deposition of the limestone and possible, though questionable, overlying Permian silici-clastics.

- At Khao Mai Daeng, a few tens of kilometers to the SE of Surat Thani, a hill shows a 50 m wide breccia fill of a former cave, sinkhole or perhaps doline.

  The breccia shows a rough bedding and a small scale vertical grain-size variation. In the smaller fraction, the finer elements are medium to coarse-grained and coarser ones commonly reach a 2 cm large diameter. The bigger fraction shows elements reaching several centimeters large and even much more. The breccia is matrix-supported, with angular to subangular elements of limestone and dolomite, beige to medium grey-brown. The matrix colour is medium reddish brown to medium greyish brown.

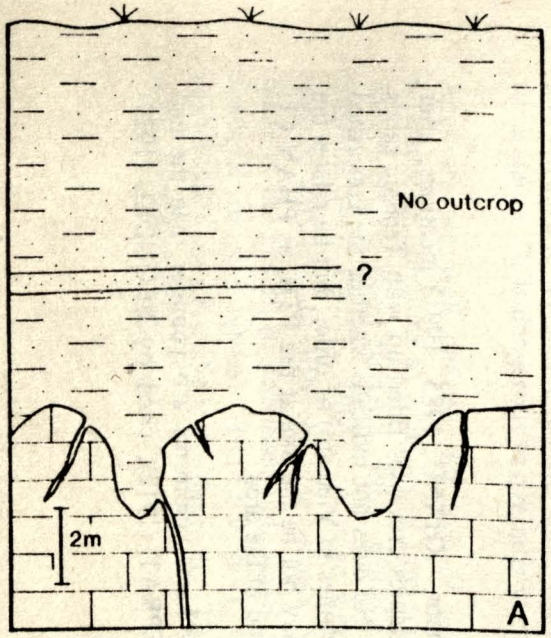
  The ancient age of the breccia is indicated by a well-developed diagenesis, as in the surrounding limestone, and by red claystones filling karst fractures, which have undergone a huge compaction and probably a high heating, as they look like porcelanites.

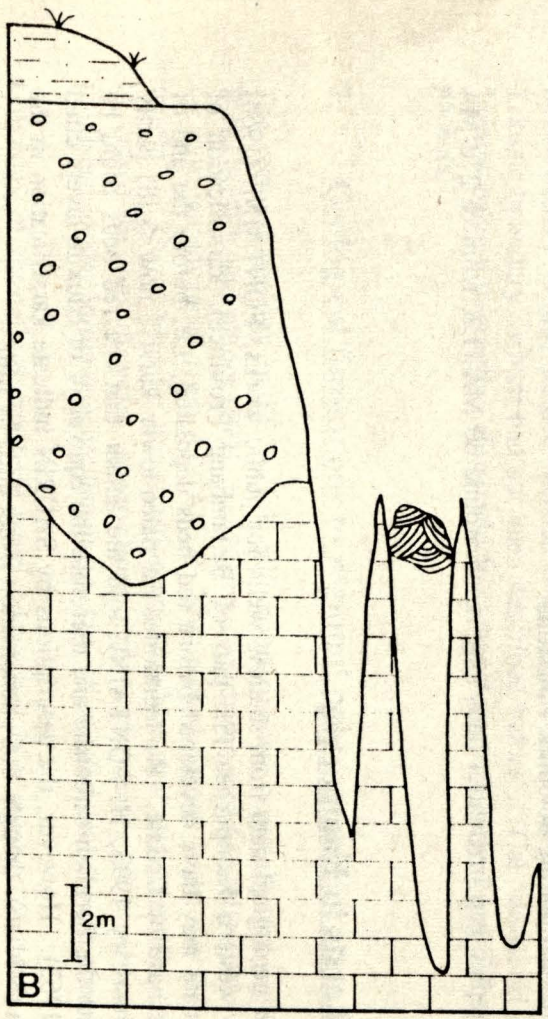
- Along the northern road from Surat Thani to Phang-na, a paleokarst plugged by red calcite was observed at Wat La Lam, and a karst fill with breccia at Wat Sok. The breccia is clearly almost as old as the surrounding carbonate, with the same degree of diagenetic evolution. The angular to subangular elements (debris fall) are comprised of both dolomite and limestone, which proves that the dolomitization developed prior to the karst. The filled cavity was at least 15 m long and 4 m wide, probably oblique or vertical.

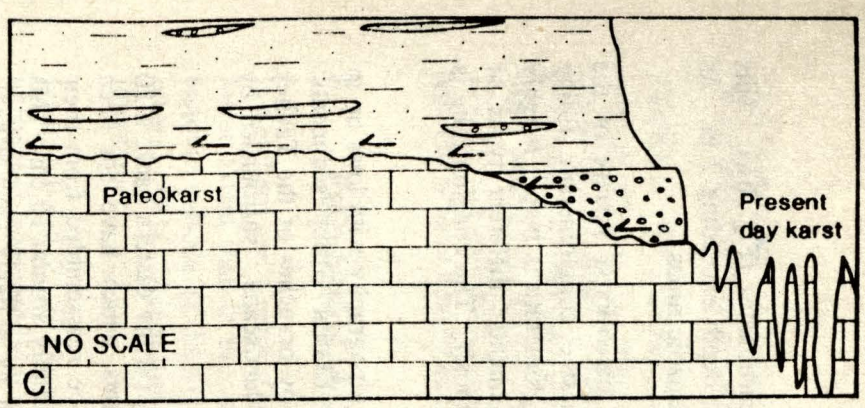
3. Paleokarsts in Laos

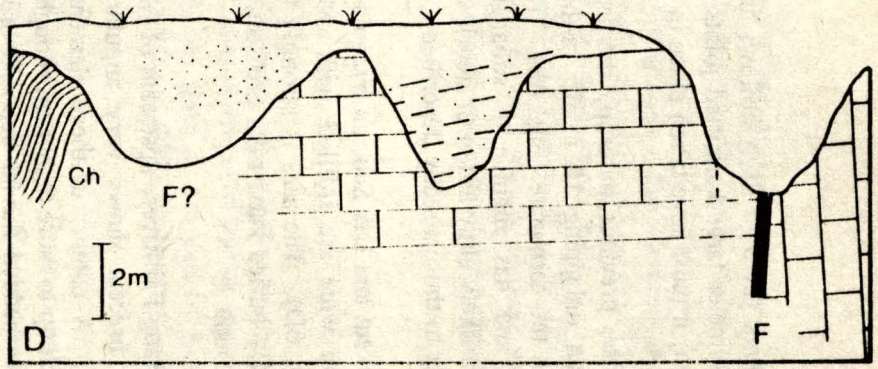
A post-Permian unconformity was clearly observed at the northern tip of the wide, mainly Permo-Carboniferous, carbonate massif located to the east of Takhek. The carbonate is unconformably overlain by dominant fluvial red beds of the Khorat Group (so far undifferentiated Rhaetian Lower Nam Phong to Liassic Lower Phu Kradung Formation) (Fig. 6).

At one location (Fig. 6A), the red beds are mostly compact clays, silty and calcareous to a variable amount, interbedded with some centimeter-thick caliches. Some sandstone beds up to 0.5 m thick are interbedded (1 bed for 10 m of clay). In the vicinity, conglomerate beds up to 1 m thick are also interbedded. They are dominantly clast-supported, have dominant limestone elements and likely represent brief alluvial fan episodes.









A,B,C : Road Ban Nakhda–Kamkeut : onlap and infill of karst paleomorphology

A : by red beds (Khorat Group)

B : by massive conglomerate (Present pinnacles have trapped sandstone bowls by gravity-low speed process)

C : synthesis of A and B

D. Road between Kamkeut and Lak Sao as A. Ch = chert beds; F = fault

FIG.6 BURIED KARST PALEOMORPHOLOGY IN CENTRAL LAOS

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These silici-clastic sediments fill 3 m deep hollows in the carbonates (Fig. 6A). Silts penetrated one to two centimeter large karstified joints, over a depth exceeding 2 m. As this silt infill looks compact, it must have taken place in the Mesozoic times.

About a kilometer from the previous outcrop, the irregular paleo-karst surface of the carbonate is proved by an onlapping 10 to 15 m-thick massive conglomerate, filling several-meter deep gulfs in the carbonate (Fig. 6B). The conglomerate is beige, roughly bedded, matrix-supported and has angular to subangular elements: different types of limestone and chert. It is a likely alluvial fan or debris cone deposit. The conglomerate is overlain by red beds similar to those already described.

Further east, between Kamkeut and Lak Sao, an irregular karst topography with lows up to 6 m deep and 5 to 10 m wide are infilled with overlying Khorat Group sediments: sandstones and shales (Fig. 6D). The area is strongly faulted by branches of the Takhek wrench fault system. Likely buried karst hills are seen in the landscape, surrounded by sediments of the Khorat Group.

In the gorges of the (Xe) Bang Fai River, upstream of Mahaxai, on the eastern bank, a 20 m wide outcrop of karst breccia shows very angular elements which have not been transported at all (Fig. 7). A number of these elements can be reassembled from their shape. Their size may reach up to more than 1 m, though it is usually around 10 cm. This rock fall deposit shows interbedded fluvial deposits brought in by a likely cave stream. Fibrous sparitic calcite is the common binder of the elements. The diagenetic evolution is as high as in the surrounding dolomitic limestone.

Overall stratigraphic gap in Central Laos may reach around 60 MA, i.e. from ca 270 MA to ca 210 MA.

4. Paleokarsts in Kampuchea

On the basis of geological data from shallow wells for public works, FONTAINE (1964) wrote that, in western Kampuchea (SE part of Battambang Province), karstification of Permian carbonate may have developed before red beds deposited, i.e. before the end of Triassic or the base of Liassic. He mentioned "a paleo-tower karst", now (still) partly buried. In February 1993, H. FONTAINE told the author that the red beds could be interbedded with the Permian carbonate and therefore the equivalent of bauxite layers cited by SAURIN (1963). However, the descriptions by SAURIN indicate karstification in the Upper Permian (Midian), though this phenomenon is not cited by him.

5. Paleokarsts in Vietnam

Little is known todate on paleokarsts in Vietnam. KHANG (1985, 1991) mentions, after MY and others (1976), the existence of paleo-lapies crevasses filled up with Triassic sands in the Lang Son area (NE Vietnam, Fig. 1)). He does not indicate whether the concerned limestones are Middle Triassic (youngest limestones in Vietnam) or older, but he relates the karst to a major tectonic phase. This phase may not be the one at the PTB, as PHAN CU TIEN (1990) places no unconformity at that time in the area.

KHANG (1985, 1991) wrote that present-day karst landforms are younger than the end Mesozoic-Paleogene peneplain. However DEPRAT (1912), cited by BLONDEL (1929)

used to consider that the tower karst of the Along Bay in NE Vietnam (Fig. 1) formed after the Permian and was onlapped by younger series such as Triassic beds.

DEPRAT (1917) wrote: "At the Along Bay, a post-Permian and ante-Rhaetian topography is being dug out .... Rhaetian deposits filled up the lows of a limestone area deeply carved out by erosion [but] ... present currents now erode them.... I could survey a number of geological sections giving room to no possible doubt". BLONDEL (1929) did not support these writings by DEPRAT, but his reasons may have been not geological (ROUTHIER, 1991). Nevertheless, DEPRAT's observations should be checked, 76 years later, as they apparently have never been since.

6. Paleokarsts in China

In Southern and Central China, paleokarsts developed at the end of Permian, but to a much lower extent than at the end of Lower Permian (Chinese time-scale), after the "*Dongwu*" tectonic episode (ZHANG, 1989) and than at the end of Lower Triassic (MAIRE and others, 1991). According to ZHANG (p. 307), the end- Permian karst is only "of local importance".

DEPRAT (1912, 1917) evidenced a post-Lower Permian karst paleo-topography, being uncovered from overlying onlapping Upper Triassic Permian sandstones.

REINHARDT (1988) studied Sichuan (Fig. 1) and found an unconformity at the Permo-Triassic boundary "which had not been described before". The "erosional event" led to a "gentle paleo-topography, along which carbonates are locally karstified (dm-size karst pockets)".

7. Geological limitations to regional paleokarst interpretation

The regional geology of SE Asia is still poorly known, specially for pre-Jurassic times. BURCHFIEL and others (1991, p. 626) by comparison to ARGAND (1924) wrote: "how far have we advanced from ARGAND? The answer appears to be not as far as might be fought". The reasons for this situation are both historical and scientific: countries in war or closed for tens of years, observations in limited quantity or at different periods, or published locally in too specific languages, lack of correlations between countries, etc.

Lithology of formations has been poorly described in a number of cases. Depositional environments are not known well enough. Some authors did not determine them accurately and were led to misleading conclusions. HUTCHISON (1989) wrote about this matter that, for instance, "it is dangerous to overinterpret the term flysch from the older literature".

Ages are not well defined, for lack of age-diagnostic fossils, sometimes for lack of reference in literature to a published time-scale. Chinese geologists use a two fold scale convenient for them (CHAO, 1965) while a three fold scale is more and more used in Thailand (FONTAINE, 1986). A stage with a given name (Kubergandian for instance) may be attributed to different time periods by different authors. Reference should be made in the papers to published time-scales with biozones, radiometric ages and relative sea-level variation curves. The LEVEN (1981) time scale or, better, the ROSS and ROSS scale (1987) are advised for the Permian. The charts of B.U. HAQ and others (1987) are good time-references.

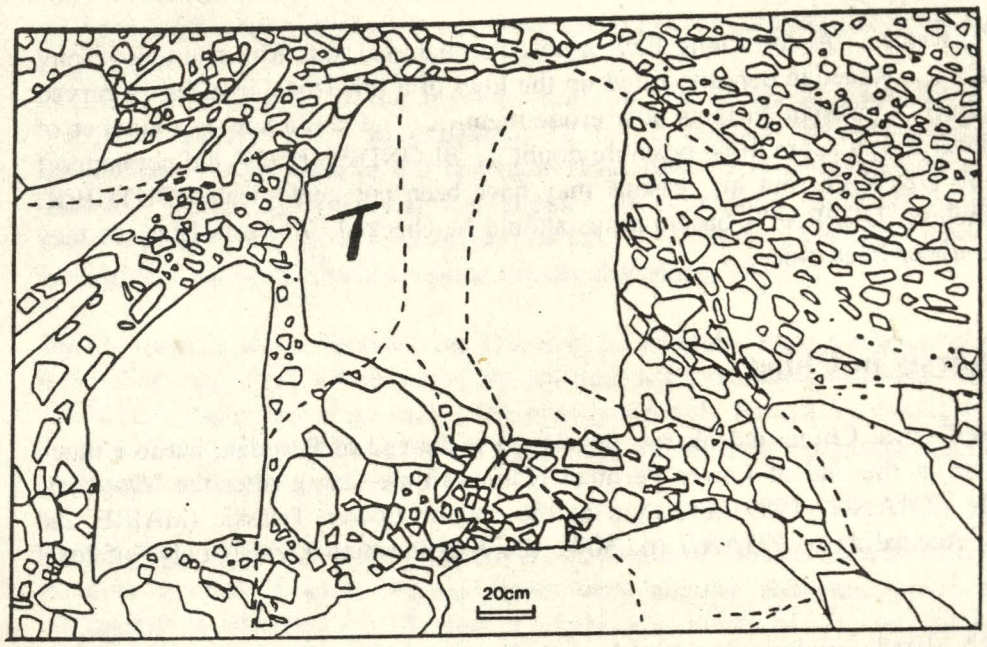

FIG.7 Karst breccia in Mahaxai area (LAOS)

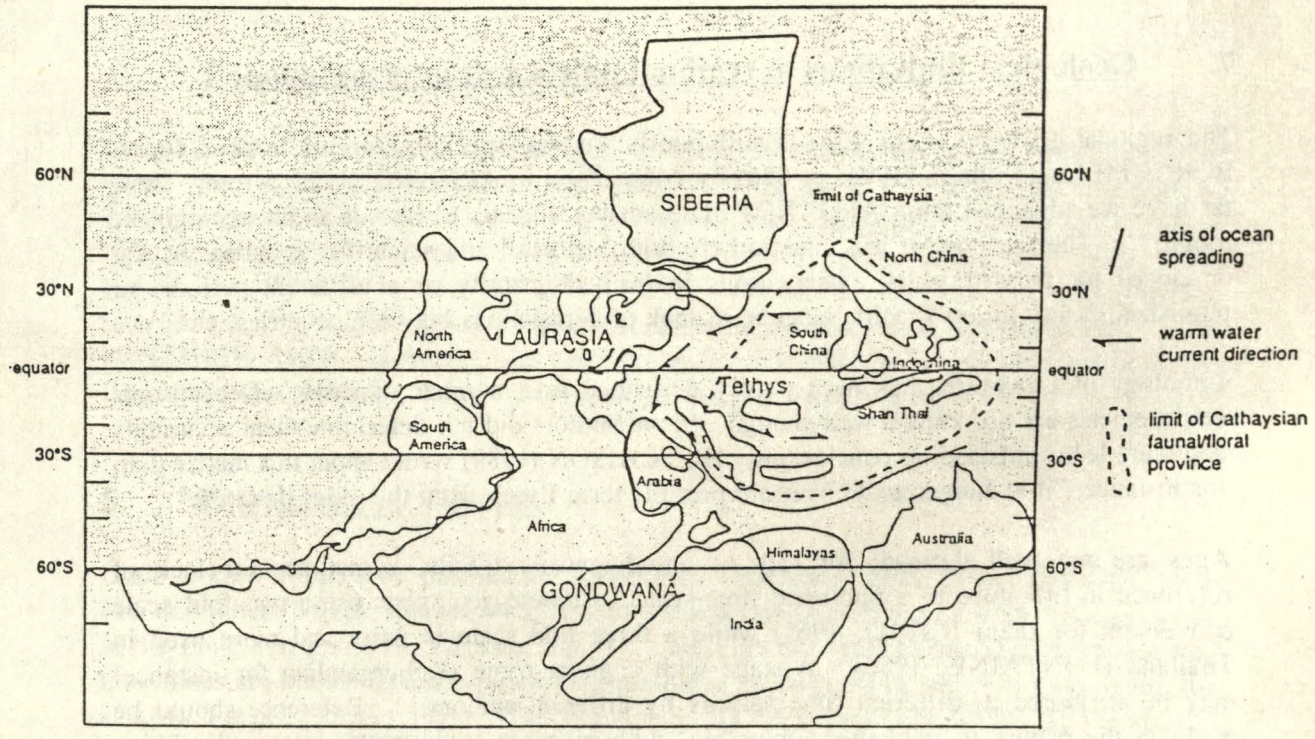

FIG.8 Late Permian Pangea, as compiled by BAIRD (1992)

There are often major discrepancies between authors, regarding the geological history. For instance, the main phase of the "Indosinian Orogeny" is attributed to all the geological periods from the Lower Paleozoic (LE THAC XINH, 1981) to the Early Norian (VU KHUC, 1991). What is the right one? Other example, the Indosinian Orogeny is accepted as the collision of the Indochina plate with plates now in South China (Fig. 1). However, some authors relate it to the collision of the Shan-Thai and Indochina plates.

In addition, the stratigraphic column widely differs in the different areas presented. In some of them, such as parts of North Central Thailand and of Central Laos, there is at the outcrop no sediment between the Rhaetian and the Upper or Middle Permian. To the contrary, in some other areas, there is only a hiatus or even a continuity (Fig. 1). In further areas, the Triassic stratigraphic column itself is splitted by further unconformities (North Vietnam for instance: PHAN CU TIEN, 1990; VU KHUC, 1990, 1991).

Tectonic types vary geographically. The unconformity (PTU) at the Permo-Triassic boundary (PTB) is attributed either to extensional block faulting as in NW Thailand (HAHN, 1984, specially, following BAUM and others, 1970), in SW Thailand (BAIRD, 1992) and in NE Thailand (KOZAR and others, 1992 who published a seismic line showing Upper to post-Upper Permian compression (p. 702)), or to compression (COOPER and others, 1989, and this paper, for the same NE Thailand). Moreover, according to WORKMAN (1975b), the intensity of folding varies regionally, so "there is no general agreement as to the time span of the regional Upper Paleozoic-Mesozoic movements and only a very general idea about the age and extent of unconformities in the stratigraphic succession".

8. Plate tectonics evolution and Late Permian-Early Triassic unconformity (PTU)

81 Plates tectonic evolution

The tectonic plates distribution in Southeast Asia at the end of Permian and during the Triassic is not sufficiently understood, but outlines are agreed upon.

The V-shaped Pangea, or Permian supercontinent (Fig. 8), had a branch in each hemispher (Laurasia to the north, Gondwana to the south). Between them was the Tethys ocean. Though the detail shape of the Pangea is still discussed, Figure 8 gives an overall view of it, acceptable for our topic. At the end of Permian, islands (wandering terranes) existed in the middle of the Tethys, though their true location is only approximately known.

Authors used to agree that all these terranes were rifted off from the Gondwana continent almost between the Silurian and the Permian, but they disagreed on the age of rifting. Terranes found more to the north (Fig. 8) had a higher chance to have been rifted off earlier. In February 1993, new results from a number of authors (CARIDROIT and others; FONTAINE and others; SENOWBARI-DARYAN and others; TOFKE and others) have demonstrated that Shan-Thai has to be splitted into at least two smaller terranes (called East and West Shan-Thai in this paper, Fig. 1) and that East Shan Thai shows laurasian fossils in Northern Thailand. If East Shan-Thai originates from Laurasia and Indochina from Gondwana, the plates tectonic setting is more complicated than expected. Further research is necessary to clarify this new problem, which has an impact on paleokarst understanding (paleoclimates).

The collision and amalgamation of all these terranes to form Southeast Asia is clearly admitted, but the age of the different sutures is the matter of significant discussions. Some authors, as TRAN and others (1979) even propose a collision, a reopening of the suture and a new collision.

Depending on the authors, the relative timing of different collisions vary. For example, the Indochina-South China plates collision occured before, or after the Shan-Thai-Indochina collision. The latter is usually considered as Triassic, mostly Middle to Late Triassic. However, earlier dates were published, specially the Middle Permian by HELMCKE (1982, 1984, 1986) or the very Late Permian by BAIRD (1992) and HARBURY and others (1990). Younger dates were given by AUDLEY-CHARLES (1983) HARBURY and others, 1990; BRISTOW, 1990).

The suturing periods between terranes in South China (WAN and others, 1991) occurred from the Early to the Late Triassic (Fig. 1). These authors conclude: "this is the fundamental consolidation stage in the area", which is in contrast with many opinions concerning the tip of SE Asia.

According to above mentioned facts, it is clear that no simple reconstruction of the distribution of Latest Permian to Triassic karsts can be made. Likely, a number of Permian carbonate platforms developed at more or less contemporaneous times, and were subsequently abandoned by the sea for different reasons, terranes collisions mainly, with enhancement of the emersion by main sea level falls.

82. Main Permian and Triassic unconformities in SE Asia

According to literature and field observations of the author, two main unconformities seem to exist on the East Shan-Thai and Indochina plates: a Latest Permian-Lowermost Triassic one (PTU) and a Late Norian-Rhaetian one (LTU). In some areas, such as Central Laos, Northern Central and Northeastern Thailand, parts of Malaysia, both can merge.

Another unconformity seems to exist in the Middle Permian (MPU). It would correspond to the compressive deformation described by HELMCKE (1984, 1986) in Northern Central Thailand and to this mentioned by PHAN CU TIEN (1990) in North Vietnam, with bauxites and breccias overlain by Late Permian marine limestone. It is widely recognized in South China as the Dongwu tectonic episode-related unconformity (with largely associated karst: ZHANG, 1989). The Dongwu event is post Maokou stage, i.e. post 260 MA. In Sichuan, bauxite and coal are reported along this unconformity (BARBARY and others, 1991), along with volcanics sealing paleokarst topography (ZHANG, 1989). In Kampuchea, SAURIN (1963) found shallow marine Murgabian-Midian bauxite.

83. The Late Permian-Early Triassic unconformity (PTU) in SE Asia

The degree of development of the unconformity, i.e. its angularity, the time gap involved and the related amount of erosion are major factors of karst evolution.

The major known area favorable to karst covers Central Laos, the Khorat Plateau subsurface and the Loei region (Fig. 1). There, long erosional-non depositional time gaps vary from 20 to 60 MA. They do not fully reflect the erosion period, as the erosion removes older series. Assuming the tectonic event generating the unconformity happened between 255 and 245 MA, then the maximum erosion period is 40 MA for North Central Thailand and the Khorat Plateau, and possibly more for Central Laos (40 to 45 M.A.?). In areas with Triassic half-grabens, this time was shorter: 25 MA?

Along the rest of West and East Shan Thai terranes, unconformity usually exists. The related time gap can be as long as in North Central Thailand, but is often shorter. In areas known for their tectonic extension from (?) Upper Permian to Triassic and even Liassic, such as Central Malaya (MOHD SHAFEEA BIN LEMAN, 1993), or the Lampang Basin to the east of Chiang Mai, Fig. 1 (FONTAINE, 1986; CHONGLAKMANI and others, 1993), sediments are commonly found in continuity, or with a minor hiatus. Around these areas, the unconformity can exist: on top of tilted blocks or in a different tectonic regime? The available information is usually not enough to solve the problem. BAIRD (1992) interpreted the Permian carbonates of the Ratburi - Hua Hin area as deposited under an extensional regime.

The PTU seems to be missing in Vietnam, Laos and Kampuchea, according to PHAN CU TIEN (1990), which is not in agreement with DEPRAT (1912, 1917) and our observations in Central Laos. Another unconformity near the Lower to Middle Triassic boundary seems well developed in a number of places in these countries.

In South China, the PTU is controversial. It has only a local importance, according to ZHANG (1989). REINHART (1988) mentions it as a discovery, but it is largely spread according to CHAO (1965). LIU and others (1988) mention shallow marine and intertidal Lower and Middle Triassic beds unconformably overlying Upper Permian strata, in southern Sichuan.

9. Factors of karst formation

91. Available time for karst evolution

Previous discussion evidenced that the true time gap related to the end Permian-Triassic Unconformity varies from zero or a short hiatus in extensional grabens, to 40 MA in North Central Thailand and below the Khorat Plateau and possibly even 45 in Central Laos.

This time span is considerable, as a few thousand years is largely sufficient for the onset of an efficient underground karst drainage and the formation of a young characteristic surface topography. Consequently, it is not surprising that well evolved karst morphology, such as a tower karst was reached there during the considered period.

92. Paleoclimate

The tectonic plate setting allows, together with indications from lithology and fossils, estimating paleotemperatures at the end-Permian-Triassic period. Figure 8 shows that Shan Thai, Sumatra, Indochina and South China all lay between latitudes of 15° S and 20° N, i.e. in the equivalent of the present intertropical zone. Indochina was under the Equator. In the METCALFE's plates reconstruction (1991), the latitudes are 5° S to 25° N, with Indochina slightly touching the equator, itself above East Malaya.

FONTAINE and others (1993) indicate a warm climate in East Shan Thai (corals...). On West and East Shan Thai, Indochina and South China plates, there are warm water carbonates (BAIRD, 1992) in a subtropical to tropical climate for Shan Thai (NIE and others, 1990; BAIRD, 1992), on the basis of floral, faunal and sedimentological criteria. The Middle Murgabian to Midian Ratburi Limestone deposited in water warmer than 15° C and possibly 18° C (BAIRD, 1992). Coral reefs are mentioned at the present 101° 30' longitude in Central Thailand by WIELCHOWSKY and YOUNG (1985). Coal seams interbedded with the Permian carbonates in Vietnam, Kampuchea, Laos, Thailand and

Malaysia and bauxitic deposits in Vietnam and Kampuchea are indicators of a humid and warm climate, according to FONTAINE (1986).

CHONGLAKMANI and others (1978) described Upper Triassic sediments typical of a warm climate. MOURET and others (1993) showed how the aridity increased during the Rhaetian, with no indication of significant temperature variation. Therefore all the karstification period remained warm and mostly wet.

93. Other factors

Factors of karstification other than time span and climate are related to lithology (purity of the carbonate, diagenetic evolution), tectonics (degree and orientation of fracturation), hydraulics (direction and intensity of the hydraulic gradient), general setting (topography, relation between hydraulic gradient direction and fracture direction). They all vary locally but were likely adequate, owing to tectonic deformation and related relief, out of the areas without unconformity (Fig. 1).

10. Conclusions

1. Wide gaps in the sedimentary record at the Permo-Triassic boundary indicate long erosion periods very favorable to karst formation. The maximum time gap (45 to 60 MA) is observed in North Central Thailand, Central Laos and below most of the Khorat Plateau. The related maximum erosion period is 40 to 45 MA.

2. The geographic distribution of the time gap is irregular. It is almost nil in most of the areas in extension (peninsular Malaysia, Northern Thailand), or limited, as in some parts of China such as Sichuan, where nearly continuous Permian-Triassic sections can be observed. In most of Vietnam, Laos and Kampuchea, it is not clearly evidenced, though paleokarst description was given as early as 1917. It is relatively developped in other areas: ca 15 MA in Ratburi area for example.

3. The karst evolution resulted in minor lapies (Sichuan), low rolling hills (North Central Thailand, Central Laos) or paleo-tower karst (North Central Thailand, ? Central Laos). Karst breccias are common as paleo-cavity fills in North Central and peninsular Thailand and in Central Laos. They are often associated with veins of pinkish to reddish calcite. The breccias partly formed during karst development but the breakdown of cave faults during burial can be a main factor for generating them.

4. The diagenetic and tectonic evolution of the karst fills is high: cementation, stylolytization, fracturation, compaction.

5. The burial of the paleo-karst morphology during the Mesozoic was followed by a strong Cenozoic erosion which resulted in a new exposure.

6. A part of present karst morphology is inherited from Permo-Triassic times. It explains well evolved karst morphology, where the Permian carbonate is just being exposed. It also explains the advanced stage of evolution, unfavorable to extensive modern underground karst development in many areas, specially in Thailand. However, where karst relief is large enough, modern karst commonly cuts through Permo-Triassic karst.

7. Permo-Triassic paleokarst is important to hydrocarbon exploration, perhaps as enhancing reservoir properties, surely in being related to irregular unconformity surface above the potential carbonate reservoirs.

ACKNOWLEDGEMENT

The author sincerely thanks TOTAL KHORAT LTD and THAI SHELL for allowing the publication of this paper.

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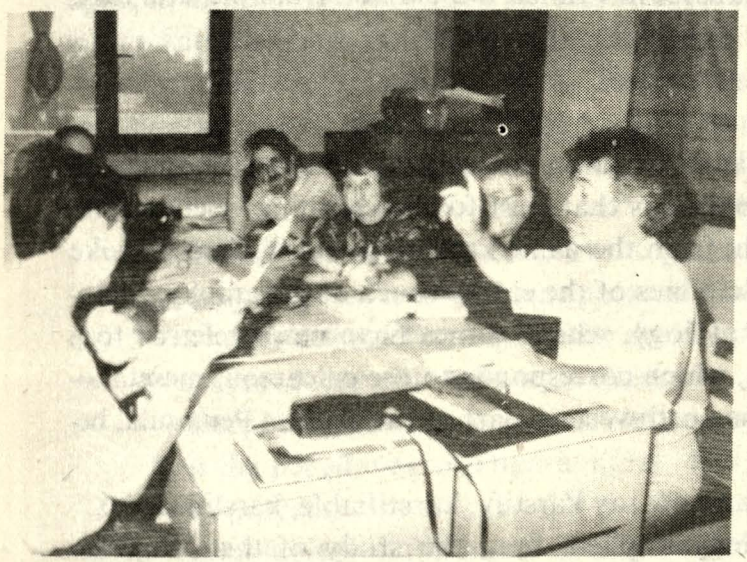

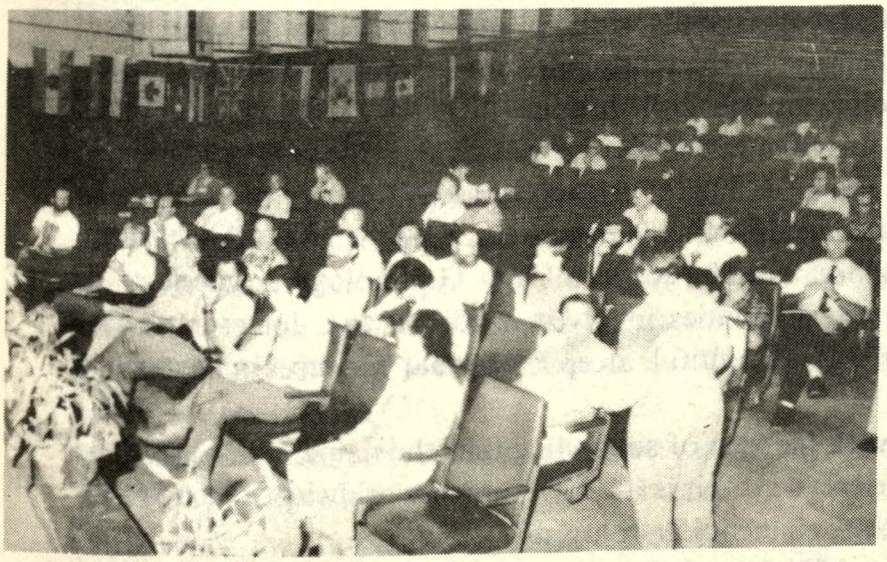

Above: Bureau Meeting
Below right: New President Paolo FORTI & Secretary – General pavel BOSAK of UIS.

Left: General Assembly of UIS

A CURRENT VIEW OF CARSOLOGY

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The scientific study of the calcareous regions in which chemical processes of dissolution occur is called karstology, a word formed of the elements karst, and logos, from the Greek. In turn, karst is the Germanic expression of the Slavic kras, which comes from the Celtic or pre–Celtic kars, which means stony desert and which comes from the Indo–European kar, which means hard stone – karst in its Italian form.

The root of these ancient words is found in the Greek chalis and the Latin calx, which gave rise to the Spanish cal – which, in turn, led to the forms caliza (limestone) and calcarea (calcareous). In English, the word is chalk.

The names of some regions in Europe that are famous for their calcareous territory pierced with caves and pits, such as the Causses in France, are derived from the latin calx, or Provencal caus.

A science with a regional name

The confusion about the concept of karst or carso, the existing doubts concerning its definition as a science and the different opinions that exist for establishing whether a region is karstic or not stem, in my opinion, from the name karstology itself, since it broke with a correct tradition of naming the disciplines of the earth – such as geography, geology, geomorphology, geophysics and climatology, whose names have never referred to a regional toponym, such as karst of carso, which corresponds to the calcareous meseta located in Slovenia, Croatia and Italy, in the northwestern part of the Balkan Peninsula, between Carniola and Istria.

Karst has come to be a verb, so we can now say karstify, karstifiable, karstified, etc.

The naming of this science karstology implied, first, the study of that Yugoslav meseta and, second the study of the other areas of the planet with these characteristics – which aren't easy to establish, because of the many different factors involved. To understand this better, consider the following. If, as the product of initial studies, instead of being born in the European karst this term had arisen in the Organos Mountains (Cuba), in the Cockpit (Jamaica), in the Guilin (China), in the Causses (France) or in Yucatan (Mexico) – to cite just five of the most famous karstic areas in the world – then that science might have been called organology, cockpitology, Guilinology, causselogy or yucatanology. This brings out the difficulties involved in identifying, for example, the plains morphology of Yucatan or the beautiful, steep cones that rise up like pagodas in the Guilin region.

I am not bringing this up with the idea of suggesting that the name of karstology be changed, for , in spite of its intrinsic defect, it is already known worldwide – though with considerable confusion by the more eminent karstologists.

All of this has made it more difficult to define what a karstic region really is, since no

description could satisfy all the regional characteristics of the very different forms of the polar, temperate and tropical karsts; the plains, mountainous or coastal karsts; or the karsts where soluble and insoluble rocks coexist on a regional basis.

Another example will serve to indicate the extent to which the confusion has reached : the Sierra de los Organos and its mogotes have sereved from the time of H.H. Meyerhoff and Herbert Lehmann up, through mine as a model of regions with karstic cones in the tropics – something which two other competent karstologists, Vladimir Panos and Otakar Stelcl, of Czechoslovakia, do not accept. The chaos is even greater, because efforts have been made to deny the karstic nature of areas which had been accepted as such. In addition, some famous karstologists don't agree that the most characteristic irregularities in the Dinaric Karst region itself, such as the poljes, are truly karstic. In this regard, remember that J. Roglic has said that, because those irregularities are the result of fluvial erosion rather than dissolution, he preferred to call poljes alien factors in the karst rather than karstic.[2]

On considering this topic, the noted English researcher Marjorie M. Sweeting said, " ... polje – type depressions develop horizontally instead of vertically as in doline development; this is a further reason for regarding poljes as basically non–karstic, since by definition karst drainage is vertical and underground."[3]

The authorized opinion of J. Roglic, expressed in his article "Les caracteres specifiques du karst dinarique" (The Specific Characteristics of Dinaric Karst), also questioned the classical concepts of karstology to some extents,

> The first scientific notions and general views on water circulation, and relief's evolution on soluble rocks, were gained in Dinaric karst. Afterwards, as the result of research in different parts of world, some popularized views are modified or abandoned. During the last decades also in Dinaric karst the new notions are acquired and old views were changed.
>
> Deepness of the karst ... in the large sequences (up to 5,000m.) of pure limestone is the peculiarity of Dinaric karst. The cyclic evolution of karst features cannot be proved.
>
> Lithological differences modify water circulation and influence the relief's moudling and, besides a deep karst in the coastal zone, there is a fluviokarstic belt on the continental side [...].
>
> Diversity of Dinaric karst results from lithological differences and climatic changes. Scientific research and technical works ... contribute mutually to a better notion of that classic karst.[4]

For their part, on studying the karst of the Mendip Hills, England, Researchers D.I. Smith and M.D. Newson, of the University of Bristol, suggested (1974) that the mechanical fluvial erosion was more important than dissolution in some karstic areas – something that the Yugoslav and German founders of karstology based on Dinaric Karst would never have considered.

In the introduction to this paper,I presented a very general difinition of karst. In fact, each author defines it in his own way, and there is no general agreement on its scope.

One of the most recent texts, called karst, by J.N.Jennings, a professor at the Australian National University, states

> Karst as defined in this book—namely as a type of landscape with distinctive landforms that arise primarily from abnormally high solubility of the bedrock – includes terrains in which processes such as mechanical action of rivers anf frost shattering have played significant, even dominant parts, though these processes are in no way special to karst. By employing such a definition, unrealistic standpoints are avoided such as that of Panos and Stelcl (1968) who excluded areas such as the Sierra de los Organos, Cuba, from karst, even though solution played a particularly great role in producing distinctive landscape there.[5]

In the '60s, after karstological studies were made in the tropics – especially in Java, Jamaica and Cuba – the European researchers themselves began to note the errors of mechanically transplanting the focuses of classical karstology of the Dinaric Karst to other parts of the world.

On referring to the difficulties encountered in applying the concepts originally acquired from Dinaric to tropical karst, H. Lehmann made this important observation,

> ... it is a misfortune that karstic research was initiated in the temperate latitudes, in which, if the karstic process wasn't interrupted during the periods of periglacial climate, it was surely strongly modified and also overlaid by other processes. Therefore, the forms that are found cannot be specific, "pure" in themselves – neither for the present climate nor for process of corrosion. Such "pure" morphologies can be found most certainly in the tropical karstic regions.[6]

Otakar Stelcl, with whom I made some studies in Cuba, stated in the introduction to Problems of the Speleological Research,

> In the last several decades convincing knowledge has been acquired about the decisive influence of the climate in the karstification process. From the point of view of these new investigations the older "classical" opinions based on the study of the Dinarian karst appear imperfect, as they cannot fully explain the manifoldness and great variability of the karst phenomena in different parts of the world.[7]

For his part, P. Fenelon defined karstology as "the study of karstic phenomena, especially the reliefs created in the calcareous massifs, in line with their structure and the diverse processes of erosion and corrosion to which they are subjected."[8]

L. Tell, of the Archives of Speleology in Norrkopin, Sweden, defined it in this manner

> In the literature karst signifies a limestone territory with fissures, dolines and other depressions, caves and swallows, with mainly subterranean waters – or in other words a typical erosional landscape but where the principal work of erosion has been corrosive.[9]

Another important contribution to present – day karstology was the emphasis placed not only on the chemical action of dissolution in karstification but also on that of the mechanical erosion in the genesis of caves and surface forms. In this regard, the monograph of D.I. Smith and M.D. Newson entitled "The Dynamics of Solutional and Mechanical Erosion in Limestone Catchments on the Mendip Hills, Somerset" and the one of G.H. Deike and W.B. White entitled "Sinuosity in Limestone Solution conduits"(1969) and of W.B. White and E.L. White entitled "Channel Hydraulics of Free Surface Streams in Ca-

ves"(1970) deserve special mention.

The foregoing is very important, as Smith and Newson affirm, for explaining the exclusive chemical action in the modeling of karstic landscapes. I would add that personal experience has shown that it is necessary to emphasize the corrosive, abrasive action of subterranean rivers, whose waters carry sand and smooth pebbles with which they beat against the calcareous massifs, as may be seen clearly in the systems of fluvial caves of the Sierra de los Organos. The same may be said of the surface rivers that flow through typical karstic areas — as, for example, the San Antonio River does between the Ariguanabo Lagoon and its ponor or sink–hole.

Marjorie M.Sweeting defines karstology in this way: "Karst geomorphology is the study of landforms in massive limestone regions but may also refer to similar landscape features developed on other soluble rocks."[10]

For his part, L. Tell stated

> In spite of the fact that many speleologists still keep the original meaning for the term of karst, more and more intensified international cave–research has forced acceptance of a wider sense of the term, and nowadays many students also agree upon the necessity of using the terms Parakarst and Pseudokarst for phenomena outside the limits of the classical conception. This was evident from discussions at the conference about terminology held in the Austrian town of Obertraun in the Autumn of 1971, arranged by the UIS.[11]

This is based on the change made by J. Cvijic, the founder of this science, between his original work[12]on karst and a later book[13]in which he created the concepts and terms of holokarst and merokarst.

Now, let us examine the meaning that Cvijic gives to his terms holokarst and merokarst. The former comes from the Greek holos, which means "whole, complete," and corresponds to a calcareous region where the karstification is total and developed on a very broad scale. Merokarst, from the Greek meros, merous, means "part." This is the imperfect, partial karst that doesn't possess all of the characteristics established by Cvijic for typical Dinaric Karst.

Others prefer the terms macrokarst and microkarst.

To the preceding terms, the Commission of Karstic Terminology of the International Union of Speleogy has succesfully introduced the term parakarst, or "similar to karst" — "a term originated in Italy, referring to the appearance of weakly developed karstic forms in badly karstifiable rocks."[14]Later, the concept of pseudokarst, or "landscape with forms similar to a karst, but developed in non–karstifiable, non–soluble rocks."[15]was coined.

Marjorie Sweeting stated,

> As P. Fenelon has said, though there are analogies between the forms of pseudokarst areas and those of karst limestones, real differences exist that "cannot be neglectad." Thus I agree with him when he says that "the classical karst, that is the karst of Cvijie and de Martonne, remains exclusively associated with limestones rich in $CaCO_3$."[16]

The expression pseudokarst is used to identify the irregularities generated by dissolution or other processes in noncalcareous rocks. J. Corbel (1975) prefers to use subkarst, which applies concretely to the forms of volcanic origin.

In Cuba, we have a magnificent example of "karst" in the peridotites of the Sierra de Moa, where I have studied dolines, small caves and karren modeled in that rock.[17]

Philosophically, I don't agree with the term pseudokarst, because there are no false processes in Nature. The term applied by Corbel isn't satisfactory, either, since the prefix "sub–" means "lower" or "below".

It may be more correct to speak of "karst in peridotite," "karst in ice." "karst in granite" and the like. While it is true that the concept of karst that is given in this way wasn't foreseen by the founders of this science, the combination of karst and a noncalcareous rock could indicate that these are similar but not equal phenomena.

By abandoning the single, classical term of karst and creating two types or phases of karst, Cvijic paved the way for other approaches and definitions and even for questioning the very bases of the science he hed founded, in which he had taken Dinaric Karst as a typical example.

The progress made in karstic investigations in the tropics has cast doubt on the use of Dinaric Karst—which had been considered classic previously — as a model. In this regard, Sweeting herself has written (1981) that the southern karst of China, with its 600,000 square–kilometer size, which makes it the largest in the world, may be taken as a base for a new model in karstic geomorphology, with the advantage that region has been studied and described for 2,000 years. My experience in the direct study of the Guilin karst reaffirms this criterion, as did my seeing Vietnamese karst in the Bay of Halon, which is the southern continuation of the Chinese karst.

I should also add that, in spite of the fact that Cuba has a land area of only 110,920 square kilometers aud 67,831 square kilomter of submerged insular shelf, it is doubtless one of the most important laboratories for karstological investigations, since it has one advantage that outweighs all others, even the Chinese one: it presents a considerable variety of kinds of karst, even though it evolved in a quite stable climate throughout the Pleistocene age. Among other kinds, in a large variety of limestone, the bare, covered, buried, fossil, reactivated and resuscitated are found, in addition to mountain, meseta, mesa, plains, plains, swampy and, above all, the very important submarine karst.

Because of the preceding, I decided to call mybook about Cubankarst Cuba calcarea (Calcareous Cuba) rather than Cuba carsologica (Karstological Cuba), since the former has a much broader meaning that makes it possible to go into any part of the country that contains karstic phenomena, even though, in many cases, they don't constitute karsts, according to the canons established by some karstologists. Those authors haven't yet agreed on the scientific bases for considering karst, and it is becoming ever more difficult to do this, because new calcareous regions with different characteristics that place them farther away from the Dinaric model are being discovered and studied.

Many authors—including some Spanish ones—prefer to speak of karstology instead of the more Latin carsology, but even they, such as the very noted Spanish researcher Noel Liopis Liado, have noted the obstacle posed by the phonetics of the Slavic word in its German version,

> The study of Karst includes such an extraordinarily vast field that the admission of the term "Karstology" would be justified—a term which has already been proposed for including the sum of knowledge which we uow possess about

> Karst; but this word isn't very phonetic and hasn't prospered. Because of the indicated diversity of knowledge that constitutes the study of Karst, we should, then, speak of the Karst sciences, as we have already done in the case of the sciences of water.[18]

Because of the fact that the first karstological studies were, as I have said, made in Yugoslavia, the vocabulary of this science isn't easily adapted to defining and classifying the tropical karstic forms. The Slavic terms for doline, polje, uvala, ponor, jama and hum, which were first borrowed by Austrian geographers and then by J.Cvjic, the father of karstology and a Yugoslav sage, became universal. In spite of the richness of the Slavic language, the specific characteristics of the karstic irregularities of the tropics, mainly in Cuba, forced European and American karstologists to devise new terms. For example, to cite just one case, the Valley of Vinales was described by Herbert Lehmann as marginal polje; prior to that, it had been called an intramountain valley by Massip and Ysalgue, and I call it an intramountain karstic valley.

Herbert Lehmann is to be thanked for having insisted on the need for a terminology of its own for tropical karst. In this, he based himself on the different forms of the karstic irregularities of Cuba and Puerto Rico, as contrasted to the Yugoslav karst.

In his talk "The Classical Terminology of Karst under the Critical Aspect of Modern Climatic Morphology," given at the School of Letters of the University of Lyons in 1960, the wise German karstologist said,

> I think that I have shown, with the simple example of tropical karst, that the classical terminology should be applied in the temperate zones and that, for the other karstic zones, with different climates, we will have to seek new, well–defined technical terms [...]. As for myself, I continue to be a student of Albrech Penck, who taught me to trust observation, not doctrine. It is observation——never a schema——that will offer, in any era, a sure authority for science.[19]

All of this leads me to reaffirm the criterion that any science develops and goes beyond its own founders. This is a dialectical process that in no way detracts from the merit of those who gave a discipline its initial breath. Speleology is no exception.

Initial studies of tropical karst

Among the first studies of tropical karst, those by J.V. Danes, of czechoslovakia, who made investigations in Jamaica and Java, are outstanding. He wrote two notable works, the first published in 1908 under the title Geomorphological Studies in the Karst in Jamaica and the second in 1910, called The Karstphenomena in the Goenoeng Sewoe in Java.

It wasn't until 1936 that Herbert Lehmann once again studied humid tropical karst—in Java—which he described in his monograph Morphologische Studien aud Java (Morphological Studies in Java) .

Lehmann, as I have said, is to be credited with having questioned the absolute validity of the classical karstic terminology of the Dinaric region for similar landscapes in the tropics. Thus, in his study of Java (1936),he said, "This configuration of the depressions makes it seem advisable to avoid the term "doline" and to speak only of "karst depres-

sions." For the word "doline" (doline = valley) as a morphological term denotes a definitely rounded, bowl–shaped or funnel–shaped karst depression." [20]

New, I would like to insert some recent contributions, some of them relating to the tropics, to round out your knowledge of karstology.

The complexity of karstological studies

The Hungarian researchers B. Bulla (1954) and Laszlo Jakucs (1977) have correctly insisted on the complexity of studies of karst and on the need to tackle them with the tools of dialectics. In this regard, Bulla stated,

> The investigations that have been carried out have made the serious mistake of having this entire process stem only from the structure of the calcareous regions or from the physical and chemical properties of limestone or from the laws governing the movement of water in them rather than analyzing all these factors as a whole. These investigations, which examine each of these factors separately, have contributed only isolated details and don,t arrive at complete knowledge. Karstic erosion cannot be interpreted only in terms of an indivisible dialectics between the water and the limestone. In effect, karst and the dialectics of its forms are very little known thus far.[21]

Jakucs, with whom I had the pleasure of going through the famous Aggtelek Cavern in his country and then, in 1970, some caves in mine, very correctly insists on factors that at times escape karstologists when they are studying a given region. For example, we have the complex natural process of karstification, controlled by several interrelated agents, such as petrovariation, epeirovariation and climatovariation, sometimes on a very small, invisible scale but causing a large effect on the result of the final action of karstification. In addition to that complexity, there are other aspects that must be clarified or solved in terms of geomorphology, such as the permeability of the karstified rocks; the relative position of the level of the phreatic water; the absolute size of the affected calcareous mass; the relief; the anthropic influence, which grows ever greater as the nature of forests is altered; the CO_2content; the water projects; and the karst obstruction.

I also feel that the following concept of Jakucs's as a fundamental theorem is very important,

> ...the karst corrosion of limestone rocks is essentially the formal imprint in the soluble bedrock of the biological and chemical phenomena of evolution of the pedosphere, the soil covering the rock. It was further established that these biological and chemical phenomena are themselves under climatic control.[22]

Alluvial corrosion

Anther concept that has gathered strenght in the karstification process is that of the alluvial corrosion or dissolution that takes place within the alluvial sediments and moraine. Researcher Ivan Gams brought this out in his monograph "Types of Accelerated Corrosion," a topic of special interest because of his new approach to the development of the evolution of poljes.

> Inundations are common at the contact between surface and underground (karstic) drainage systems. These inundations are determined by the fact that

surface high water levels are not related to maximum discharge potential of underground drainage channels (Jenko 1958, p. 58). In stagnant water, the material carried by the river is deposited.Areas liable to be flooded, therefore, receive much sediment and consequently represent districts with deep soils where intensified biochemical processes take place. The exact processes are not yet fully explained, but speleological investigation has revealed signs of intense corrosion in caves on the outlet side of periodically inundated karst poljes [...] An examination of the development of Globodol polje (Lower Carniola) showed that inundation was the reason why the polje bottom was lowered at the same rate as the neighbouring non–karstic area. In the poije at a high water stage flood water comes up from the limestone bedrock, passes through several metres of sandy soil and then later sinks again into the alluvium (Gams 1959).The prevailing opinion in modern speleological literature is that carbon dioxide needed for corrosion is mostly dissolved in water as it passes through the soil. Enrichment with carbon dioxide occurs twice in water, which comes out of springs and later sinks into alluvium, but in the case of Globodol, cited above, the enrichment occurs three times; 1. as rain and snow water penetrates through soil in the original catchment area; 2. as the water rises through the alluvium covering the bottom of the polje and 3. as it sinks again through the same material. Further investigation is necessary to ascertain the time when accelerated corrosion takes place (during the inundation or later) in these inundation areas.[23]

The intensity of karstification

several researchers have studied the relative intensity of karstification in different parts of the world; in the periglacial and high mountain area, it amounts to 6 percent; in the temperate zones, 9 percent;in the Mediterranean areas, 12 percent; in the deserts, 1 percent; and, in the tropical regions, 72 percent. In these last areas, as may be seen, karstification is eight times as great as in the classical karst.[24]

Notes

1. P.Fenelon, 1968, p. 48.
2. J.Roglic, 1964.
3. Marjorie M.Sweeting, 1973, p.207.
4. J.Roglic in M.M.Sweeting, 1981, p. 292
5. J.N.jennings, 1971, p. 23.
6. H. Lehmann, 1956, p. 4
7. Otakar Stelcl, 1965, p. 7.
8. P. Fenelon, 1968, p.50.
9. L. Tell, 1976, p.381.
10. M.M Sweeting, op. cit. p. 1.
11. L.Tell, op. cit. p.384.
12. J.Cvijic, Das Karstphanomen, 1893.
13. The Geography of Calcareous Terrain, 1969.

14. L. Tell, op. cit, p.382.
15. Ibid
16. M.M.Sweeting, op. cit, xiii.
17. A.Nunez Jimenez, et al . 1967
18. N.Liopis Llado, p. 26.
19. H,Lehmann, 1960, p. 6
20. H..Lrhmann,in Sweeting, op.cit. p.324.
21. B.Bulla, 1954, p.459.
22. Laszlo Jakucs, 1977, p.141.
23. Ivan Gams, in Sweeting, op. cit, p.127–128.
24. Laszlo Jakucs, op. cit. p. 235.

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DISCOVERY OF A NONTROGLOBIOMORPHIC RACE OF THE EUROPEAN CAVE SALAMANDER Proteus anguinus (AMPHIBIA : CAUDATA : PROTEIDAE) –a preliminary report

Boris SKET J. W. ARNTZEN

Abstract

More than 300 years after the first mention of Proteus in literature a very instructive copy of its epigean ancestor has been found in southeastern Slovenia. While all other populations are highly specialized and mutually almost indistinguishably similar, the "black Proteus" is very distinct. Although evidenlly bound to cave waters, it is permanently dark pigmented. Its eyes are well developed, its head and skull morphologies, vertebrac number and body proportions are different. Nevertheless, the allozyme analysis has shown that it is closely related to one of the troglobiomorphic populations which is in Lurn genetically less close to other troglobiomorphic ones.

EXISTENCE AND FORMATION OF LARGE CAVES IN SILICI – CLASTIC SEDIMENTS BELOW BASALTIC LAVA–FLOWS, NIUT MOUNTAINS AREA, KALIMANTAN BARAT, BORNEO, INDONESIA

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Abstract

The Niut Mountains are a major, though poorly known, volcanic complex, made up of a large number of lava flows which originated from lateral and summit vents. Basalts to basaltic andesites are dominant; andesites and even dacites have been observed. Basaltic flows from a "star" pattern all around the volcanic complex and overlie a variety or rock formations. Among these, turbidites folded to vertical and subvertical dips, and fluvial sandstones weathered and rounded to boulders, prior to the lava filled up paleo–lows,

form the substratum of probably young Quaternary, almost unweathered basalt sheets.

Caves of big size formed along the irregular surface separating the silici–clastics and the basalts. Though this is not systematic, the cave section is usually large (10–30 m up to 70 m+) but low (5–6 m to ca 11 m). The length is usually moderate (ca 100 m), but can exceed 300 m (in the latter case, there is an underground river). These caves are found in two main settings:

1. on valley flanks, approximately perpendicular to the slope, at the base of basalt escarpments;

2. below hill tops, at a shallow depth. The roof of such caves is commonly cut through by vertical to subvertical shafts which reach the ground surface.

The formation sequence is the following:

1. minor to moderate water flow at the base of the fissured lava–flow, with moderate transportation of fine particules,

2. slight mechanical destabilization of the lava flow, with a slight opening of existing fissures,

3. concomitant increase of vertical hydraulic conductivity, with formation of roof collapses at the rock interface and emplacement of absorption pseudo–dolines at the ground surface.

4. further increase of the hydraulic conductivity, with further development of roof collapse and pseudo–dolines, and corresponding particles removal,

5. shaft formation through the basalt section, by junction of roof collapses and pseudo–dolines, facilitating large inputs of surface water into the rock interface, with waterfalls during the rainy season and corresponding erosion of the underlying silici–clastics, and particle transportation,

6. rock falls from the roof of the cave, inducing cave widening,

7. "death" of downslope shafts and formation of new ones further upstream in the cave, general collapse of large parts of cave roof next to the outside slope and corresponding development of higher cliffs above the cave entrance.

Caves formed below hill tops are assumed to have a presently choked outlet and, indeed, are not active anymore.

FORMATION OF UNDERGROUND STREAMS IN VOLCANIC ROCKS :TAHITI, FRENCH, POLYNESIA, AND BALI, INDONESIA

Claude MOURET

Abstract

Significant underground streams may be encountered in volcanic rock formations. Among these, lava flows and breccia originating from lahars or "nuees ardentes" show good examples.

In Tahiti, former lava tubes in basaltic lava–flows were progressively penetrated by

water from overlying creeks. Eventually, the lava tubes collect all the water of these creek.

This capture started with isolated infiltration along fractures or cooling cracks in the bedforming rock of surface streams. Little by little, with a higher rate during floods, the combination of rock leaching, grain desagregation, abrasion and varying pressures created an enlargement of rock discontinuities, a destabilization of the vault of tubes, collapses, which all resulted in the progressive opening of swallow holes.

The result, after this evolution of subsequent passage widening and roof collapse over long distances, is the present Hitiaa Cave System, with two large tunnels(141 and 128 m long) up to 15 m in section, a natural bridge and an upstream cave with branches(488 m long).

Underground parts are separated from each other by collapsed parts of the initial lava cave.

A large vauclusian–like spring, the "Bain de Vaima", is interpreted as related to a lava tube system, sunk in relation with the last transgression.

In Bali, goa Apetaungan is a cave developing 88 m length. Upstream, water enters the cave from a narrow passage, at the base of an opening to the outside. If flows in the axis of the cave, this one becoming downstreamward wider and wider, both horizontally and vertically. The bearing rock formation is a matrix–supported breccia, related to a major volcano: the gunung Batur. The cave is interpreted as related to a sunk surface stream, thanks to fractures (structural or compactional), into an easily erodible breccia.

THE KARST OF KHAMMOUANE, CENTRAL LAOS

Claude MOURET

Abstract

The karst of Khammouane was investigated by French geographers as early as 1889, and until the early fifties of this century. New investigations were conducted in 1992. They consisted of morpho – lithological studies, structural observations and geological –hydrogeological surveys related to the organization of the karst. A number of caves were explored.

The karst of Khammouane extends in Laos over 290 km, along a SE– NW trend from the Vietnam border to the unconformably overlying Mesozoic silici–clastics of the Phu Phanam, a summit at 1442 m. The average width of the karst is 25 km, but it has been splitted by erosion into a number of smaller mountains separated by poljes. River sinks and springs are relatively numerous, but their access is hazardous, due to remains from the war. Shafts opened to the outside exist, but the extreme density of high and sharp pinnacles, often reaching 10 m, makes their study difficult. The present morphology of tower karst is well developed, both on the edges and inside the mountains. High cliffs, up to 300 m high, often separate carbonate mountains from adjacent plains on eroded anticline arches where underlying sandstones are exposed.

The karstified rock is usually a Permo– Carboniferous dolomitic limestone, alter-

nated with thinner dolomites. Devonian carbonates also outcrop. Dolomitic limestones display classical karst morphologies, while dolomites are prone to more rounded shapes and to rough pinnacles without sharp edges. More clayey limestones are prone to more massive mountains, where the karst morphology is somewhat less typical.

Underground karst is well developed, as major underground streams already explored and fossil passages demonstrate it. Paleokarsts formed during the stratigraphic gap following the deposition of Permian sediments, which is approximately 60 MA long, and more precisely the period following tectonic activity around 255–245 MA (i.e. some 45 MA). Paleokarsts include both surface features and underground patterns.

WAKE–RELATED FORMATION OF RUNNELS IN CARBONATE AND SILICI–CLASTIC ROCKS ALONG MAJOR ASIAN RIVERS: CHINDWIN IN MYANMAR (ex BURMA) AND YANGZE IN CHINA

Claude MOURET

Abstract

Observations conducted in 1989 proved that runnels may and do form on the rocky banks of major navigable rivers, mostly above the average dry season level. The runnels are due to the up–and–down motion of the water surface, driven by the wind (natural factor) or by the swell which is related to river navigation (human induced factor).

The energy generated by these two causes of up–and down motion is, of couse, of a rather different magnitude: winds are most of the time rather moderate, and very strong only a few days a year, when able to create significant water vertical motion along river banks; boats, to the contrary, may be very numerous and are often powerful boats: they consequently determine powerful waves behind them. These waves are able to induce vertical motion of the water along the river banks. The large number of boats explains the well carved runnels observed along certain rivers, specially in gorges (Yangze River) or in certain meanders (Chindwin River), or in any way where boats have to follow river banks (channnelized river bed). Resonance effects may enhance the duration, and even the amplitude of the phenomenon.

During its vertical motion, water alternately oscillates between a level lower than the normal one of the river and a higher one. This explains why the runnels may develop downto below the dry season river level. Their vertical distribution reflects the vertical frequency of river level at given elevations, which is, at a given location, a function of the bed section, and mostly of the climate over the watershed.

Runnels formation is in the present case the result of abrasion by free particles in the water and of dissolution (in carbonates specially). The shape of the runnels is due to the channelization of the downgoing water around original surface irregularities of the bare rock bank (fingering effect).

LARGE UNDERGROUND CHAMBERS IN THE PHILIPPINES:CHARACTERISTICS AND FORMATION

Claude MOURET

Abstract

Two areas in the Philippines have shown, so far, major underground chambers. One of them is the karst of Sagada, the western margin of which is specially rich in voids. In the longest and widest cave system, called Latipan–Loko–ong, three chambers have been explored. The biggest one is the Sagada Chamber, 95 m long, 59 m wide and 10 to 20 m high. The three chambers formed in both the Oligocene Sagada Limestone and the underlying basement, the contact between the two lithologies being a reverse fault (dipping eastward, approximately 45 degrees). The basement is not very compact in the cave and suffers easy erosion. It is clear from the observations in situ that the more easily erodible basement is a cause of chamber formation. Cave streams flowing along the limestone– basement contact play an active role in eroding preferably the basement, thus mechanically destabilizing it, and by consequence creating voids themselves destabilizing the limestone vault. Meandering of the streams increases the erosion. Debris are easily washed and dissolved away in such a setting, which plays a major role in the large chambers formation. The Sagada Chamber was formed by a combination of all the factors mentioned.

Other voids are observed in other cave systems along the same edge of the karst of Sagada, in a similar setting.

In the island of Samar, Calbiga Karst, Langun–Gobingob Cave System, the Panayoran Chamber is 275 m long, 165 m wide and 80 m high. Close to it, two other smaller chambers exist: 150 × 100 × 80 m and 105 × 60 × 6 to 15 m. A collapse chamber, now a doline, on trend with the others, measures 330 × 180 × 95 m; it is lying next to a remaining large underground void, itself 110 × 70 × 50 m.

The Langun entrance, ca 1 km from the voids previously mentioned, which are all in the Gobingob area, is itself 145 m wide and ca 60 m high. It opens on the side of a giant doline, probably a collapsed passage.

The two cases of Sagada, in the Central Cordillera of northern Luzon, and of Calbiga, in Samar, prove that in the Philippines, large underground chambers discovered so far form in large cave systems, i.e. in areas of specially well–developed karstification. If at Sagada, void formation is made easier by softer basement rock, in Calbiga, only the Tertiary limestone is apparently involved in it.

ACTIVITIES REPORTS AFTER UIS–BULLETIN (No.38)

REPORT FOR ACTIVITIES OF THE COMMISSION OF PHYSICAL CHEMISTRY AND HYDROGEOLOGY OF KARST OF UIS FOR THE PERIOD 1989–1993 YR.

Yavor SHOPOV
Secretary of the Commission

The Commission have 100 members from 31 countries, 2 International programs and a working group:

1. The PIGEK program led by A. Eraso and M. Pumlina is started in 1980 and is still in progress.

2. The luminescence of cave minerals program, led by Y. Shopov was started in 1988 and pressumed to finished before the XI Speleological Congress, but it is still in progress and is suggested to continue as long as the necessary data will be accumulated. The Status report of this program is applied.

3. The Working Group on Speleothem records of environmental changes is started in 1990 and is suggested to become permanent working group of UIS. The Statue report of this Group is applied.

In 1991 Shopov tried to prepare an activities report of the Commission for 1981–1991 yr, but only 7 members sent their personal reports, so it was impossible to prepare such a report. We thank to C. Hill, E. Joyce, I. Muller, H. Franke, R. Pavusa and both S. Roda for their reports.

There was 3 in official meetings of the commission in USA in 1991–1993. The last one during the IGCP 299 field trip in Washington was the first joint meeting of all karst commissions of all scientific unions working on karst. It was a new step of integration of karst research. Shopov suggested to make joint list of members of all karst commissions and to make joint meetings during every congress dealing with karst, because separate meetings of any commission was never attended by more than 15 of it's members. Any of the commissions is free to make additional closed meetings. The next such meeting will proceed during the Geomorphology congress in Hamilton. Several joint projects of interest for all commissions was suggested and discussed. Such are the international database of karst regions, world karst map, etc. It is largely believed, that this integration can strongly stimulate and accelerate the development of the cave and karst research. Probably many unpublished data will be distributed through this network and the moral ethic of all people using it has to be superb, because stilling of ideas and data will be very easy. Any such cases must be reported immediately to all leaders of the karst commissions and

the access of the offenders to the network must be denied immediately. I already detected one such case.

In order to have better integration the leaders of all karst commissions was invited to become members of all other commissions. It was accepted. This way our commission received several more excellent members. The list of members of the Commission was sent to the leaders of the other commissions. In order to improve the scientific level of the Commission it's secretary invated several distinguished karst researchers to join the Commission.

STATUS REPORT OF THE INTERNATIONAL PROGRAMME "LUMINESCENCE OF CAVE MINERALS" OF THE UIS COMMISSION OF PHYSICAL CHEMISTRY AND HYDROGEOLOGY OF KARST

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The International Programme "Luminescence of Cave Minerals" (IPLCM) of the UIS commission of Physical Chemistry and Hydrogeology of Karst has been started in early 1988 and was presumed to be finished before the XI Speleological Congress with printing of the book "Luminescence of Cave Minerals". All laboratory measurements had to be done in the laboratories of Sofia University by the leader of the program. But the economic collapse of the socialistic countries cause destruction of this lab in the and of 1990. This cause big difficulties and delay of the research. prof. Derek Ford rescue the program in 1991, inviting its leader to build a luminescent microzonality (LLMZA) lab in McMaster. This caused a shift in the field of research of the Program, because no any spectroscopic equipment was available for the program any longer, but it was originally designed to be mainly spectroscopic program rather than LLMZA program. The contribution of the members to the spectroscopic part (Scage I, see (11) was extremely low – only P. Forti, J. Mikushevski and J. Slacik sent several slides of luminescence for spectral measurements (stage II.1,2 [1]) to the leader. But many members sent speleothem samples for spectral measurements from : Japan (T. Arakawa, N. Kashima), Poland, Armenia, India (J. Mikuszewsky), Somalia (M. Williams), Italy (P. Forti), Czechoslovakia (J. Slacik), USA (C.Hill, D.Ford, M. Buck), Israel (A. Frumkin), Mexico, Cayman Islands, Bahamas, USSR, Canada and Hungary (D. Ford). IPLCM have 42 members from 19 countries, but so far only 18 members from 9 countries contributed something to the program. Most active was the Shopov's team of 7 members from Bulgaria, which made all measurements of the program. Shopov determined 41 types of luminescence in cave calcite, 6 types in aragonite, 5 types in the new mineral $CaCO_3$–II and in gypsum, 4 types in quartz and hydromagnesite, 3 types in vaterite hydrozincite, 2 in baucite, opal and huntite and 1 in purpurite. Totally 78 types of luminescence in 12 cave minerals (cm) has

been detemined. Although thousands spectra of luminescence has been measured the accumulated information is still not enough for using of the luminescence of CM for diagnostic of many CM, because 49 minerals existing also in caves are known to have luminescence in mines, but the luminescence of 35 of them was never observed in caves. Determination of spectra of more rear CM is most important for this purpose. Obtaining of slides of luminescence or small samples (1 gram) of them will be necessary [2]. Luminescence of cave halite and darapskite was also photographed.

The involvement of non–qualified cavers in the program was almost zero, in spite of the predicted high involvement. The best way to rise their participation is to increase the interest in the field by printing of the book "Luminescence of Cave Minerals" and to continue the IPLCM as long as sufficient data about the luminescence of speleothems in the world will be accumulated.

Starting from 1991 all activities of the IPLCM has been concentrated on LLMZA research. It has been a major success from point of view of the relations of the luminescence intensity in speleothems and the paleotemperature, the rainfall in the past, solar activity, the local and global climate, soils, plants population during the speleothem growth, stable isotopes, cosmogenic isotopes and it's application for dating. It lead to significant rise of the interest of the main stream scientists to the speleology. Two of the leading cosmogenic isotopic scientist has been involved in the program. Papers on speleothems start to appear in major astrophysics and space physics publications. This results also attract the attention of many other scientific unions and programs. Results of the IPLCM are subjects of the IGCP 299 and 253 Projects of IUGS, International Geography Union Commission (formerly working group) on "Human Impact and Environmental Changes in Karst" and the IGBP 6.3 PAGES "Global Changes" Project of the International Council of Scientific Unions. This way IPLCM contributes to the increasing of the rating of the UIS amongst other scientific unions. This is due to the development of a series of New extremaly powerful and very sophisticated research methods. Shopov's method of Laser Luminescent Microzonal Analysis (LLMZA) derives from carbonate sediments the same information as stable isotopes, but with 100–100,000 times higher time and linear resolution, so it's time series looks as an improvement of the stable isotopes ones. These methods allowed us to obtain the largest paleoclimatical time series ever obtained from one sample, which contained 110,000 measurements, covering the last 22000 yrs with time step of 5 points per yr (two months) and to reach the highest so far (for a paleoclimate record) time resolution of 6 hours for a small part of another speleothem. This made the LLMZA method the most sophisticated and powerful paleoclimatic method. There are significant interest to use this method for study of paleoclimatic records in corals and sea cores.

The base of these methods is measurement of the production of fulvic and humic acids by plants in the past by measurements of it's concentration in growth layers in carbonate sediments or corals. This methods are applicable for any low temperature sediments but the best ones are Calcite Speleothems. Their luminescence is produced by organic molecules – products of life processes of the plants. By measurements of the intensity of it's luminescence we measure their concentration in the layers with subsequent age (which represents their production in the past). Most of the fulvic acid is direct product of the photosynthesis, which is modulated by the visible solar insolation. The Infrared Solar

Irradiation determines in a great part the surface temperature of the soil. So the temperature controls the rate of formation of the humic and fulvic acids by disintegration of plants remains and humus, because the rate of this chemical reaction depends exponentially on the temperature (in the soil). So the production rate of those compounds will be determined by the highest temperature (near the surface) in the soil layer. Fulvic and Humic acids are soluble in water and it is transported into the cave by rain waters and copresipitates together with $CaCO_3$ in flowstones. So variations of the intensity of luminescence represent multiplicated by the photosynthesis mechanism and chemical reactions variations of the solar insolation. The parallel measurements of stable isotopes (representing the paleotemperature) and LLMZA records can solve the fundamental debate in which extend solar activity determines the earth climate.

Shopov derived a proxy of the annual rainfall precipitations in the Pleistocene from high resolution LLMZA time series, by measurements of the annual growth rate variations of speleothems. These variations are determined in high degree by the annual run–off. This research was complicated by the continuous attempts of Peter Smart and Andy Baker to still the work of the leader and to published it in "Nature" under their names.

This information is important for long–term prognoses of the Climate and Solar Activity, for paleogeological and paleogeographical reconstructions and for monitoring of the past changes in the chemistry of ground waters. It allows solving of various questions of climate and global changes which can not be solved with the data form direct observations, because of their short duration. Shopov measured peleoclimate LLMZA records from speleothems for the last 250,000 yrs, which are in good correlation with sea core ones, but with far higher resolution.

Speleothem samples from McFails Cave, New York, Raths Nest Cave, Alberta, Cold Water Cave, Iowa and Jewel cave, South Dakota has been studied by LLMZA.

A new speleothem dating method "Autocalibration dating" was developed (table 1). It has the highest precision of any dating method for dating of short time intervals.

A new method for time – resolved photography of phosphorescence was developed in December of 1993 (table 1). It is extromely useful for study of hydrothermal cave minerals and the thermal history of the caves and is of significant interest for the Working group "Hydrothermal caves" of the UIS Commission on Paleokarst and Dating. It was used to study the thermal history of the caves in Guadeloupe Mts., New Mexico, in Black Hills, South Dakota, USA and in Budapest Hungary very successfully, confirming the stable isotope data. The advantages of this method are that it is very fast and non–destructive, and can be used in situ directly in the cave.

During the work of the Program it's leader developed 2 new methods (table 1) in addition of the 3 previously developed methods and 5 techniques for speleothem luminescence research [1]. It is a very powerful instrumentaion for speleothem reserch. The development of the TRPP method was sponsored by D. Ford through one of his NSERC research grant.

Table 1. New Methods for Research of the Luminescence of CM

Method	Authors	Obtainable Information
I. Autocalibration Dating (ACD)	Shopov Y Dermendjiev D Buyuklieve G. (1988)	High Precision Speleothem Dating of Speleothems of any age, Climasic & Solar Activity cycles, variations of the speleothem Growth Rate.
II. Time Resolved Photography of Pohosphores–cence (TRPP)	Shopov, Tsankov (1993)	Determination of minerals, registration of color & zonality of phosphorescence of different centers, it's spectra & location, extraction of single mineral samples, changes of chemism and the temperature of the mineralforming solutions, (determination of the lifetime of the luminescent centre.

It was very unfortunately that Ing. Josef Slacik, who was one of the most acitve members of the IPLCM dead in 1990. The Program leader expressed his deep regrets to his family and colleagues. The IPLCM leader requested the collaborators of J. Slacik from TARCUS group Ch. Jancharik and VI. Lysenko as well as P. Bosak to help him to obtain information about the work of J. Slacik and to sent their papers on speleothem luminescence. But they do not respond to the request thus bury a significant part of the data on speleothem luminescence. At this circumstances there are no way to reflect Slacik's studies sufficiently in the book "Luminescerce of cave minerals", because most of his results are published in local Czescoslovakian Journals, which are not distributed out of the country.

The book "Luminescence of Cave Minerals" is under preparation. It's illustrations are almost ready. They consist of 200 spectra of luminescence, 100 LLMZA scans and 160 color photos of phosphorescence, time resolved phosphorescence, fluorescence and UV photography of speleothems. 200 pages of the text are already prepared, but the final text is expected to be twice bigger. More than 80% of the data in this book are never published before, including the detailed descriptions of the methods, equipment and spectra of luminescence of cave minerals. It is expected to be ready for reviewers by the end of 1993. The leader contacted many scientific publishers, but they find the topic to be too specific to be able to gain enough sales to make enough profit for them. So a help from UIS will be necessary to publish this book.

Conclusrons

In conclusion the IPLCM was very successful and produced significant contribution to the cave science and to it's appreciation by other sciences.

It is recommended to publish the book "Luminescence of cave minerals" as soon as it will be ready in order to attract more participants in the program.

It is recommended to continue the Program as long as it will collect all data necessary to produce a non–destructive diagnostic of cave minerals using their luminescence. When it will be completed a "Manual for diagnostic of Cave Minerals" can be published. The base of this manual will be the very sophisticated diagnostic system of CM, incorporated in a computer program for diagnostics. The computer program is already designed.

STATUS REPORT OF THE WORKING GROUP ON "SPELEOTHEM RECORDS OF ENVIRONMENTAL CHANGES" OF THE UIS COMMISSION OF PHYSICAL CHEMISTRY AND HYDROGEOLOGY OF KARST

Yavor SHOPOV
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Calgary, Alberta, Canada T2N IN4

The working group Speleothem Records of Environmental Changes in the Past (SRECH) of the UIS commission of Physical Chemistry and Hydrogeology of Karst has been started in the end of 1990. It was founded by biggest part of the members of The International Program "Luminescence of Cave Minerals"(IPLCM) after a suggestion of T. Arakawa, later developed and proposed by Y. Shopov at the official meeting of the commission in Brno, CSSR in September 1990. The original proposal was approved by this meeting and several days later supported by the ICSU Round Table on "Space and Solar influences on the Environment". The structure of the program is described in table 1. It has separate leaders of the different topics of research and one coordinator. D. Lal, Y. Shopov, A. Latham, D. Ford and T. Arakawa, P. Forti, G. Brook and W. White was elected for topic leaders and Y. Shopov for coordinator of the Group. T. Arakawa later proposed N. Hori and H. Muira for topic leaders of the paleotectonics topic. But they does not respond to the letters of the coordinator as well as leaders A. Latham and G. Brook. So their contribution to the Group so far is zero and I search for new leaders or co– leaders of the Paleomagnetism and Pollen analysis topics.

In the coarse of the work of SRECH two new subjects has been introduced : IV.4 Dating of Sea Levels with leader Joyce Lundberg and III.2. Paleotemperature records in Speleothem Ice with leaders Charles Yonge and W. McDonald. A.T.Jull (AMS facility, University of Arizona) was also suggested as co–leader of the topic I.1. The leaders of the new topics has not been approved yet by any meeting of the commission, but I will highly recommend their approval, because they was the most active topic leaders. The topic III.2 produce the only clear atmospheric temperature record (in any material), which does not depend on the global ice volume because the ice is precipitated directly from vapour and is of great interest. I want to express special gratitude to C. Yonge, who being unemployed himself managed to produce more than half of the stable isotope data from speleothems. D.C.Ford also contributed much to the Group by financial support of the topic I.2 from his research funds since 1991.

The general goal of the Group is to measure as much as possible environmental records in a single speleothem and to compare them. This way we can derive principally new information, not obtainable by any single record or method. So far we made comparison between records I.1, I.2 and III.1 which was a major success. A comparison between stable isotope and luminescent records was done on samples from Raths Nest Cave, Canada; Jewel Cave, South Dakota, US and Duhlata cave, Bulgaria. It produced the following in-

formation:

1. By comparison between ^{18}O and LLMZA records:

a. The sign of the correlation between the ^{18}O records and the paleotemperature has been easily determined. It is in right correlation in the case of the Bulgarian sample and in anticorrelation in the case of Canadian samples.

b. The evaporitic fractionation in the US sample was easily determined.

2. By comparison of ^{13}C and LLMZA records:

a. The main source of CO_2 in the speleothem was determined. In the case of right correlation (which is more usual) it is respiration of the plants growing over the cave or the bedrock CO_2. In the case of anticorrelation it is the decompostition of the soil (Duhlata cave).

b. Major changes in the plants population over the cave was determined in Rats Nest cave producing reversing of the sigh of the correlation during the speleothem growth. It suggests a forest fire or restoring of the forest.

3. By comparison of ^{13}C, LLMZA records and color photography of luminescence:

a. It was determined that changes from $C_3$to C_4types of plants and back usually are not the source of ^{13}C variations in speleothems as believed before. This variations are due to variations of the bedrock carbon participation in the speleothem calcite. Only in parts of the Jewel cave sample which grow unusually long (through glacial and interglacial periods) changes of the plants type was observed.

4. By comparison of LLMZA, ^{13}C, ^{18}O records and AMS ^{14}C dating:

a. It was determined, than in the case of anticorrelation between ^{13}C and LLMZA records a strong isotopic fractionation occurred and produced ^{14}C dates older then the real with up to 25000 years. Similar error, but with reversed sign was reported by S.–E. Lauritzen by comparison of ^{14}C and U / Th ages. Some practical suggestions to avoid this errors are prepared, but in general we can recommend to avoid any ^{14}C dating of speleothems, because the error of this method can exceed the range of datable ages.

b. It was determined a ^{14}C "spike" around 16000 B.P., suggesting a supernova explosion. An alternative explanation of this "spike" as a solar effect is under discussion.

This results are the beginning of a new era in the understanding of the paleoenvironmental records in speleothems and at all. It lead to significant rise of the interest of the main stream scientists to the speleology. Two of the leading cosmogenic isotope scientist has been involved in the program. Papers on speleothems start to appear in major astrophysics and space physics publications. This results also attract the attention of many other scientific unions and programs. Results of the SRECH are subjects of the IGCP 299 and 253 Projects of IUGS, International Geography Union Commission (formerly working group) on "Human Impact and Environmental Changes in karst" and the IGBP 6.3 PAGES "Global Changes" Project of the International Council of Scientific Unions. In fact SRECH is already compatible both in size and results with the PAGES IGBP project and I am going to suggest to ICSU to start a new project on the topics of SRECH. It can attract very significant funds from the budget of ICSU, which is the best and reachest of all scientific unions. The IGCP 299 leader Y. Daoxian sugggested me to apply for independent IGCP project of the IUGS with the topics and goals of the Group. But my opinion is that we must first try to propose an IGBP project, because this projects

are highest level scientific projects. If this attempt will be not successful, than we may try an IGCP project after IGCP 299 will finish.

The main contribution in the progress of the research was done by the leaders of the topics I.2, III.1 and I.1. Leaders of the topics III.2, IV. 2 and IV. 4 was also active, but their research still did not produced records comparable with this from the first 3 topics, to be correlated properly. Topic I.1 has a project to calibrate the cosmogenic isotopes by measurements of their concentration in dated speleothem. This project is of great significance for many dating methods, especially for ^{14}C dating and for dating of geomorphological futures by in situ produced cosmogenic isotopes. It requires very rear speleothem samples, so this project is still on stage of searching for samples. We are looking for calcite speleothems in non–carbonate caves (in gypsum, anhydride, etc), speleothems containing nitrogen, chlorine or sodium, which grew for a long time (flowstones of carbonate chlore apatite, etc.) everybody are welcome to contribute to this study. Requirements for the samples can be obtained from Y. Shopov or P. Forti. Unfortunately T. Arakawa fell very sick and is out of communication since 1991. So I would suggest as an extra co–leader of the topic III.1 C.Yonge, who was most active in the field.

Further collaboration with the leading streams in the cosmogenic isotope scientists is under way. It cause the change of the name of the Group from "Speleothem records of Environmental Changes in the Past" to "Speleothem Records of Environmental Changes in the Solar System" in order to underline the global character of the information derived by topics I.1 and II.2. T. Arakawa suggested to omit the sentene "in the past".

Speleothem samples from Bulgaria, Japan, Somalia, Italy, USA, Cayman Islands, Bahamas, Canada and Israe) was used in this research. The Group have 38 members from 17 countries, but so far only 23 members from 12 countries contributed something to the program. Most active was the Bulgarian and Canadian team. The LLMZA research has been a major success – it allowed us to obtain the largest paleoclimatical time series ever obtained from one sample, which contained 110,000 measurements, covering the last 22000 yrs with time step of 5 points per yr (two months) and to reach the highest so far (for a paleoclimate record) time resolutich of 6 hours for a small part of another speleothem. This made the LLMZA method the most sophisticated and powerful paleoclimatic method. There are significant interest to use this method for study of paleoclimatic records in corals and sea cores.

Shopov derived a proxy of the annual rainfall precipitations in the Pleistocene from high resolution LLMZA time series, by measurements of the annual growth rate variations of speleothems. These variations are determined in high degree by the annual run–off.

This information is important for long–term prognoses of the Climate and Solar Activity, for paleogeological and paleogeographical reconstructions and for monitoring of the past changes in the chemistry of ground waters. It allows solving of various questions of climate and global changes which can not be solved with the data from direct observations, because of their short duration. Shopov measured peleoclimate LLMZA records from speleothems for the last 250000 yrs, which are in good correlation with sea core ones, but with far higher resolution.

A new speleothem dating method "Autocalibration dating" was developed. It have the highest precision of any dating method for dating of short time intervals.

A new method for time–resolved photography of phosphorescence was developed in 1992. It is extremely useful for study of hydrothermal cave minerals and the thermal history of the caves and is of significant interest for the Working group "Hydrothermal caves" of the UIS Commission on Paleokarst and Dating. It was used to study the Thermal history of the caves in Guadeloupe Mts., New Mexico, in Black Hills, South Dakota, USA and in Budapest, Hungary very successfully, confirming the stable isotope data. The advantages of this method are that it is very fast and non–destructive, and can be used in situ directly in the cave. A new topic III.5 "Luminescent records of hydrothermal activity" with leader Y.Shopov is suggested on the base of this method.

The leader of the International Geography Union Commission on "Human Impact and Environmental Changes in Karst" Ugo Sauro suggested to J. Lundberg, D. Ford and Y. Shopov to write a small technical manual on Speleothem Paleoenvironmental and Dating methods for physical geographers. It should be done later after the important congresses in 1993 are over.

Conclusion

In conclusion the Working Group SRECH is very successful and produce significant contribution to the cave science and so it's appreciation by other sciences. It is one of the most promising activities of UIS and is an unique opportunity to attract the attention of the main stream scientists.

It's activities are equally interesting for the members of all karst commissions and I would suggest the SRECH to become a permanent Working Group of the UIS, as volcanic caves, etc.

Speleothem Records of Environmental Changes in the Solar System

Types of the Proccess Method	Obtainable information leader	resolution	Time range [yrs]
I. CHANGES IN THE SOLAR SYSTEM			
1. Cosmic Rays Flux variations; Cosmogenic Isotopes Variations	Cosmic ray flux and solar activity in the past, star explosion D. Lal (USA)	form 1 a?	0–40000
2. Solar Insolation; Laser Luminescent Microzonal Analysis (LLMZA)	Solar activity & climatic variation in the past, speleothem growth interruptions, volcanic eruptions Y. Shopov (C)	from 6 hours,	0–∞ a.
II. GLOBAL EARTH PROCESSES			
1. Paleomagnetism; Magnetometry of Speleothems	Paleomagnetism, rock orientation changes in the past A. Latham, R. Gilson (UK),	from 50 a.	0–∞ a.

III. REGIONAL PROCESSES

1. Paleoclimate and Paleotemperature in Calcite Speleothems; Stable Isotopes	Paleotemperature, possible plant population, precipitations and climatic cycles in the past D. Ford, C. Yonge (C), T. Arakawa (Jap)	<25 a.	0–∞ a.
2. Paleotemperature in Speleothem Ice; Stable Isotopes	Air paleotemperature, air CO_2 isotope composition C. Yonge, W. McDonald (C)	<25a.	0–∞ a.
3. Paleotectonics & Paleoseismics; Orientation of Speleoth. Growth	Paleoseismics, rock displacesments & bendings P. Forti (it), N. Hori (Jap)	<100 a?	0–∞a.

IV. LOCAL PROCESSES

1. Pollen Analysis	Plants population & paleoclimatic changes G. Brook (USA)	from 10 a?	0–∞ a.
2. Luminescent Spectra Analysis	Soil & plants population variation W. White (USA)	?	0–∞a.
3. Chemical Microanalysis; By Laser Emission Spectral Analysis	Chemical pollutions	from 1 a?	0–∞ a.
4. Dating of Sea Levels; U / Th Dating	Sea levels variations J. Lundberg (C)	from 100 a	0–500000 0–∞a.
5. Luminescent Records of Hydrothermal Activity; Time Resolved Photography of Phosphorescence	Advances of hydrothermal waters, estimation it's temperature Y. Shopov (C)	from 0.1 a. ?	0–∞ a.

COMMISSION ON PALEOKARST AND SPELEOCHRONOLOGY OF THE INTERNATIONAL SPELEOLOGICAL UNION CURRENT NEWS AND PLANS

Pavel BOSAK
Commission President

The Commission on Speleochronology of the U.I.S. (UNESCO, cat. B) started its activity in 1960. In 1981 its name was completed to the Commission on Paleokarst and Speleochronology. In the present time, about 30 members participate on commission activities. Some achievements and goals of past period should be especially noted : the editing of an international monograph *Paleokarst. A Systematic and Regional Review*(Elsevier–Academia, Amsterdam–Praha, 1989) summarizing state–of–art in paleokarst studies and the international expedition *Tyuya–Muyun'*89 into mineralized paleokarst in desert environment of the Central Asia of the USSR (now in Kirghistan).

Recently active Commission programs consist of :

(1) The formation of the documentation centre in Vienna (contact address : Dr. Karl Mais, Institut fur Hohlenforschung, Naturhistorisches Museum, Messeplatz 1 / 10 / 1, A–1070 Wien, Austria) collecting information and literature not especially only from Austria and our Commission, but also literature and information concerning past–region of Austrian–Hungarian Monarchy. Documentation centre invites also complete bibliographies of paleokarst and speleochronology from all countries (or specialists), members and non–members of the UIS, for computer data processing.

(2) the completing of terminology of paleokarst (karst) headed by Prof. Dr. Jerzy Glazek (now moved to the Poznan University). The aim is to compare applied terminologies of paleokarst in different countries, schools, companies and for different purposes.

(3) the Commission scientific workshops. As mentioned above, one expedition was successfull in 1989. The second should be canceled in 1990 for violent political situation in the Kirghistan. Under preparatoin is the plan and program for several possible workshops. There are four possibilities for future several years :

(a) Salento Peninsula (Apulia, Italy) to study speleochronology in some seashore caves (small and large mammals, Uranium Series dating of speleothems, stable isotope studies, laser luminescence, paleomagnetism, karst evolution phases). The workshop will be organized in collaboration with the Apulian Speleological Society.

(b) Vienna Basin (Austria) to study karst and paleokarst of hills surrounding the Basin in connection with paleogeomorphology and hydrothermal activity (small and large mammals, Uranium series dating, stable isotope studies, paleomagnetism, karst evolution phases, sedimentology of karst fills, geomorphology). The workshop will be organized in collaboration with Institute for Speleology, Museum of Natural History, Vienna, Austria.

(c) North Norway. Workshop will be focused on the study of paleokarst phases and periods in present arctic region. Program is under preparation. The workshop will be organized in cooperation with Bergen University, Bergen, Norway.

(d) Bohemian Karst (Czech Republic). The workshop will deal with various paleokarst forms and Cenozoic evolution of the region (small mammls, Uranium Series dating, paleomagnetism, stable isotope studies, geochemistry and mineralogy of fills and weathering products, sedimentology of karst fill, geomorphology, karst evolution). The workshop will be prepared by the Czech Speleological Society and the Geological Institute of the Czech Academy of Sciences (Prague, Czech Republic).

Field workshops will be organized in a very simple and therefore cheap manner with the aim to prepare publication on studied problems. The field operation are expected to last about 14 to 30 days, according to problems to be solved and extent of area. Workshops will be organized each two or three years.

(4) The project Speleochronology, i.e. preparation of an international monograph summarizing the state–of–art in speleochronology methods illustrated by selected case histories. The content is nearly finished and negotiations with publishers are in an advanced phase. Project is headed by P. Bosak, D.C. Ford and S.–E. Lauritzen.

CONGRESS SCHEDULE

Date	Morning	Afternoon	Evening
Saturday		14:00 – 22:00	
31 July		Registration	
Sunday		9:00 – 22:00	
1 August		Registration	
Monday		9:00 – 22:00	
2 August		Registration	
		14:00 – Official Opening of the Congress	19:00– Reception
		14:30 – General Assembly of UIS	
Tuesday	8:30 – 12:00	14:00 – 17:00	19:00 – 21:00
3 August	Sessions and Meetings		Slides and Video
Wednesday	8:30 – 12:00	14:00 – 17:00	19:00 – 21:00
4 August	Sessions and Meetings		Slides and Video
Thursday	One day trips		Free time
5 August			
Friday	8:30 – 12:00	14:00 – 17:00	Cultural performanc
6 August	Sessions and Meetings		
Saturday	8:30 – 12:00	14:00 – 17:00	19:00– Banquet
7 August	Sessions and Meetings		
Sunday	General Assembly	Departures for	Post–Congress excursions
8 August	Plenary Ceremony		
Monday	Departures for Post–Congress excursions		
9 August			

PLENARY MEETING

TEXTS OF ADDRESSES

Declaration of the opening the XI International Congress of Speleology by Prof. WANG Sijing of the Chairman of Organizing Committee of XI ICS

Mr. President, Distinguished delegates, Ladies and Gentlemen:

It gives me great pleasure, on behalf of the Organizing Committee, to say a few words of welcome at the opening ceremory of the XI International Congress of Speleology and to meet with the delegates coming all the way from the world.

At this Congress, there are speleologists, karstologists, geoscientists, experts on cave utilization and speleotour, and cavers. All of you concerned with speleosciences have gathered here to exchange ideas and information, it will certainly raise the study of this field, the development and utilization of cave to a new level.

Cave is a precious natural valuables. The anestry of mankind depended on cave as a habitat to keep out the severe cold and extremely hot, and wild beast as well. Cave with peculiar scenery has a strong appeal to the tourist and explorer. Cave is an object of following with interest for a long time past the exploitation of minerals and underground water resources. Today, this distinguished gathering just show that cave is given much more attention of mankind day by day and the study of speleology is growing from advanced level higher and higher.

This is the first time of the International Congress of Speleology ever held in Asia, it will be made good progress on speleosciences and sport, and with the development and utilization of cave resources, speleotour and speleoexpedition cause will be sure of great developing accordingly.

Finally, I wish to extend my sincere welcome once again to all the participants, I hope that all of you attending here will experience pleasure, a successful and flourishing Congress.

Have a good time in China.

Thanks for your attention.

Welcome address by Prof. Hubert TRIMMEL of the President of UIS (be omitted)

Welcome speech by Prof. XU Zhihong of the Vice President of Chinese Academy of Sciences

Ladies and Gentlemen, Dear friends:

Today, the XI International Congress of Speleology, the only one of its kind held in Asia in UIS' history, is successfully opened. On this occasion, I am pleased to extend our warm welcome and thanks to all the friends and guests present. Your participation has made this congress a reality. I believe it will undoubtedly improve the development of

speleology and karst research in China and of the world.

Caves and carbonate rocks are not only reservoirs for water, oil, natural gas, and some solid minerals, they also represent an important resource themselves in the sense that they are utilized sometimes as sites for medical treatment, tourism and recreation. However, caves are also associated with spontaneous hazards, including water inrush in mines, collapse and ground subsidence. This imposes threats to the well being of buildings, engineering projects and other economic activities of human beings. To prevent and combat these adverse aspects calls for international joint efforts.

In China, carbonate rocks are widespread, covering nearly two million square kilometers, and the kinds of karst landform vary in different major tectonic regions. In particular, southwest China is a famous and important karst cave area in the world. Let's trace a little back to history. In Ming Dynasty of ancient China, XU Xiake, a great traveler, wrote a book named "Travels of XU Xiake". It is the earliest document concerned with karst and caves in the world. After the founding of the People's Republic of China, our researchers have done a lot of work and accumulated plentiful literature in this field.

This congress provides a good opportunity for us to explore and expand our knowledge of karst and speleological expedition and research. Let's join our hands from this congress on to promote the speleological research in the furture.

I hope that this Beijing Congress will turn out to be a successful and fruitful meeting of great historical significance in the progress of the speleological research. Again, I wish to express our appreciation to our counterparts all over the world for their kind support.

Finally, I wish all of you a pleasant experience in China.

Thank you.

Words of welcome by Prof. HU Zhaosen of the Vice President of National Natural Seience Foundation of China (be omitted)

Speech of congratulation by Prof. LIU Dongsheng of the President of International Union for Quaternary Research

Mr. President, distinguished guests, ladies and gentlemen:

Please allow me on behalf of the International Union for Quaternary Research, the China Association for Quaternary Research and myself to extend my warm congratulations to the opening of the XI International Congress of Speleology.

Caves are widely distributed in the world and closely related to the history of humans since the Quaternary. They provide rich information on the environmental evolution as well as human activites. Speleology, cave research and expeditions, has significant scientific importance in Quaternary research and has greatly enhanced the understanding of the Quaternary.

The sister sciences Speleology and Quaternary are both dealt with the study of the very recent geological events and with the human economics and social development. They are very resemble in their multidisciplinary characteristics. The International Union of Speleology, for more than 28 years, as mentioned by Prof. Trimmel, greatly enhancing the advancement of the study of the caves and karst, is a big international organization combining the research, expedition, sport, tourism, development together and concerned

with the development of the karst regions. This Congress getting together so many people from different countries and from different disciplines is a proof of its great success in the past and a guarantee of its flourishing future . I believe the progress in Speleology will improve the advancement of the Quaternary research. I wish the International Union of Speleology and the International Union for Quaternary Research will develop their much closer cooperation in their common interests in the future.

China is a country with plenty of caves and one of the countries with a long history in cave studies. In recent years speleological research in China has made a great progress in the respects of surveying, fundamental studies, tourism as well as technical methodology. As compared with many other countries, however, we are still at the beginning. We appreciate highly the cooperation with scientists from different disciplines and different countries. This Congress, held in China for the first time, is an opportunity too, for all the participants to exchange ideas and information, especially for the chinese scientists to learn from scientists and colleagues from other countries.

Finally, I wish the Congress a great success and wish all friends a pleasant experince in China. Thank you.

Message by Prof. Antonio NUNEZ JIMENEZ of the Vice President of FELAC (be omitted)

Closing words by Prof. ZHANG Shouyue of the Secretary General of the XI ICS

Mr. President, distinguished guests, ladies and gentlemen:

Nearly 300 speleologist from all over the world have spent a pleasant and fruitful week at this Congress in Beijing. Within this week, we meet old friends, make new friends, and exchange our academic views and advances in speleology. We have gained lots of new understandings on the cave — a special eco–environment.

The effective working records of the Bureau of UIS (1989– 1993) have been highly appreciated by the General Assembly of UIS. A new Bureau of UIS is generated by the General Assembly of UIS, and will be fully supported by speleologists in the world. We wish the new Bureau of UIS would make greater progress in the next four years. New member countries have been added to our International Union of Speleology. We warmly welcome their involvement and cooperation to make a consolidated and friendly Union.

The caves in China have been and will be further investigated by the participants of the Congress through the pre– and post– congress excursions. A more open China will create better conditions for our research and cooperation.

We sincerely hope that the participants from every country could have the opportunity to come back to China sometime in the near future to perform joint research and expeditions in this promising land.

Time pasts fast, but friendship stands forever. We thank you all for coming to Beijing.

See you again in Switzerland 1997.

Thank you.

COMPETITIONS OF SPELEOLOGICAL ARTS AND PUBLICATIONS

PRIZEWINNERS

	Winner	Place	Title
Video:	G.FAVRE	First	The river beneath the jungle
(Stone Forest cup)	(Switzerland)		
	John GAU	Second	Deep in the labyrinth
	(Great Britain)		
	WU Xiaoping	Third	The soaring dragon cave
	(China)		
Slide:	J.A.LABEGALINI	First	Brazilian caves /
(Yaolindong cup)	(Brazil)		Peruacu valley
	J.M.JAMES	Second	Speleothems in caves of
	(Australia)		the Nullarbor / cave in
			marble
	C.F.LINO	Third	Brazilian caves
	(Brazil)		
Photo:	Xingwen county	First	Skylight
(Zhijindong cup)	(China)		
	ZHU Shengliang	Second	Fiery trees and
	(China)		silvery flowers
	WANG Tianrui	Third	Indulge in pleasure and
	(China)		forget home duty
Publications:			
(Tenglongdong cup)			
Category:			
Expedition report	Speleogical team		Gebihe '89
	(China–France)		Karst de Chine
Album series	U.WIDMER	First	Jewel of the under–
	(Switzerland)		ground–Lechuguilla
	C.F.LINO	Second	Cavernas: caves of the
	(Brazil)		fascination of under–
			ground Brazil
	Rene DELON &	Third	La grotte de Clamouse
	Michel SIFFRE		
	(France)		

INTRODUCTION OF PRIZE CUPS NAMED AFTER SHOW CAVES AND SCENIC SPOT

Zhijindong Cave

Zhijin Cave is a well–known show cave throughout the country. It is famous uniquely for its pretty large and beautiful speleothems.

The Cave located at Guanzai village about 1300 m a.s. l. in the cone karst area distances 23 km northeast from Zhijin town in Guizhou province. It lies on the lower reaches of the Yijiehe river, feeding into the Liuchonghe river with two collapsed dolina named Dacaokou and Xiaocaokou respectively.

Zhijin Cave, 4215 m in length with only one entrance, is made up of five major passages. The widest section is 150 m with general widths at 30–50 m. The highest ceiling is 65 m, normally 20– 40 m. The largest chamber is some 46200 sq.m in area where breakdown occurred widely. With a great range of cave water levels between the wet and dry seasons and intense neotectonics, large scale collapse occurred. The top level passage was partly connected with the next lower one, which gave rise to some large chambers.

There is a good range of speleothem types of different forms in the Cave, such as mushroom–, petal– and cone–shaped stalagmites. More than 100 stalagmites with a height of over 40 m and various columns are normally several to tens meters in diameter. One petal–shaped stalagmite with 14.7 m in height and 0.3–1.2 m in diameter is very beautiful and unusual. Most of the small, beautiful, pure speleothems and some helictites are deposited on these large stalagmites, columns and fallen stalagmites, such as rod–, bamboo–, petal– and mushroom –shaped forms and some helictites.

Zhijin Cave developed in the Triassic carbonate rocks, the structural control is responsible for most of the passages, leading NNE–SSW and NE –SW. In addition, the bedding planes play an important part in determining the location of the inclined passages. The cave area is a complete unit closed by either impermeable layers or structures with an area of 48 sq.km.

Zhijin Cave has been openned to the public since 1985 and attracted tourists more than 400 thousands.

Starting from Guiyang, the capital of Guizhou province, it can take you two ways to get there.

– Guiyang via Anshun to the Cave 100 km along the expressway from Guiyang to Anshun and then change the bus 120 km from Anshun to Zhijin Cave.
– Guiyang to Zhijin Cave 170 km by bus directly.

JIN Yuzhang

Lunan Stone Forest

Lunan Stone Forest with an area of some 912 sq.km is situated 85 km to the southeast of Kunming city, the capital of Yunnan province.

People can only get there from Kunming by bus. The area includes hundreds of sceneries like Major, Minor and Naigu Stone Forests, Zhiyun Cave, Jibailong Cave, Qifeng

Cave, Lunar lake, Long lake, Round lake and Big waterfall, etc. The Major and Minor Stone Forest, the reputed "first wonder in the world", 15 km NE from Lunan, are easily accessible by a second–rank highway.

The Naigu Stone Forest at 9 km NE of the Major Stone Forest is uniquely shaped like mushrooms, screens etc.

There are about 84 karst lakes, the Lunar lake, Long lake, Round lake and White Cloud lake are wide–spread in Lunan region, linking together with various highway or the country road nearby.

The Big waterfall 19 km SW from Lunan county flows down over 90 m, known as the most spectacular waterfall in Yunnan province.

Regarding the underground karst, there is a cave group of Zhiyun Cave, Jibailong Cave, Qifeng Cave and a newly discovered Shima Dragon Palace with an underflowing over 100 m.

Lunan Stone Forest is famous , as mentioned above, for its characteristic scenery all over the world. Not only is it affracting the internal and foreign tourists, but also more karst scientists.

The altitude of stone forest areas varies from 1750 m to 2000 m, they can be developed whether at the top of hillock or the bottom of the uvala and doline, but most of them at the top and slope of the hillock. The Stone Forest consists of karren, according to their dimension they can be divided into two kinds: the karren with a height ranging from 1 m to 5 m or so, and distributed from 1890 m to 2000 m above sea level ; the other with a height from 2–3 m to over 10 m, while some of them at the bottom of doline are up to a height of 20–30 m, often showing the trace that the lower part of the corroded karren has been covered with soil. The area belongs to the subtropical plateau monsoon climatic zone, it can be divided into dry and humid seasons every year and the whole year is springlike. The annual average temperature is 15.6 C and the annual precipitation is 962.5 mm.

The analyses of the origin of stone forest are as follows:

– Early Permian carbonate rocks

The Stone Forest can be developed both in limestone and dolomite, and with concretionary chert or with dolomitic consitituent as well, it can be also developed in the carbonate rocks with many different texture–genesis types. It can be seen that there is not any relationship between the constituent or texture of carbonate rock and the karren in Lunan Stone Forest area.

The single thickness of carbonate rock layer may be related to the form and development of Stone Forest.

In general, the network fracture is more sparse in the thick layer than in the thin one. The root of karren, like the mushroom– shaped stone forest, is thinner than the upper part, this is because the root is composed of gentle strata with mainly the middle thick layer and the thick layer on the up part, causing the influence of differential density of fracture.

– The system of structure fissure and stratigraphic occurrence.

In the shape of gentle space is an important factor to form the Stone Forest. If the carbonate rock mass is under the tectonic stress and the rock mass in profile forms

a series of oblique fissure, the weak plane of rock mass would share with the plane of strata and the oblique fissure would be diffcult to keep such a tall karren remaining stable.

The dip of carbonate rock formation in Lunan Stone Forest area is mostly 5 or even below 5 . The network of rock fracture is formed by vertical fissure.

– Subsoil corrosion in the vadose zone.

It is no doubt that karren is the production in the process of karren corrosion , the corrosion of exposed carbonate rocks by raining and those by covering soil. The development of karren covered with soil is very important, and usually occupies half of the karren, even more than 2 / 3 in height. The evidence of corrosion by covering soil are the undercut, through hole and solution notch on the karrens which result from the increasing corrosion by vadose water being rich in organic carbon dioxide. It can be shown that the traces of the solution pan (kamenica) are formed by soil patch –like on the carbonate rock surface; and after the soil removed, the solution notch remains and is formed by marginal corrosion. Having not flown freely, the vadose water flows along the rock wall contacting with soil to carry on the corrosion. The through hole with sharp wall is formed between two solution notches in the subsoil.

JIN Yuzhang

Tenglongdong Cave

Ever since 1980s, Tenglong Cave within the boundaries of Lichuan city, Hubei province, has been paid close attention by world–wide tourists and speleologists.

Lichuan city situated at 30 N and 109 E belongs to the Enshi Tujia and Miao Autonomous Prefecture.

The city extends over an area of more than 4600 sq. km. It is a mountainous area, some summits exceed 2,000m a.s.l. but most of them are between 1,100 and 1,500 m, the lowest point of the city being only 300 m a.s.l. Near the city streams the Qingjiang river.

There flows one of the most important tributaries of the Yangtze river. Downstream of the city, the Qingjiang disappears and turns into an underground stream for a distance of some 10 km as the crow flies. The big underground stream caused the development of an enormous cave system, Tenglong Cave.

Tenglong Cave located in upper reaches of Qingjiang river over 1000 m a.s.l. is now one of the popular tourist lines for its power and grandeur. With a measured lengh of over 34 km is the longest cave of China at present.

Since limestone is most abundant in western Hubei, an extensive karst has been developed. The karst landscape is typical for south– central China, classified as a 〃 qiufung–uvala 〃 mountain landkarst.

Qinfung is the indication for conekarst with gently sloping hills. Due to its geographical position, Lichuan possesses a mild and agreeable climate and the seasons are well marked, belonging to monsoon system. Its annual temperature is about 12.9℃ and around 20℃ on an average per day in summer.

From Lichuan, the Qingjiang river flows northeastwards between the steep slopes of wooded hills over some 6 km and disappears in a huge tunnel after a spectacular waterfall

of more than 10 m with the lower entrance there.

In the same cliff there is also an upper entrance to the Monster's palace. This ancient entrance is still huger than the lower one and reaches a width of 50 m, a height of some 70m.

The main upperentrance of the cave gives access to the upper level. It is the most developed, as well in length as in volume, including several km of galleries, frequently exceeding 50 m in height and 40 m in width. These two entrances present the upstream access to the cave: the present–day ponor and the ancient one. In the same area however, three other cave entrances can be found, named Fish Cave (Nianyudong) which is in fact a window on the main river, Oxnose Cave (Niubizidong) and Cold wind Cave (Liangfendong).

The Qingjiang rushes in the Cave with a velocity and a power preventing any attempt of navigation. The river makes a tremendous noise and occupies the whole bottom of the gallery most of the time and sometimes even disappears into a sump.

The upper and lower levels of the cave systems are connected by several inclined passages, but in some places, the lower level can also be reached by very beautiful pitches opening in the dry valley, like Xiangshuidong and Longgudong. There is a stream from a resurgence –Black Cave to Liangqiao Dam 3.5 km from down reaches and 0. 2 km from Black Cave to Longdan Stream suitable to drift for its shallow and rapids.

The dry valley, lying above the Cave between the entrance of the water and the resurgence is very uneven and varied, sometimes wide, more often narrow and gorge–shaped, it displays a broken ground profile with dolines and lakes.

A newly–found Yulong Cave was explored on a mountain 1200 m a. s. l. in south bank of Xuezhaohe river. There is a main cave of 635 m in length, an average width of some 12 m and an area of about 6545 sq.metres. The Cave is protected so well that many developed speleothems have ever been destoryed and polluted.

Four possible ways can be taken to reach Lichuan:

- From Wuhan (Hubei province), one can reach Enshi by air and from there by bus Lichuan only 97 km.
- From Chongqing (Sichuan province) , which can be reached by air from Beijing, one can travel downstream by boat to Wanxian and then to Lichuan by bus.
- From Dayong(Hunan province), which is famous for its pseudokarst landscape of the Zhangjiangjie National Park, by air or by train. From there, one reaches Lichuan by a busride of about 300 km.
- From Yichang, which can be reached by air or by train from Beijing, it takes you one day and two nights along the Yangtze river by boat to Wanxian, about 340 km upstream and then by bus to Lichuan.

JIN Yuzhang

Yaolindong Cave

Yaolin Cave, one of the best tourist attraction and the second site of new developing natural landscapes in China, is located in Touglu county about 90 km southwest from Hangzhou, the capital of Zhejiang province, at 29 ° 53′N and 119 ° 32′E. The modern climate belongs to mid–subtropical with an annual average temperature of 16. 7 C and an annual precipitation of 1400 mm. The Cave lies under the Luotuoshan karst hill, and its expedition can be traced back as early as in the Sui–Tang dynasty(A.D. 581–907). The ancient poets extolled its enchantment and written on the Cave wall. But it was buried until September 1979 to begin the exploitation.

The Yaolin Cave developed in Carboniferous and Permian pure carbonate rocks which CaO content up to 50–54 %. The Bipu syncline with major structural line of NNE controls the strike of the main cave. The main passage is 960 m long with an average width of 26 m but widest 70 m, mean height of 10 m but highest 22 m, total area of 26180 sq. m and total volume of 353100 cubic m. This cave includes six chambers and an underground river connects the multi–leves of active large cavern.

The Yaolin Cave developed from Mid– Pleistocene, and the oldest speleothems have been dated 350 ka BP by U series. Due to the climatic and base level variation in the Quaternary, the evolutionary process of the cave has undergone four stages:

– Separate pocket – like cave development stage which developed isolated cave in the phreatic zone to form the first high cave;
– Dispersed extension stage when neotectonic movement uplift brought the caves near the groundwater table and continued solutional enlargement under humid and hot climate, as the Juxianzhong speleothems oxygen isotope temperature of 22℃ in 134 ka BP;
– Connecting stage in the middle Wurm stronger interglacial solution which extended successively near the surface of phreatic zone, and connected 1–6 chamber and a young subterranean stream was formed with the velocity 15–43 cm / s;
– Modern underground river development stage, it was cold and dry in the end of late Pleistocene and the East Sea level fell to 150– 160 m in response to the cave incised downward, leading to the cave′s roof collapsing on a large scale, but in the middle Holocene the temperature once increased, the underground river continued extension and formed a lower level conduit near the phreatic surface.

The modern enviroment in Yaolin Cave is as follows: The air temperature is stable at about 17℃, yearly difference is 0.1–0.3℃ and highest change never exceeds 1.2℃, the intensity of temperature invesion of 0.2–0.5℃ / 10 m and the relative humidity more than 95 %; The contents of environmental tritium isotope in groundwater are 39–64 TU; There are 40 species of cave animals living in the cave.

LIN Junshu

EXCURSION COURSES AND NUMBER OF PARTICIPANTS

PRE–AND POST–CONGRESS EXCURSIONS

Excursion courses	Number of participants
No.3 High and frigid tufa landscape of Jiuzhaigou–Huanglong on the eastern rim of Qinghai–Tibert Plateau	
B. July 24 – 31	10
A. August 9 – 16	3
No.10 Stone forest–karst landscape on plateau and caves in Yunnan	
B. July 24 – 31	7
No.15 Caving in north Guangdong	
B. July 27 – August 1	13
No.16 The route " Guilin–Yangshou "	
B. July 27 – 31	20
A. August 9 – 13	25
N0.17 The route " Nanning–Ningming–Liuzhou–Guilin "	
A. August 9 – 15	13
No.18 Cave in temperate zone, Longmen Grottoes and ancient capital – Xian	
B. July 25 – 31	9
A. August 9 – 15	14
No.20 Karst on high latitudes and coast in China	
A. August 9 – 14	8
No.24 Trip to the high plateau karst, Jinshajiang deep canyon, Naxi minority matrilineal society and Yuanmou earth forest	
A. August 9 – 17	13
	Total : 135

ONE DAY MID–CONGRESS TRIPS

Trip routes		Number of participants
D.1	Shihuadong Cave and Tanzhe Temple	33
D.2	Yinhudong Cave(Silver fox Cave)	47
D.3	Zhoukoudian Cave and the Peking Man Museum	24
D.4	Yunshuidong Cave and Jumahe river karst landscape	46
D.5	The Great Wall and The Ming(A.D. 1368–1644) Tombs	140
D.6	The Summer Palace and Xiangshan Mountain	34
D.8	The Palace Museum (Forbidden City) and The Tien An Men Square	19
D.10	Liulichang Traditional Cultural Street and Lama Temple	18
		Total : 361

ASSEMBLY OF MEMBER COUNTRIES OF UIS

NEWLY ELECTED BUREAU OF UIS

President	Paolo FORTI	Italy
Vice–President	Julia JAMES	Australia
	J.Ayton LABEGALINI	Brazil
Secretary–General	Pavel BOSAK	Czech
Secretaries–Advisory	Petar BERON	Bulgaria
	Stephen A.CRAVEN	South Africa
	Andy EAVIS	Great Britiain
	Alexander KLIMCHUK	Ukraine
	David LUCKINS	United States
	J.Guadalupe PALACIOS	Mexico
	Urs WIDMER	Switzerland
	ZHANG Shouyue	P.R.China

THE CONGRESS' STORY

The XI International Congress of Speleology was held in Beijing, China from 2 to 8 August, 1993, under the sponsorship of the Chinese Academy of Sciences, the National Natural Science Foundation, the Geological Society, the Geographical Society, the Zoological Society and the Soil Science Society of China. The President was Professor WANG Sijing and the Organizer Professor ZHANG Shouyue.

The Congress was held in the Institute of Science and Technology Information of China. Five pre– congress excursions and six post –congress excursiobs were successful. A little bit less than 300 people attended the Congress, where some 120 papers and 12 posters were presented.

The one–day mid–congress fieldtrips deserved a great success, as well as the receptions and final banquet. The welcome and the organization were very fine and the two General Assemblies were held the first and the last days in excellent conditions.

Many presidents of Commissions were unhappily absent, and the meetings of most of the Commissions attracted only a rather reduced attendance.

On the other hand, the International Speleofilm, Video and Speleoslide Competition had a great succes, and the winners were rewarded by beautiful prizes, mainly original cups.

Prof. Camille EK
Secretary General of UIS

SUMMARY OF PARTICIPATIONS

ALPHABETICAL LISTING OF REGISTRANTS AT THE XI ICS

Country and Name	Membership	Address
Argentina		
BENEDETTO Carlos	C.	Casilla de Correo 103 (5600) San Rafael–Mendoza
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REILLY Stephen	F.	Gottage 2, Jenolan Caves, N.S.W. 2790
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WHITE Nicholas James	F.	
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OEDL Friedrich	F.	A–5020 Salzburg, Getreidegasse 21
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Brunei

ROBINSON Lynn	L.	ODE / 54, BSP, Seria
THOMAS Vaughan	L.	idem

Bulgaria

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KO King Tjoen	F.	JI Ir H Juanda 30 Bogor
SUWESTA Awey	L.	idem

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FORTI Laura	A.	
BENELLI Vanda	A.	
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IACONO Giovanna	L.	idem
LEANTI LA ROSA S.	L.	idem
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GALLETTI Iolanda	A.	
SAMMITO Giorgio	L.	idem
SANTORO Vito	L.	idem
ZACCARIA Giancarlo	L.	idem
ZORZIN Roberto	C.	Museo Civico di Storia Naturale, Sezione di Geologia E.

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KASHIMA Masako	A.	
UENO Shun–Ichi	F.	Department of Zoology, National Science Museum (Nat.
UENO Yoshiko	A.	Hist) 3–23–1 Hyakunin–cho. Shinjuku. Tokyo 169
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Annotations of Membership:

F. —— Full right; S. —— Student; O. —— Organizer.

A. —— Accompany; C. —— Corresponding;

L. —— Limited right; G. —— Guest;

ATTENDANCE OF THE CONGRESS BY COUNTRY AND PARTICIPATION FORM

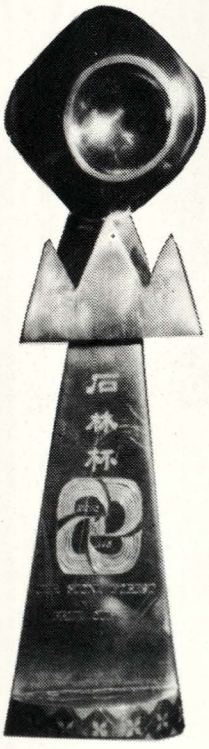
Country	Participation form							
	Full	Accomp.	Limit.	Student	Corresp.	Guest	Organizer	Others
Argentina					2			
Australia	8	2	2		1	1		
Austria	3	2				1		
Belgium	1	1				1		
Brazil	10	2	2					
Brunei			2					
Bulgaria		1				1		
Canada	1							
China	55		7	1		4	25	
Cuba	2					1		
Czech	3	2				2		
France	12	5	1					
Germany	2	1	2					
Greece	1							
Guatemala			1					
Hungary						2		
Indonesia	1		1					
Italy	3	7	6		1	1		
Japan	3	2						
Lebanon	2							
Lithuania								1
Mexico	1							
Netherlands	2	2		1				
Norway	1							
Portugal				2				
Russia	4							
South Africa	2	1						
Slovakia	1							
Slovenia	1					1		
Spain	3							
Sweden	3	2						
Switzerland	5	1	1	1	1			2
Turkey	1							
United Kingdom	1	5				1		
United States	15	10	1		1			
Total	147	46	26	4	7	16	25	3

VARIOUS OPINIONS OF THE CONGRESS

SEE YOU IN SWITZERLAND IN 1997!

AUTHORS INDEX OF PROCEEDINGS AND SUPPLEMENT

Prize–Giving at Closing Ceremony



Above left: WANG Huaiji, manager of Stone Forest Scenic Spot, awarding the Stone Forest Cup for Video to G.FAVRE (Swiss).
Above right: A copy of Zhijindong Cup to the Organizing Committee by HE Shirong, manager of the Cave.

WANG Weicheng awarding the Yaolindong Cup to J.A.LABEGALINI (Brazil), the Speleoslide's winner.

Tenglongdong Cup awarded by ZHOU Hua, the Cave manager, to U. WIDMER (Swiss), the winner of Album Series.

Opening Ceremony of the XI ICS

Above right: Hubert TRIMMEL, the President of UIS, addressing welcome at the Opening Ceremony
Below middle: Plenary Meeting
Left (from left to right): Julia JAMES, Camille FK, ZHANG Shouyue and LIU Dongsheng.
Below left: XU Zhihong
Below right: HU Zhaosen